

Determinants of Farmers' Decision of Soil Fertility Management Options for Maize Production in Southern Ethiopia

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ABSTRACT

In Ethiopia, food insecurity has always been a burning problem. The gap between demand for and supply of food can be minimized through protecting and managing soil fertility and thereby increasing productivity of crops. This study was conducted in major maize growing areas of southern Ethiopia. The objectives of the study were to assess soil fertility management options available to smallholder farmers and identify the factors that affect their decision making to apply a given alternative in maize crop. The study was based on the cross sectional data obtained from a random sample of 385 smallholder farmers. A multinomial logit model was employed to identify socioeconomic, institutional and environmental factors determining farmers' decision regarding the choice of a particular soil fertility management option. The result indicated that size of farm, access to credit, availability of extension services and training pertaining to soil fertility management were important factors affecting the decision to use a particular soil fertility management practice.

Keywords: Maize, multinomial logit model, Southern Ethiopia, soil fertility management

1. INTRODUCTION

Land degradation and decline in soil fertility have become serious threats to agricultural productivity in Sub-Saharan Africa. The declining fertility of soils because of soil nutrient mining is regarded as a major cause of decreased crop yields and per capita food production in Africa; and decreasing soil fertility accompanied with increasing population pressure is one of the major causes of the gap between demand for and supply of food (Henao and Baanante, 2006; Adane, 2007). The use of chemical fertilizers has been considered as crucial to boost crop productivity specifically that of cereal crops. Soils in most of the Sub-Saharan Africa have inherently low fertility and do not receive adequate nutrient replenishment (FAO, 2001; Chinangwa, 2006).

In southern Ethiopia, various attempts have been made for about four decades to restore the fertility of degraded arable land since the early 1970s. The aim of these efforts was improving the crop and livestock productivity and increasing the production of raw materials for domestic use and foreign export. Greater emphasis was given to promote the use of modern inputs such as improved seeds and chemical fertilizer. Facilitating the provision of fertilizer and promoting soil fertility replenishing technologies received continued importance in all past extension programs. These efforts, however, have not helped much in increasing agricultural productivity and production in the Wolaita and Gofa area of southern Ethiopia as it can be portrayed from ever worsening food insecurity and pervasive poverty (World Bank, 2011). The areas are highly food insecure due to a combination of factors including high population pressure, low soil fertility and

frequent rainfall irregularities (USAID, 2004). The level and extent of use of soil fertility maintaining technologies remains low and the gains in productivity were far from expectations.

Maize is major staple and cash crop produced in Ethiopia in greater extent than any other crop (CSA, 2010). In the package of production practices recommended for improvement of maize productivity, fertilizer is recommended as a key input. However, its application has been low due to a number of factors that influence the decision of smallholder farmers in choosing soil fertility management practices. Efforts that reduce the risks and uncertainties farmers face in choosing the appropriate soil fertility management options and enhance their decision-making capabilities remain to be investigated. This study was, therefore, undertaken to assess the soil fertility management decisions of smallholder farmers in southern Ethiopia and identify factors influencing the choice of alternative soil fertility management options.

3. METHODOLOGY

The study areas: This study was carried out in Wolaita and Gamo Gofa zones of Southern Nations, Nationalities and Peoples Region (SNNPR) of Ethiopia. Wolaita zone encompasses agro-ecologies of high, middle and low altitude land areas with proportion of 9; 56; and 35 percents, respectively, distributed in 12 districts. The zone has asphalt and all weather roads which interconnect the entire 12 districts with exits to neighbouring zones and regional capital or all central parts of the country. Wolaita Sodo, which is the capital of the zone, is situated at about 390 km from Addis Ababa on the line through Shashemene to Arbaminch. With rainfall dispersed throughout the year into two main rainy seasons and small showers in dry months, there is usually some crop growing in the fields or home garden. It is an area of intensive agriculture; where farming system combines annual and perennial crops. The use of improved soil fertility management practices such as chemical fertilizer and compost has been in place in the zone for more than four decades since the time of Wolaita Agricultural Development Unit (WADU), a World Bank financed project, which introduced improved agricultural technologies in the area.

Gamo Gofa zone is situated bordering Wolaita and has wider agro-ecological and socio-cultural settings. The general elevation of the zone ranges from 600 to 3300 meters above sea level. Arbaminch is the capita town of the zone, located at 505 km from Addis Ababa. This study was concentrated in Gofa area of Gamo Gofa zone located west of Arbaminch town behind the humid mountainous highland agro-ecology dissecting the mid and lowland agro-ecologies. This area was specifically selected from the zone for the study on the basis of its high extent of maize production and representativeness for maize producing areas. It is located some 140 km south from Wolaita Sodo. There are seven districts in this area having high, middle and low altitude land areas. The level of use of chemical fertilizer and other improved soil fertility management practices in this area is very low even though there has been continued effort by the government's agricultural extension program for more than a decade. Most farmers are still reluctant to the use of chemical fertilizer despite the fact that fertilizer use has been promoted by the government. Even though farmers recognize some yield advantage over the local practice, they believe it is not sufficient enough to cover the high cost of fertilizer due to low market price of maize output.

Sampling procedure and the data: In order to select sample households, multistage sampling technique was followed. In the first stage, study districts were purposively selected based on the extent of maize production. The numbers of districts selected were two each from Wolaita and Gofa areas. In the second stage 2-3 villages where different soil fertility management practices have been promoted by extension agencies were selected from each district based on the discussion with district agricultural extension service officers. Finally sample farmers who have been participating in the soil fertility management efforts were randomly selected from each village to administer the survey.

The sample size for the study was determined based on the following formula given by Israel (1992).

$$n = \frac{Z^2 pq}{e^2} \quad (1)$$

where n = the sample size needed,

112 Z = the inverse of the standard cumulative distribution that corresponds to the level of
 113 confidence,
 114 e = the desired level of precision,
 115 p = the estimated proportion of an attribute that is present in the population and
 116 q = 1-p.

117 With the assumption that there is large population but we do not know the variability in the
 118 proportion about the use of soil fertility management practices, p = 0.5 was considered as
 119 suggested by Israel. Based on this, a total of 385 households were selected for the study
 120 assuming a 95 percent confidence level and ± 5 percent precision. The households were selected
 121 from each village using random sampling method. The dataset contained detailed information on
 122 household's socioeconomic and demographic characteristics, farm characteristics, input utilization
 123 and institutional as well as policy related variables.

124
 125 **Conceptual framework and empirical model:** The conceptual framework for analysis of soil
 126 fertility management decisions is based on the approach to consumer theory developed by
 127 Lancaster (Lancaster, 1966). It is assumed that the choice of soil fertility management option is an
 128 activity in which the alternative options, singly or in combination, are inputs in which the output is a
 129 collection of characteristics. The neoclassical economic theory assumes that each decision-maker
 130 is able to compare two alternatives *a* and *b* in the choice set using a preference-indifference
 131 operator $\geq$. If $a \geq b$, then the decision-maker prefers either *a* to *b*, or is indifferent. Utility rankings
 132 are therefore assumed to rank collection of alternatives indirectly through the characteristics that
 133 they possess. A given soil fertility management option embodies a number of characteristics that
 134 may influence choice decisions. In addition, given characteristics of alternative soil fertility
 135 management outcomes, other socioeconomic and demographic characteristics of the farm
 136 household may influence the choice of an option. Then the observed choice for an alternative soil
 137 fertility management option is likely to be the result of a complex set of interactions between
 138 comparable alternatives and farmers' socioeconomic and demographic characteristics.

139
 140 Soil fertility management decisions involve choices between alternative management practices. A
 141 multinomial logit (MNL), therefore, can be used to analyse the decision behaviour of smallholder
 142 farmers in using soil fertility management technologies. The dependent variable (in this case the
 143 choice of soil fertility management options) is a discrete variable with J+1 alternatives (j = 0, 1, 2...
 144 J). Multiple response choice models, such as MNL and multinomial probit (MNP), are more
 145 desirable compared to binomial logit and probit models in that they allow exploring factors
 146 conditioning specific management practices as well as combination of management practices.
 147 These models estimate the effect of explanatory variables on a dependent variable involving
 148 multiple choices. This study used a MNL model to analyse the soil fertility management decisions
 149 of smallholder farmers involving multiple unordered discrete dependent variables based on the
 150 specifications by Greene (2003). The MNL model is based on the random utility model. The utility
 151 to a user of an alternative is specified as a linear function of the household and the farm specific
 152 characteristics, the attributes of alternative institutional factors as well as a stochastic component.
 153 The probability of choosing an alternative is equal to the probability that the utility of that particular
 154 alternative is greater than or equal to the utilities of all other alternatives in the choice set.

155
 156 The soil fertility management choices included in the model were Chemical Fertilizer only (CF),
 157 Farmyard Manure only (FYM), Compost only (COM), Crop rotation only (CRO), crop residue
 158 (CRE), integrated soil fertility management (ISFM) and no soil fertility management (NO). Thus,
 159 the dependent variable was defined as a discrete variable taking values 0, 1, 2, 3, 4, 5 and 6
 160 representing the above choices. The MNL provides a set of probabilities for the J+1 choice set for
 161 a farmer with characteristics X_i as follows.

$$162 \text{ Prob}(Y_i = j | X_i) = \frac{e^{\beta_j X_j}}{1 + \sum_{k=1}^J e^{\beta_k X_k}} \text{ for } j = 0, 1, 2 \dots j, \beta_0 = 0 \quad (2)$$

163 The MNL model assumes that the odds for pair of outcomes are determined without reference to
 164 the other outcomes that might be available. This is known as the independence of irrelevant
 165 alternatives (IIA) property. Hausman and McFadden (1984) proposed a Hausman-type test of this
 166 hypothesis. Basically, this involves the following steps. First, estimating the full model with J

167 outcomes included; these estimates are contained in $\hat{\beta}_F$. Secondly, estimating a restricted model
 168 by eliminating one or more outcome categories, these estimates are contained in $\hat{\beta}_R$. Finally,
 169 assuming $\hat{\beta}_F$ as a subset after eliminating coefficients not estimated in the restricted model.

170

171

172 The Hausman test of IIA is defined as:

$$173 \quad H_{IIA} = (\hat{\beta}_R - \hat{\beta}_F^*)' [\hat{Var}(\hat{\beta}_R)]^{-1} (\hat{\beta}_R - \hat{\beta}_F^*) \quad (3)$$

174 where H_{IIA} is asymptotically distributed as chi-square with degrees of freedom equal to the rows

175 in $\hat{\beta}_R$ if IIA is true. Significant values of H_{IIA} indicate that IIA property has been violated.

176 Hausman and McFadden noted that H_{IIA} can be negative and a negative H_{IIA} is evidence that

177 IIA holds. The log-likelihood can be derived by defining, for each farmer, $d_{ij} = 1$ if the soil fertility

178 management alternative j is best preferred by the farmer i and 0 if not, for the $J-1$ possible
 179 outcomes. Then for each i , one and only one of the d_{ij} 's is 1.

180

181 The parameter estimates of the MNL model provide only the direction of the effect of the
 182 independent variables on the dependent variable, but estimates do not represent either the actual
 183 magnitude of change nor probabilities. Differentiating equation (2) with respect to the explanatory
 184 variables provides the marginal effects of explanatory variables on soil fertility management choice
 185 variable. Accordingly, the marginal effects of characteristics on the probabilities can be obtained by
 186 differentiating equation (11) as follows:

$$187 \quad \delta = \frac{\partial P_j}{\partial X_i} = P_i \left[\beta_j - \sum_{k=0}^j P_k \beta_k \right] = P_j [\beta_j - \bar{\beta}] \quad (4)$$

188 where $\bar{\beta} = \sum P_j \beta_j$ is a probability weighted average of the β_j . The signs of the marginal effects

189 could be different from the signs of coefficients due to $\bar{\beta}$.

190 **Variable specification:** The decision to choose a particular soil fertility management option
 191 depends on agro-ecological, farmer and farm specific as well as institutional factors. These factors
 192 include the agro-ecological location of farm household, sex of household head, livestock holding of
 193 the household, farm size, number of farm plots, use of hybrid maize variety, extension visit,
 194 distance from farm to village development centre, training received on the use of improved soil
 195 fertility management, off/non-farm income and access to credit.

196

197 The agro-ecological variable takes values 1, 2 and 3 for high, middle and low altitude land areas,
 198 respectively. Sex of household head is a dummy variable which takes the value 1 for women
 199 headed and 0 for men headed households. Total livestock holding of the household is measured
 200 as a continuous variable in terms of the tropical livestock unit (TLU). Farm size refers to the total
 201 land available to the household as cultivated, fallowed, grazing, and tree land measured in
 202 hectares. The variable number of plots represents the total number of plots available to the
 203 household in separate locations.

204

205 The use of hybrid maize seed is measured as a dummy variable taking the values 1 if the farmer
 206 has planted hybrid maize seed and 0 otherwise. Extension visit refers to availability of extension
 207 service to the farmer taking values 1 if the extension agent has visited farmer's field during the
 208 cropping season from the beginning to the end and 0 otherwise. The distance from farm to village
 209 development centre is measured as continuous variable in hours taken to walk from farmer's
 210 residence to the village development centre. Training received on the use of improved soil fertility
 211 management is measured as a dummy variable taking values 1 if the farmer has received such
 212 training and 0 otherwise. Off/non-farm income is a continuous variable measured in birr
 213 representing total income earned from off-farm and non-farm sources. Access to credit is
 214 measured as a dummy variable taking 1 if the farmer has received credit for maize production and
 215 0 otherwise.

216

4. RESULTS AND DISCUSSION

Soil fertility management decision outcomes: Farmers in the study areas apply different soil fertility management practices to produce maize depending on their choice which is a function of several natural, socioeconomic and institutional factors. These soil fertility management options include the use of practices such as chemical fertilizer only, farmyard manure only, compost only, crop rotation, crop residue and integrated soil fertility management. However, about 12 percent of sample farmers applied no soil fertility management practice at all. It can be depicted from Table 1 that about 82 percent of the sample households used either chemical fertilizer or integrated soil fertility management for maize production.

Table 1. Soil fertility management practices used by farmers for maize production

Soil fertility management practice	Frequency	Percent
No soil fertility management (NO)	45	11.7
Chemical fertilizer only (CF)	157	40.8
Farmyard manure only (FYM)	13	3.4
Compost only (COM)	6	1.6
Crop rotation (CRO)	1	0.3
Crop residue (CRE)	4	1
Integrated soil fertility management (ISFM)	159	41.3
Total	385	100

Determinants of farmers' decision of soil fertility management: The result pertaining to MNL model on soil fertility management decisions are presented in Table 2. The results reveal that the use of chemical fertilizer was significantly influenced by agro-ecological zones, sex of household head, family size, use of hybrid maize seed, training received on improved soil fertility management practices and access to credit. Agro-ecological location of the household rated from high to low altitude areas in an ascending order negatively and significantly influenced the use of chemical fertilizer at less than one percent significance level. This suggests that farmers in extreme low altitude land areas are unlikely to use chemical fertilizer due to the perception that their soils are fertile and due to uncertainty of rainfall, they may not take risk to spend on fertilizer.

Table 2. Empirical results of soil fertility management decisions based on MNL model

Variable	CF	FYM	COM	CRO	CRE	ISFM
AGROECO	-1.356***	-0.995	-0.328	594.435	19.849	-2.807***
SEX	-24.267***	-24.036***	2.650	-4726.385	-7.755	-23.328***
TLU	0.048	-0.267	0.190	-810.609	-0.828	0.029
FARMSIZE	0.712**	0.253	-1.035	920.801	1.813**	0.481
NUMPLOTS	-0.1918	-0.158	-20.143***	-1509.155	.054	-0.222
HYV	1.3279***	-0.370	-4.184	1032.973	.265	1.131***
EXTVISIT	1.657***	-0.574	1.686	478.345	1.693	1.157
DISTDC	-0.690	-0.901	-1.166	522.779	0.924	-0.862
TRAINSFM	0.977**	1.637*	0.143	10875.23	-0.246	1.332***
OFFINCOME	0.0002	0.0004*	0.0004	0.713	-0.002	0.0002
CREDIT	1.625**	0.132	-43.627	5594.295	-43.070	1.376**
Constant	25.569	25.509	16.375	-13617.74	-54.777	28.629
Log likelihood				-348.83317		
Number of obs.				378		
LR chi ² (66)				227.36		
Pseudo R ²				0.2458		

***, ** and * indicate the level of significance at 1, 5 and 10 percent, respectively.

Sex of the household head was also highly significant and negatively influencing the use of chemical fertilizer at less than one percent significance level. Thus, women-headed households are less likely to use chemical fertilizers as compared to men-headed households. This could be due to the lower risk bearing capacity of women-headed households resulting from their meagre resource positions.

249 Farm size had a positive and significant effect on the use of chemical fertilizer at 5 percent level of
250 significance. Farmers with larger farms applied more chemical fertilizer than those with smaller
251 farms. This indicates that efforts that promote chemical fertilizer on larger farms are more effective
252 than on small farms to increase the level of use of chemical fertilizer and thereby increase maize
253 productivity. The use of hybrid maize seed had a positive and significant effect on the decision to
254 use chemical fertilizer to produce maize. There was a tendency on the part of farmers who planted
255 local maize varieties to opt for the use of other (or no use of) soil fertility management practices.
256 This implies that the use of chemical fertilizer is highly related to the use of improved maize seed
257 since the use of improved varieties requires the application of chemical fertilizer as part of the
258 package of technologies for maize production. Training received on improved soil fertility
259 management practices positively and significantly affected farmers' decision to use chemical
260 fertilizer at less than one percent significance level. This depicts that farmers who received training
261 on improved soil fertility management used chemical fertilizer for maize production than those who
262 did not participate in these trainings. Thus, increased efforts to train farmers on the use of
263 improved soil fertility management practices are likely to increase the probability and level of use
264 of chemical fertilizer for maize production. Access to credit had a positive and significant influence
265 on the decision to use chemical fertilizer at 5 percent significance level. This could be due to the
266 reason that easy credit availability tackles capital constraints faced by smallholder farmers to
267 acquire the purchased inputs, especially chemical fertilizer. Therefore, improving farmers' access
268 to credit during cropping times is crucial for increasing chemical fertilizer use.

269
270 The use of farmyard manure was highly influenced by sex of household head at less than one
271 percent level of significance. The negative relationship between the probability of use of farmyard
272 manure and sex of household head indicates that women-headed households had lesser labour to
273 transport farmyard manure for maize production which is located in the outfield. Furthermore, the
274 use of farmyard manure is restricted to the availability of livestock. As a result, the lower livestock
275 holding of women-headed households inhibits the use of farmyard manure. Training received on
276 the use of improved soil fertility management practices had a positive and significant effect on the
277 decision to use farmyard manure. This could be because trainings improve farmers' knowledge
278 and skill with regards application of available soil fertility management practices. Thus, increased
279 access to knowledge and skill required to better utilize farmyard manure is likely to improve the
280 probability of use of farmyard manure for maize production. Moreover, off/non-farm income had
281 positive and significant influence on the use of farmyard manure. This could be because there is a
282 possibility that the resources that are required to purchase chemical fertilizer for maize production
283 could be diverted to off-farm opportunities. Additionally, since there is no market for farmyard
284 manure and its alternative uses are limited, it is more likely to be used as a soil fertility amending
285 input for crop production.

286
287 The use of compost is only influenced by the number of farm plots the farm households possess.
288 The negative and significant relationship between number of farm plots and use of compost could
289 be related to bulkiness and labour demanding nature of compost. If there are many plots located at
290 different places, transportation and application of compost would be difficult. Therefore, farmers
291 with single or small number of farm plots in the study areas are more likely to prepare and apply
292 compost for maize production than those with fragmented and larger number of farm plots.

293
294 Farmers with larger farms in the study areas usually leave maize stalk after harvest and
295 incorporate it into soil while preparing the land for the next crop. This was revealed in the result
296 that the decision to use crop residue as a soil fertility management option for maize production was
297 positively influenced by farm size at 5 percent level of significance. Better management of crop
298 residue and use of it as soil fertility amending material is observed to more practical if extension
299 works concentrate on farmers with larger farms. The reason for this is that the quantity of crop
300 residue from smaller farms is low and could be totally taken up by other competing uses such as
301 livestock feed and fuel wood.

302
303 As to the application of integrated soil fertility management, the most important variables were
304 agro-ecology, sex of household head, use of hybrid maize seed and training received on improved
305 soil fertility management. Agro-ecological location of farm households had statistically significant
306 effect on the farmers' decision to use integrated soil fertility management at less than one percent
307 level of significance. The negative sign suggests that farmers in low altitude areas are less likely to

308 apply the integrated soil fertility management practice than farmers in middle and high altitude
309 areas.

310
311 The decision to use integrated soil fertility management practice was negatively and significantly
312 affected by sex of household head. Hence men-headed households are more likely to integrate
313 different nutrient sources for maize production than women-headed households. This could be due
314 to the resource limitation of women-headed households as discussed earlier. Hybrid maize seed
315 use had highly significant effect on the decision to use integrated soil fertility management at less
316 than one percent level of significance. This could be because the use of hybrid maize seed
317 requires farmers to use better soil fertility management as the high yielding varieties are high input
318 feeders. Moreover, government authorities who supply hybrid maize seed to farmers encourage
319 them to apply better soil fertility management practices to obtain better yields. Training received by
320 farmers on improved soil fertility management had a positive and significant effect on their decision
321 to use the integrated soil fertility management at less than one percent level of significance. This
322 implies that trainings on the use of the integrated soil fertility management farmers' through their
323 skill and knowledge enhancing effects are more likely to increase the level and extent of use
324 integrated soil fertility management practices. Access to credit was also important institutional
325 variable in significantly influencing farmers' decision to use the integrated soil fertility management
326 practices at 5 percent level of significance. This shows that improving farmers' access to credit
327 improves their ability to purchase the inputs required for integrated soil fertility management and
328 increases the probability of use of integrated soil fertility management.

329
330 **Effects of changes in determinant factors:** According to the MNL model results, the most
331 important soil fertility management decision outcomes of the sample farmers in the study areas
332 were chemical fertilizer, farm yard manure and integrated soil fertility management. The marginal
333 effects of significant explanatory variables on the probability of each of these outcomes were
334 computed and have been presented in Table 3. A change in agro-ecology from high to middle
335 altitude area or from middle to low altitude areas reduces the probability of use of chemical
336 fertilizer as a soil fertility management practice by about 31 percent. Moreover being woman
337 household head reduces the probability of use of chemical fertilizer by about 24 percent. A one
338 hectare increase in farm size would lead to 6.5 percent increase in the probability of use of
339 chemical fertilizer. A change in the use of hybrid maize variety from being non-user to user
340 increases the probability of use of chemical fertilizer by more than 8 percent.

341
342 A change in the variable extension visit from 0 to 1 would increase the probability of use of
343 chemical fertilizer for maize production by 16.5 percent. A change in status of the farmer from
344 being non-trained to trained farmer on the use of improved soil fertility management options would
345 result in 7 percent increase in the probability of use of chemical fertilizer. A change of household
346 from being non-user to user of credit service for maize production leads to more than 8 percent
347 increase in the probability of farmers' use of chemical fertilizer.

348
349
350

Table 3. Marginal effects of explanatory variables on soil fertility management decision outcomes

Variable	Marginal effects		
	CF	FYM	ISFM
AGROECO	0.313	0.015	0.379
SEX	0.237	0.003	0.190
FARMSIZE	0.065	0.005	0.046
HYV	0.083	0.034	0.010
EXTVISIT	0.165	0.057	0.057
TRANSFM	0.070	0.007	0.097
CREDIT	0.083	0.016	0.039

351
352 With respect to the marginal effects of explanatory variables on the decision to use farmyard
353 manure a change in the dummy variable sex from 0 to 1 would lead to a slight (0.3 percent)
354 decrease in the probability of the use of farmyard manure as a soil fertility management option for
355 maize production. A change in the training variable form 0 to 1 increases the probability of using
356 farmyard manure.

357

A unit change in agro-ecological location of household from high to middle altitude area or from middle to low altitude area would reduce the probability of use of integrated soil fertility management by about 38 percent. Similarly, a change in sex of household head from male to female reduces the probability of use of integrated soil fertility management by 19 percent. A change in the status of the household head from non-user to user of hybrid maize results in one percent increase in the probability of use of integrated soil fertility management. Likewise, a change in the values of dummy variables training and access to credit from 0 to 1 would result about 10 and 4 percent increase in the probability of use of integrated soil fertility management practices, respectively.

4. CONCLUSION

The study has identified different soil fertility management practices applied by farmers in the study areas including chemical fertilizer, farmyard manure, compost and integrated soil fertility management. Agro-ecological location of households had a significant influence on the use of chemical fertilizer and integrated soil fertility management. Accordingly, raising the awareness of farmers in the low altitude areas about the benefits of improved soil fertility management practices through field demonstrations needs to be emphasized. Efforts that improve output market performance are required to reduce lowland farmers' fear of risks in decision making. The probabilities of use of chemical fertilizer, farmyard manure and integrated soil fertility management were found to be less in the case of women-headed households. Efforts have to be made to improve women's access to credit and initiate women empowerment programs. Training played a significant role in farmers' decision to use chemical fertilizer, farmyard manure and integrated soil fertility management for maize production. Hence, improvement of the quality and coverage of focused training programs should be undertaken to improve soil fertility. Size of farm and number of farm plots were also important factors that influenced farmers' choice of soil fertility management technologies. This suggests the need for consolidation of farm plots to increase farm size and concentration of efforts that promote the use of improved soil fertility management practices on farmers who have few or single large plots.

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