CHAPTER VI

FACTORS AFFECTING THE ADOPTION OF CHEMICAL FERTILIZERS IN MAIZE CROPPING SYSTEMS

This chapter presents empirical results concerning factors determining the adoption of chemical fertilizers and different levels of chemical fertilizer adoption in maize cropping systems in the study area.

6.1 Logit model for the adoption of chemical fertilizers

This analysis was conducted to identify socio economic, institutional and physical factors related to the adoption of chemical fertilizers. The dependent variables took the value of 1 if the household used chemical fertilizers and 0 otherwise.

These binary responses (0 or 1) can be modeled with binary logit and probit regressions. In order to explain the behavior of this type of dichotomous dependent variable, we have to choose a cumulative distribution function. While logit model uses cumulative logistic function; probit model uses the normal cumulative distribution function. But the results of logit analysis can be easily interpreted and method is simple to analyze (Bacha *et al*., 2001). Therefore, logit model was used in this study to identify the factors affecting to the adoption of chemical fertilizers.

Independent variables that were hypothesized to affect the adoption of chemical fertilizers included the characteristics of household head such as age, education, membership in a farmer organization, experience in maize cultivation and number of extension officers' visit within a season. In addition, it was also included some

characteristics of households such as total maize area, average land-labor ratio, off farm income, number of livestock, variety, yield, borrowed capital and also methods of threshing, and finally two townships as a physical factors.

The results of logistic regression to analyze the effect of these variables on the adoption decision of households' to chemical fertilizers application are presented in Table 6.1.

Table 6.1 Logistic regression analysis for the adoption of chemical fertilizers in maize cropping system

Variables	Coefficient (β)	Odds ratio (Expβ)	Probability
REGION (1 = Yatsauk, 0 = Pindaya)	3.066	21.449	0.000***
Livestock (1 = Yes, 0 = No)	1.107	3.025	0.037**
Extension officers' visit (1 = Yes, 0 = No)	1.251	3.492	0.025**
Off farm income group (kyats/ year)	0.643	1.903	0.105^{ns}
Average land-labor ratio (ha per labor)	0.351	1.421	0.082*
Experience in maize cultivation [years]	- 0.071	0.931	0.045**
Local variety (1 = Yes, 0 = No)	-0.237	0.789	0.749^{ns}
Constant	-1.765	0.171	0.058

Source: Survey data (2009)

Note: *, **, ***, ns show 10%, 5%, 1% level of significance and non significance respectively. Nagelkerke $R^2 = 0.444$

Omnibus Tests of Model Coefficients: $\mathbf{X^2} = 56.077$, df = 7, Sig = 0.000

Percentage of Correct Predictions: 84.4 %

1ha = 6.25 rai

Where,

REGION = Dummy variable (1 = Yatsauk, 0 = Pindaya)

Livestock = Dummy variable (1 = household has livestock, 0 = household has no livestock)

Extension officers visit = Dummy variable (1 = Extension officers visited to Maize field, 0 = Extension officers did not visit to maize field)

Average land-labor ratio = Average land per household labor (ha)

Experience in maize = Experience in maize cultivation (years)

Off farm income group = Average off farm family income (kyats/year)

Local variety = Dummy variable (1= local variety, 0 = hybrid variety)

The results of the logistic regression (Table 6.1) showed that five of the predictor variables significantly influenced chemical fertilizer adoption. The significance level of the independent variable REGION was shown at 0.000 with a coefficient (B) of 3.066. The odds ratio of 21.449 can be interpreted that farmers in REGION = 1 (Yatsauk) are 21.4 times more likely to adopt chemical fertilizers than those in REGION = 0 (Pindaya). It may be because of accessibility to transportation and modernization. The farmers in region Yatsauk who have more accessibility to transportation and modernization are more likely to adopt chemical fertilizers than those in the region Pindaya who have less accessibility and modernization.

The other three most significant variables included in the model are livestock; extension officers' visit and experience in maize cultivation are all significant at the 0.05 level in the overall regression model. These showed positive relationship with the

adoption of chemical fertilizers with the exception of the variable on experience in maize cultivation.

The significant level of independent variable livestock was shown at 0.037 with a coefficient of 1.107. If livestock increase one unit, it leads to 3 times increase in the odds that the farmers to accept chemical fertilizer application, assuming that the other variables are constant. The farmers who owned livestock can sell the livestock and purchase chemical fertilizers to apply in their fields. Degu *et al.* (2000) approved that Total Livestock Units (TLU), agro-ecological zone, extension services and use of credit significantly influenced the probability of adoption of maize and fertilizer packages in Ethiopia.

The odds ratio of annual extension officers' visit can be interpreted as follows. If extension officers visiting time is increased one unit, it leads to 3.5 times increase in the probability that the farmer to accept chemical fertilizer application, assuming that the other variables are constant. Extension officers visit to the maize field is significantly and positively affected to the adoption of chemical fertilizers in maize. The farmers who were visited by extension officers are more inclined to apply chemical fertilizers because they can get the knowledge of fertilizer technology from extension officers (Adunga 1997).

The variable on years of experience in maize cultivation is significant but negatively related with the adoption of chemical fertilizers in maize. It means that the farmer who has less experience in maize growing is likely to adopt the fertilizer application technology. Farmers with many years of maize growing experience most likely did not want to change their desire on using chemical fertilizer because the

previous experience of farmers can be expected to either enhance or diminish their level of confidence. It has been argued that with more experience, farmers could become risk-averse regarding the adoption of chemical fertilizers (Bisanda *et al*. 1998).

The last predictor variable is average land-labor ratio, which showed positive relationship with the adoption of chemical fertilizers in maize. It has a coefficient of 0.351 with a significance of 0.082, and with 1.421 odds ratio. It means that if average land-labor ratio is increased by one (more land (ha) per labor) unit, it leads to 1.4 times increase in the probability of the farmer to adopt chemical fertilizers in maize fields. Land to labor ratio is positively and significantly related to inorganic fertilizer uptake, confirming the hypothesis that as land pressure increases, farmers resort to more productive ways of intensification (Hardwick *et al*. 2004).

On the other hand, other factors hypothesized to affect the adoption did not have significant coefficients. They included off farm income of the household and using a local maize variety. This means that cultivation of local or hybrid varieties is not an important reason for the adoption of chemical fertilizer in maize production in study area. Off farm income is not significantly affecting in the adoption of chemical fertilizers because there is not much difference in the off farm income between adopter and non adopter households.

One of the outputs of a logistic regression model is the model of coefficients. The Omnibus tests of model coefficients show whether or not all of the variables entered into the regression equation have a significant effect on predicting the dependent variable.

The Chi-square value of 56.077 as shown in Table 6.2 is significant value at 0.000 with the seven variables in the regression equation.

Table 6.2 Omnibus Tests of Model Coefficients

		Chi- square	df	Sig.
Step 1	Step	56.077	7	0.000
	Block	56.077	7	0.000
	Model	56.077	7	0.000

In the logistic regression model, a classification table compares the predicted values for the dependent variable with the actual observed values in the data. As can be seen in the classification table shown as Table 6.3, the regression equation of seven independent variables predicts the adoption or non-adoption of chemical fertilizers correctly 84.4 percent of the time. Specifically, 125 of the 132 adopters and 16 of the 35 non-adopters were predicted correctly. These results indicate that the seven variables taken as a whole have a significant predictive capability on the decision by the farmers on whether or not to adopt chemical fertilizers.

Table 6.3 Classification table [a]

Observed		Predicted		
		Adopt or not adopt chem. fertilizer		Percentage corrected
		No	Yes	
Adopt or not adopt chem. fertilizer	No	16	19	45.7
	Yes	7	125	94.7
Overall percentage				84.4

a. The cut value is .500

The results of the Model Summary in Table 6.4 show the -2 Log likelihood and the R^2 for two different tests (Cox & Snell and Nagelkerke). These tests are used to indicate how well the model fits the data. Smaller -2 Log likelihood values indicate that the model fits the data better; a perfect model has a value of zero. The R^2 indicates that between 28.5 percent and 44.4 percent of the dependent variable (adoption of chemical fertilizers) can be accounted for by all the predictor variables in the equation. The R^2 value is not high but is enough for the evaluation in this regression model.

Table 6.4 Model summary

Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
1	115.399[a]	.285	.444

[a] Estimation terminated at iteration number 7 because parameter estimates changed by less than 0.001.

When Hosmer- Lemenshaw test is significant, it means that the observed counts and those predicted by the model are not close, and the model does not describe the data well. When the Hosmer- Lemenshaw test is not significant it means that the observed and the predicted counts are close and the model describes the data well. The results of logistic regression model in Table 6.5 shows the Hosmer and Lemeshow test is not significant (0.769). So, it means that the observed and the predicted counts are close and the model describes the data well.

Table 6.5 Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	4.891	8	.769

6.2 Multinomial logit model for the adoption of different levels of chemical fertilizer

Multinomial logit regression model was also conducted to identify socio economic, institutional and physical factors related with the level of adoption of chemical fertilizers. To identify factors affecting probability of the adoption of different levels of chemical fertilizer application in the study area, a multinomial logit model (Nkamleu and Coulibaly 2000; Cramer 1991; Madalla 1983) was applied in this analysis. The advantage of multinomial logit is that it permits the analysis of the adoption decisions across the various soil fertility management alternatives – allowing the determination of choice probabilities for different categories of soil nutrient management practices.

Independent variables that were hypothesized to affect the adoption of different levels of chemical fertilizers included the characteristics of household head such as age, education, membership in a farmer organization, experience in maize cultivation and number of extension officers' visit within a season. Moreover, some characteristics of households such as total maize area, average land-labor ratio, off farm income, number of livestock, number of oxen, variety, yield and also methods of threshing, and finally two townships as a physical factors were also included.

The multinomial logit regression was fitted to analyze the effect of these variables on the adoption of different levels of chemical fertilizer application and the results are presented in Table 6.6.

Table 6.6 Results of Multinomial logit model for the adoption of chemical fertilizers

	Variables	Constant	REGION	HHHAGE	OX
	Estimate	0.96	-1.75	0.01	0.01
Low	SE	1.08	0.70	0.02	0.04
level	Wald	0.79	6.28	0.30	0.08
	P-value	0.39	0.01**	0.58^{ns}	0.78^{ns}
	Estimate	2.39	-3.65	-0.01	-0.50
Medium	SE	1.44	0.99	0.03	0.28
level	Wald	2.74	13.48	0.22	3.29
	P-value	0.09	0.00**	0.64^{ns}	0.07*
	Estimate	1.01	-3.71	0.04	0.05
High	SE	1.07	0.68	0.02	0.03
level	Wald	0.89	30.00	4.06	1.94
	P-value	0.35	0.00***	0.04**	0.16^{ns}

Note: *, **, ***, ns show 10%, 5%, 1% level of significance and non significance respectively.

Sample = 167, Chi square test = 80.004, df = 9, significant = 0.000,

Nagelkerke $R^2 = 0.418$

Where,

REGION = Dummy variable (1 = Yatsauk, 0 = Pindaya)

HHH AGE = Average age of household head (years)

OX = Dummy variable (1 = household has oxen, 0 = household has no oxen)

The result of multinomial logit analysis (Table 6.6) indicated that, a number of factors were influencing the adoption of the three levels of chemical fertilizers. Among all independent variables, three independent variables included in the model are significantly affecting the three levels of chemical fertilizers.

REGION dummy is positively related with the adoption of levels of chemical fertilizers and is the most highly significant in medium and high levels of chemical fertilizer application in maize. It is also highly significant in the low level of chemical fertilizers used. It means that the probability of the adoption of chemical fertilizers in Yatsauk township has increased because of its accessibility of transportation and modernization.

Age of the household head also positively influences the adoption of chemical fertilizers, in the case of high level of fertilizers used. It seems that among adopters, the relatively aged farmers who have more resources have a greater tendency to accept a high level of fertilizer use (Damisa and Igonoh 2007). However, age of the farmer was not significant in the adoption of low and medium level of fertilizer use.

Oxen negatively affect the adoption of chemical fertilizer in the medium level of fertilizer use. The greater number of oxen will decrease the probability of chemical fertilizer adoption. This reveals that households who owned oxen are less likely to apply chemical fertilizers as they have enough animal manure to apply in their maize fields. This variable is not influencing the adoption of chemical fertilizers with low levels and very high levels of fertilizer application (Table 6.6).

In this model, there are some independent variables that are not significantly affecting the adoption of chemical fertilizers. These factors are gender, level of education, experience in maize cultivation and membership in a farmer organization of the household's head, household's land area under maize cultivation, off farm income, borrowed capital, variety, extension officers' visit, use of compost and problems with acid soil condition.

In situations where the expected rainfall (weather) condition is bad, farmers are unwilling to use fertilizer. This is because farmers are not insured against losses as a result of bad weather and forced to pay the cost of fertilizer they received on credit (Fufa and Hassan 2006).

6.3 Summary

In this chapter, regression analysis revealed that the factors that determine chemical fertilizers adoption were REGION, livestock, extension officers' visit, land-labor ratio and experience in maize cultivation. All variables were positively significant in chemical fertilizer adoption except the variable of experience in maize cultivation. The factors that determine levels of chemical fertilizers used were REGION, no of oxen and household head age in study area. Therefore, the most important one is accessibility and modernization but technology sharing by extension officers is also essential in this regard. Finally, farmers who possess oxen are less likely to adopt chemical fertilizers. Although one expects that as land pressure increases, farmers would resort to more

productive ways of intensification in chemical fertilizer adoption but the results of logit regression analysis revealed that as farmers had more land per labor, they were more likely to adopt chemical fertilizers. This can be because small land owners can rely on organic fertilizer but as land gets larger, this source of fertilizers is no longer adequate.