Middle-East Journal of Scientific Research 5 (5): 425-434, 2010
ISSN 1990-9233

Determinants of Fertilizer Use and Soil Erosion Control Measures in Maize Based Production System in Greater Trans Nzoia District, Kenya

[1]*J.M. Wanyama*, [2]*L.O. Mose*, [1]*S.C. Rono*, [1]*A.A.O. Masinde and* [3]*N. Kariuki*

[1]Kenya Agricultural Research Institute, Kitale, P.O. Box 450-30200, Kitale, Kenya
[2]Kenya Agricultural Research Institute, Headquarters, P.O. Box 57811, Nairobi, Kenya
[3]CENART, P.O. Box Kitale, Kenya

Abstract: Despite the key role maize plays in food security and income generation in Trans Nzoia district and the country at large, its productivity has not been impressive especially in the past four decades during which stagnation/decline in maize yield led to frequent food security problems. This has been attributed to soil fertility decline with emphasis on fertilizer use. The purpose of this study was to assess the determinants of fertilizer use, and soil erosion control. A survey was carried out in Trans Nzoia district in 2005 where 415 respondents were randomly selected from three strata (small scale, medium scale and large scale farmers). The results revealed that soil fertility is still on the decline attributed to poor soil replenishment and soil erosion. Using logit and tobit models the results showed that agricultural training, extension visits to farmers, acreage under maize production and the sex of household head, had a significant effect on likelihood of farmers adopting fertilizers in maize production. The type of employment of household head, and proportion of area under maize significantly influenced intensity of fertilizer use. Soil conservation technologies are type of work and extension visits had significant influence on soil erosion control. The multiple factors influencing fertilizer use and soil erosion control demands involvement of many stakeholders along the chain.

Key words: Determinants · Fertilizer · Soil erosion · Kenya

INTRODUCTION

Land degradation will remain an important global concern because of its adverse impacts on agricultural production, food security and the environment [1, 2]. Inappropriate land management practices, particularly in areas with high human population densities have continuously contributed to loss of soil productivity of resource poor farmers. This in turn affects their food security and livelihoods. It is recognized that soils are a major natural resource for mankind existence particularly those from rural areas. The process of soil formation takes a relatively long period while poor management activities result quick soil loss leading to rapid land degradation. In areas like Trans Nzoia where maize and livestock activities are intense, land degradation can be high if nutrient replenishment through fertilizer application and soil erosion control is not practiced. Soil fertility decline is a major constraint to maize which is the staple food security crop in Kenya [3, 4]. Farmers have limited capacity to invest in soil conservation and fertilizers which is attributed to diverse constraints. This study was designed to assess the factors influencing the adoption of fertilizers and soil erosion practices in Trans Nzoia district. This district is known for maize production and the crop is the most important staple food crop in Kenya. Maize is the most important single agricultural commodity, estimated to contribute more than 25% of agricultural employment and 20% of total agricultural production. Maize yields in the district started declining from the 1990s to date. The decline has been attributed to a decline to declining soil fertility and possibly due to an increase in world fertilizer prices [5-8]. The problem of declining maize yields is magnified by the fact that population continues to increase annually at a rate of about 2.9% leading to decreasing per capita consumption. The combined effect of increasing human population and poor maize yields on the country's capacity to feed the population is then accelerated annually [9, 10]. The major contributory factors are soil erosion and poor use of fertilizers and possibly due to poor output pricing [11]. The focus of this study is on soil erosion and fertilizer

Corresponding Author: J.M. Wanyama, Kenya Agricultural Research Institute, Kitale, P.O. Box 450-30200, Kitale, Kenya

utilization in maize production and their effect on maize productivity. What are the fertilizer levels and what factors determines its utilization? The study was guided by the following objectives to: i) assess fertilizer and soil erosion technology use patterns among typical farm types ii) analyze factors contributing to fertilizer use in maize production in Kenya and assess the factors influencing soil erosion control.

METHODOLOGY

Site Description

Conceptual Framework: The neoclassical theory of farm production indicates that the decision making process of what, how, when and how much to produce begins with an individual farmer who is the head of a household [12]. The traditional models that empirically assess agricultural household behaviour are based on the basic idea that farmers aim at maximizing a utility function given by consumption possibilities subject to availability of resources (eg farm size, technology, education, cash) and budget with which to satisfy consumption. Decision making is a process through which farmers go through from awareness through trial and adoption [13, 14]. The influencing factors to farmers' decision making are diverse and can be grouped into farmer, farm, institutional, policy and environmental characteristics [13]. These factors need to be identified for appropriate development of interventions. This study was designed to address these factors. These factors can be well modelled by assuming that a farmer maximizes the utility by adopting fertilizer and soil erosion technologies. The decision to adopt is influenced by many factors. Related studies have shown that adoption work can be fully analyzed using logit and tobit models [15, 16].

Data Type, Sources and Collection Procedures: Primary and secondary data were collected to achieve the study objectives. Extra information on determinants of probability (likelihood) and intensity of adoption and farmers' perception on use of fertilizer and adoption of improved soil erosion practices collected included: demographic, socio-economic, environmental situations, credit facilities, extension service and other relevant data having direct or indirect bearing on the study were gathered from sample households using interview schedule and in two group discussions. Relevant data were also gathered through examination of secondary sources like reports and records maintained by change agents including district agricultural office. Primary data were collected through personal and face-to-face interview using structured and pre-tested interview schedule that were filled up by recruited and trained enumerators under the close supervision of the research team. Qualitative information was also recorded from the farmers to complement the quantitative data collected. Collection of primary qualitative information was managed by carrying out informal and formal interviews. To ensure validity of the qualitative data, information was cross checked by conducting discussion with development agents and the district agricultural office staffs within the study area. Finally primary data were supplemented with secondary data in order to ensure adequacy and reliability of information gathered.

The household survey was carried out in April 2005 by multi-disciplinary team research and extension teams. Prior to data collection the questionnaire was field-tested for relevance, flow of questions, repetitions of some questions. In this study a three stage sampling technique was employed. The first stage was purposive selection of divisions in the district, followed by selection of sub-locations and lastly random selection of households in three categories was purposively included into the sample. Identification of the categories was done through literature review. All the three categories of farmers were selected. After preparing a list of farmers in each category to establish sampling frame, households were determined based on a probability proportional to size of total farmers in each group. A total of 415 respondents (small scale farmers=236, medium scale =120 and large scale =59) were randomly selected using simple random sampling technique from a sample frame established at village levels. The survey covered to main agro-ecological zones (Upper midland-UM, Upper highlands-UH) in Trans Nzoia district. The district was further stratified into three major regions; Central, Cherangáni and Mt Elgon zones. There was a key informant survey to complement some responses not satisfactorily answered in the household survey.

Analytical Procedures: The data were then analyzed using descriptive statistics (mean, proportions, standard deviation and range), regression (Logistic and Tobit) analyses [6, 15]. It is recognized that descriptive statistics do not effectively predict the combined effect of the explanatory variables on the dependent variable. Subsequently this problem solved by selecting and using appropriate econometric models. Logistic regression may be used to compare relative important variables, to evaluate interaction effects and to determine the impact of the control variables. In this analysis binomial logistic regression model was utilized. Binary logistic (logit) regression model is employed when the dependent variable is dichotomous while the independent variable can take any form. Thus, the logit model was used to evaluate factors influencing declining adoption of fertilizers and soil erosion control technologies. The dependent variable indicated whether the farmer adopted the technology (=1) or did not (=0). The logit regression model applies the maximum likelihood estimation after transforming the dependent variable into logit variable (the natural logarithm of the odds of the dependent occurring on not). The logit regression calculates changes in the log odds of the dependent variable but not changes in dependent variable like the in the case of Ordinary least square regression model. Logit model is a logistic distribution bound between 0 and 1. The model was specified as shown in equation 1 [1].

$$\log\left[\frac{\text{Prob}(event)}{\text{Prob}(no-event)}\right] = \beta_0 + \beta_1 X_1 + ...+ \beta_k X_k \quad (1)$$

Where β_{is} are estimated coefficients and X, are independent (explanatory) variables such as farmer, farm characteristics and other socio-economic variables. The variable hypothesis and descriptions in the model are shown in Table 2. Hypotheses testing were done using t-test. The predicted probabilities can be computed using the logistic function (equation 2). The probability of adopting fertilizer or soil erosion control technologies can be computed give the independent variables.

$$\hat{P} = f(X_i, \hat{\beta}) = \left[\frac{\exp(X_i \hat{\beta})}{1+\exp(X_i \hat{\beta})}\right] \quad (2)$$

The standard Tobit regression model [4, 9] is specified as equation 3.

$$Y_i = Y_i^* = \beta X_i + u_i \quad (3)$$

if $\beta X_i + u_i > Y_i^*$

Y = 0 if $\beta X_i + u_i \leq Y_i^*$ I = 1, 2, ..., N

Y =Y^* if $Y^* > 0$

Where Y is the dependent variable, a continuous variable at 0, Y* is the underlying latent dependent variable, X is a vector of explanatory variables, β is a vector of parameters associated with explanatory variables and N is the number of observations, including a constant which are estimated using the maximum likelihood method and u_i is the error term assumed to be independently distributed as N (0, σ^2). It is assumed in the model that there is an underlying unobserved latent variable which is observed when $X\beta+u_i$ is greater than Y*. This point is termed the threshold point and normally expressed as an unobserved index. The Tobit model parameters were estimated by maximizing the Tobit likelihood function (equation 4) of the following form [15].

$$L = \prod_{Y_i^*>0} \frac{1}{\sigma} f\left[\frac{Y_i - \beta_i X_i}{\sigma}\right] \prod_{Y_i^*>0} F\left[\frac{-\beta_i X_i}{\sigma}\right] \quad (4)$$

Where f and F are respectively, the density function and cumulative distribution function of Yi* $\prod_{Y_i^* \leq 0}$ means the product over those farmers i for which Yi* ≤ 0 and $\prod_{Y_i^*>0}$ means the product over those i for which Yi>0.

Prior to running the logit and Tobit regression models all the hypothesized explanatory variables were checked for the existence of multi-collinearity problem. There are two measures that are often suggested to test the existence of mulit-collineality which are Variance Inflation Factor (VIF) (equation 4) for association among the continuous explanatory variables and contingency coefficients (equation 5) for dummy variables. In this study, variance inflation factor (VIF) and contingency coefficients were used to test multi-collinearity problem for continuous and dummy variables respectively. According to [12], VIF can be defined as:

$$VIF(X_i) = \left(1 \Big/ (1+R_i^2) \right) \quad (5)$$

Where R_i^2 is the squared multiple correlation coefficient between Xi and the other explanatory variables. The larger the value of VIF, the more trouble on multi-collinearity. As a rule of thumb, if the VIF of a variable exceeds 10 (this happens if R_i^2 exceeds 0.95), that variable is said to be highly collinear [17, 15]. Similarly, contingency coefficients were computed for dummy variables using the following formula (equation 6);

$$C = \sqrt{\chi^2 \Big/ (n+\chi^2)} \quad (6)$$

Where, C is contingency coefficient, χ^2 is chi-square value and n = total sample size. For dummy variables if the value of contingency coefficient is greater than 0.75, the variable is said to be collinear [17].

Definition of Variables and Hypotheses

Dependent Variable: The dependent variables in this study were adoption and non-adoption of fertilizer and soil erosion practices for logit model and levels of fertilizer used on maize production for Tobit model. Levels of fertilizer used were a continuous dependent variable.

Independent (Explanatory) Variables: The explanatory variables of importance in this study are those variables, which were thought to influence on likelihood and intensity of adoption of fertilizer and soil erosion practices. These included household's personal and demographic variables, economic variables, household socio-psychological variables and institutional variables. These Explanatory Variables Are Defined as Follows: *Membership to an organization (organ)* - Membership to an organization was hypothesized to increase farmers' access to fertilizer and soil erosion information technologies through interactions with other farmers and change agents. This was hypothesized to increases farmers' probability of adopting the technologies. This is was a dichotomous variable (1= farmer is a member of an organization, 0= farmer is not a member). *Farmer's age (age)* - Age was assumed to be a proxy for experience in farming. Therefore it was hypothesized to positively influence the adoption of fertilizer and soil erosion information technologies. In addition age can also be a proxy to non-innovativeness. The scenario means that increasing farmer's age positively influences adop\tion of fertilizer and soil erosion information innovation and can contribute to increasing soil productivity. *Years in farming (timefam)*- It was expected that the more the experience, the higher the probability of adopting fertilizer and soil erosion information innovations and thus positively influence increased crop yields. *Farmer's education (highsted)* - This was considered as a dichotomous variable, 1= yes (secondary to university education), 0 =primary or no education. Education was assumed to make farmers understand the fertilizer and soil erosion information innovations easily and subsequently increase maize yields. It was therefore expected to positively influence adoption of fertilizer and soil erosion information innovations. *Sex of household head (sex)* - This was coded as a dichotomous variable with 1=male and 0 = female. Studies undertaken have shown that access to resources and services(information, credit) vary by gender. It was hypothesized that the variable could positively or negatively influence the adoption of fertilizer and soil erosion information technologies. *Family size (famsize)* - It was anticipated that the larger the family size the bigger the pool of labour available. The variable was expected to increase the probability of adopting the fertilizer and soil erosion technologies. *Credit (cedit)* - Credit was an important variable that was expected to fuel adoption of fertilizer and soil erosion information innovations. This was assumed to be a proxy to financial access which assists farmers to purchase inputs to adopt fertilizer and soil erosion technologies. It was also a dichotomous variable, 1= yes (accessed credit) and 0 = no (not accessed credit). *Land tenure (ownedtit)* - This is assumed to be a proxy to security of tenure which gives farmers ability and incentive to invest in productivity enhancing fertilizer and soil erosion information technologies. Farmers would procure loans and buy inputs. It was treated as a dichotomous variable, 1= yes (own land with title) and 0 = Otherwise (all other forms of land tenure systems where there is no security). *Farm size (totacres)* - Farm size is a proxy to wealth. It was anticipated that it could influence adoption of this technology positively. However, in some cases, the bigger the farm sizes, the more the flexibility for crop rotations. In such cases, this variable was expected to negatively influence the adoption of these technologies. *Access to extension (extvisit)* - This was a dichotomous variable, 1=yes (had access to extension in the past 5 years), 0 = otherwise (not access extension service in the past years). Extension is a proxy to access to the technology (new skills) and is expected to increase the farmer's probability of adopting the the technologies. *Access to extension (famtrain)* - This is a dichotomous variable, 1=yes (had extension training in the past 5 years), 0 = otherwise (not had extension training in the past 5 years). Extension was assumed to be a proxy to access to maize technologies and is expected to increase the farmer's probability of adopting the maize technologies. *Type of employment (wrkdum)* - Type of employment of farmers was hypothesized to be a source of cash to purchase input to adopt fertilizer and soil erosion information technologies for enhanced maize production. It was assumed to positively influence adoption of fertilizer and soil erosion information technologies. This was a dichotomous variable (1=employed; 0=otherwise). *Proportion of farm under maize (sharemze)* - Proportion of acreage under maize can be a proxy to farmers' increased welfare. The proportion of area under maize was hypothesized to positively influence adoption of soil fertility enhancing technologies and subsequently improve maize productivity. *Distance to market (Distancemkt)* - This was a proxy to farmer's proximity to fertilizer markets. This was assumed to negatively (if the distance is more) and positively (if distance is less) influenced adoption of fertilizer use and subsequently maize productivity. *Sex of decision maker of maize acreage (demzeacr)* - Sex of decision maker was assumed to influence the adoption of technological components and subsequently influence maize productivity. The decision maker on maize acreage was hypothesized to positively influence fertilizer and soil erosion technologies. *Maize variety (Varsed)* - Improved maize varieties were hypothesized to positively increase adoption of fertilizer. This is because improved maize varieties had higher yields than unimproved ones (Improved=1; Otherwise=0). *Price of maize grain per kg. (mktpri04)* - Price of maize grain was assumed to positively influence the adoption of maize technological components and subsequently improve maize productivity. The higher the maize price the higher the adoption of maize innovations and the higher the maize productivity. *Yield per acre (yield)* - Yield is a measure of maize productivity and is a function of adoption of fertilizer and soil erosion maize innovations. It was assumed that the higher the yield, the higher the adoption of maize technological components.

RESULTS AND DISCUSSION

Soil Fertility Perceptions- Soil Types and Fertility Trends: The types of soils have a significant bearing on soil fertility status. Farmers classified soils on their farms as shown in Table 1. Most of the farmers (40%-61%) across the entire three farm types classified their soils as loamy. Farms classified as having clay and clay loamy soils ranged from 4% to 28%. The volcanic soils mainly situated along the slopes of Mount Elgon were found in 16% of surveyed farms. The soils listed by farmers have high agricultural potential for maize production but can easily be depleted through nutrient mining if poor agricultural practices are applied. Therefore, in order to reverse declining fertility and for sustainability, they require conservation practices and attention with respect to external inputs in the form of fertilizers provided to optimize production. Soil fertility nutrient supply and demand by crop influence the maize yield trends. Perceptions influence farmers decision-making as indicated by [18]. Farmers through experience use a number of surrogate indicators like weeds, crop colour, soil colour, crop yields and soil types to rate soil fertility status and trends. Farmers gave their perceptions on soil fertility trends on maize plots as shown in Table 2.

Table 1: Soil types by farm type in Trans Nzoia district, Kenya

	% of farmers		
Soil type	Less than 5 acres	5-19 acres	More than 20 acres
Loam	61	49	40
Sandy-clay	8	15	---
Sandy	9	22	---
Clay-loam	11	28	12
Clay	8	4	---
Sandy-loam	--	5	---
Red volcanic	---	---	16

Table 2: Farmer perceptions on soil fertility status in Trans Nzoia district

	% response			
Fertility status	Large	Medium	Small	All
High fertility	3.1	40.6	56.3	21.5
Medium fertility	12.3	43.4	44.3	66.9
Low fertility	27.8	22.2	50	11.5
Trends in fertility changes in last 5 years				
Increasing	0	10.2	18.7	13.2
Decreasing	66.7	67.8	61.3	64.5
Fluctuating	16.6	8.5	8.0	9.2
No change	16.6	13.6	12.0	13.2

Table 3: Logit results of factors influencing adoption of fertilizers in Trans Nzoia district

	B	S.E.	Wald	Sig.	Exp(B)
Age	-0.018	0.028	0.426	0.514	0.982
Gender	0.085	0.883	0.009	0.923	1.089
Highsted	-0.155	0.367	0.177	0.674	0.857
Mktpri04	-0.229	0.221	1.076	0.300	0.795
Famtrain	1.400	0.635	4.858	0.028	0.247
Extvisit	1.125	0.655	2.950	0.086	0.325
Ownedtit	0.258	0.578	0.199	0.655	0.773
Sharemze	4.663	1.565	8.881	0.003	0.009
Frmtype	1.013	1.417	0.511	0.475	2.754
Yield	0.002	0.046	0.002	0.962	1.002
Demzeacr	-1.009	0.528	3.658	0.056	0.364
Constant	8.960	4.177	4.601	0.032	7782.782
-2 Log likelihood	69.390				
Cox and Snell R-Square	0.429				
Nagelkerke R-Square	0.585				
Chi-square	49.94***				
Prediction Improved	91.10				
Prediction local	70.60				
Over all prediction	62.20				

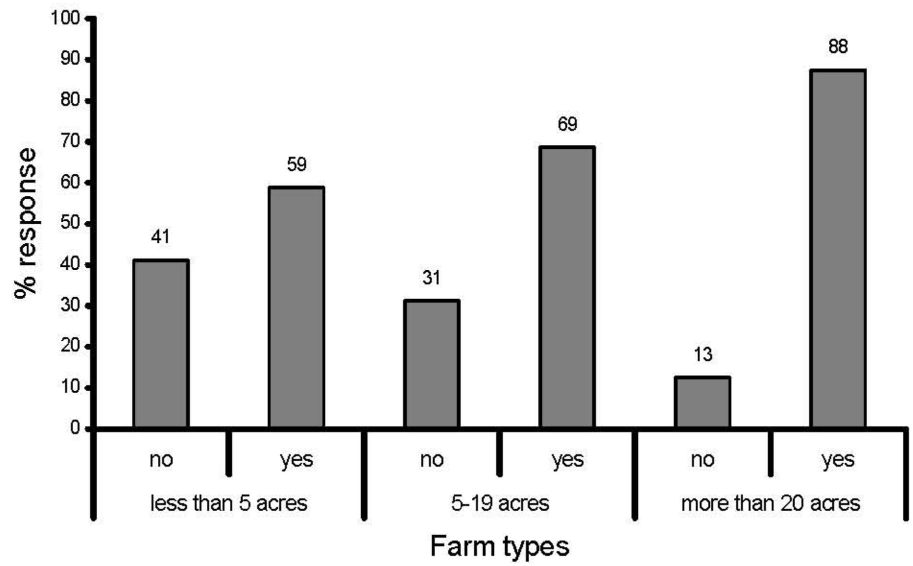

Fig. 1: Percentage farmers experiencing soil erosion on the farms

Farmer perceptions on soil fertility status and trends motivate them to make farm decisions which influence improvement in farm productivity. Over 78% of farmers in all the three categories perceived soil fertility status to be low and medium while about 65% indicated that the fertility trend is progressively decreasing. Since majority of farmers perceived not only low but also declining soil fertility status, this could be one of the main contributors to declining maize yields in Trans Nzoia district. Farmers in Trans Nzoia district have continued to cultivate their land without putting in place the proper soil management practices. Continuous cultivation of land has been shown to lead to decline in soil fertility [4, 14, 19].

Soil Erosion: A number of technologies were developed and released to farmer. Figure 1 shows that most (51%) of the farmers across the entire three-farm types still experience significant soil erosion problem despite many decades of soil conservation projects in the district. Experience of soil erosion by the farmers would rationally be expected to drive farmers to adopt soil conservation technologies. Of the soil conservation structures, *Fanya juu* terrace is the most adopted followed by grass strips and cut off drains (Fig. 2). Those soil conservation technologies that are least adopted include cover cropping, contour ploughing, agro-forestry and water drainage strategies in water logged zones.

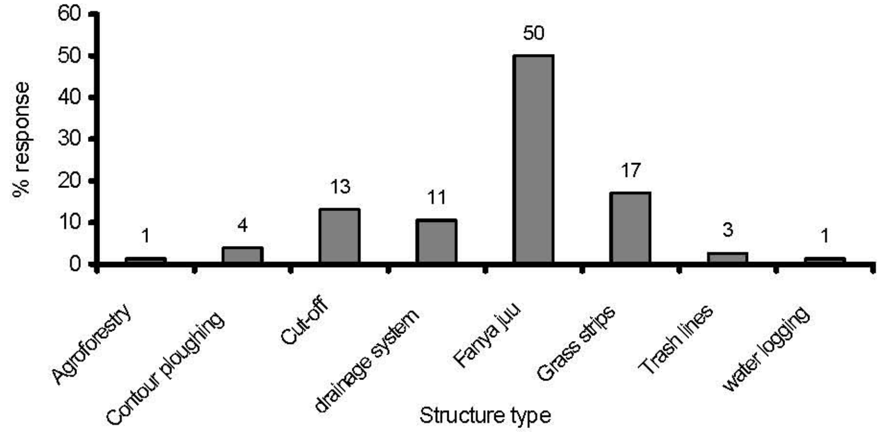

Fig. 2: Soil erosion control structures on farms

Agroforestry/woodlots are the lowest in the region against the declining forestry cover in the country. There is no satisfactory explanation as to why *Fanya juu* is widely adopted as a soil erosion control measure. Explanations probably reside in tradition and government intervention measures and ease of implementation. One thing is however certain; that farmers have continued to experience the problem of soil erosion. Soil erosion inevitably leads to declining capacity for soil to produce more yields. Research needs to be carried out to come up with more cost effective and farmer friendly soil conservation measures.

Factors Influencing Adoption of Fertilizers: Table 3 shows the factors that significantly influence the likelihood of farmers' adoption of fertilizers. They were; agricultural training, extension visit to farmers, acreage under maize production and the sex of decision maker on how much acreage was put on maize production. Agricultural training had a significant effect on likelihood of farmers adopting fertilizers. This implies that trained farmers are likely to adopt the use of fertilizers than untrained one and this could be attributed to the knowledge related to the fertilizers gained during the training. The proportion of farm acreage under maize positively influences farmers to adopt the use of fertilizer. The odds in favour of adopting fertilizers significantly increased by 0.01 ($p<0.01$) for farmers who had higher proportion of farm under maize. Thus, the higher the maize acreage, the more likely that the farmers will apply fertilizers. This could be attributed to the fact that farmers with higher maize acreage are also commercially oriented and may want to reap maximum net benefits by obtaining optimum yields through application of fertilizers. The study also revealed that farmers who were constantly in contact with extension were likely to adopt fertilizers. The odds in favour of adopting fertilizers increased by 0.33 for farmers who had access to extension services. This is because the variable significantly and positively ($p<0.1$) influences the likelihood of adopting fertilizer. This is attributed to the fact that the type of fertilizer and amount to apply on maize has been a major impact points in extension message to farmers. This included farm demonstration on farmers' fields. The decision maker on the amount of acreage under maize negatively and significantly ($p<0.1$) influenced the likelihood of using fertilizers on maize. Sale of maize positively influences farmers to use fertilizers. It appears that income from maize is used to purchase fertilizers. However, the coefficient was not significant. Thus the availability of good market for maize is a good incentive for farmers to use fertilizers. Other factors that were positively related to the likelihood of adopting fertilizers include yield of maize, farm type (SSF, LSF and MSF), ownership of title deed and gender of the household head.

Shown in Table 4 are variables that significantly explain the intensity of fertilizer adoption. These variables were: type of employment, proportion of area under maize. Farmers with higher proportion of their farms under maize production tended to use less fertilizer rates than those with less. The amount of fertilizer used decreases with the age of farmers. The higher the education the higher the amount of fertilizers applied however the coefficient was not significant. The higher the maize price per unit the more the amount of fertilizers applied. The yield of maize positively relates to amount of fertilizers applied by farmers.

Table 4: Tobit maximum likelihood estimates of factors influencing the intensity of adoption of fertilizers in Trans Nzoia district

	β	SE	t-value	p-value
Age	0.019	0.0066201	2.93	0.005
Gender	0.173	0.2300	0.75	0.455
Highsted	0.132	0.980	2.07	0.045
Typework	0.356	0.169	2.11	0.041
mktpri04	-0.011	0.059	-0.19	0.852
Famtrain	-0.181	0.185	-1.29	0.199
Extvisit	-0.132	0.150	-0.88	0.382
Ownedtit	-0.226	0.162	-1.39	0.170
Sharemze	-3.924	1.525	-2.57	0.012
Demzeacr	-0.296	0.368	-0.80	0.424
Yield	0.003	0.054	0.05	0.962
Distance to market	0.097	0.074	1.31	0.193
Fertrdu	-0.262	0.165	-1.59	0.119
Tmeinpro	-0.008	0.010	-0.78	0.438
Timefam	0.002	0.002	0.75	0.457
Respsex	0.197	0.191	1.03	0.309
Totacres	-0.011	0.027	-0.42	0.677
Varsed	-0.030	0.253	-0.12	0.907
Wrkdum	0.356	0.169	2.11	0.041
Constant	0.077	0.968	0.08	0.937
LR Chi^2	22.26			
Pseudo R^2	0.44			

Table 5: Results on factors influencing adoption of soil erosion in Trans Nzoia district

Variable	β	S.E.	Wald	Sig.	Exp(B)
Age	0.018	0.023	0.594	0.441	1.018
Gender	0.183	0.723	0.064	0.800	1.201
Highsted	0.218	0.304	0.515	0.473	1.244
Typework	-0.433	0.231	3.517	0.061	0.649
Extvisit	0.995	0.491	4.110	0.043	2.706
Famtrain	0.081	0.541	0.022	0.882	1.084
Ownedtit	0.280	0.490	0.326	0.568	1.323
Tmeinpro	0.040	0.031	1.638	0.201	1.041
Constant	-1.545	1.710	0.817	0.366	0.213
-2 Log likelihood	65.410				
Cox and Snell R-Square	0.440				
Nagelkerke R-Square	0.600				
Chi-square	51.740				
Prediction yes	93.100				
Prediction no	78.100				
Over all prediction	87.800				

Factors Influencing Adoption of Soil Erosion Technologies: From Table 5, the variables that significantly influence the adoption of soil conservation technologies are type of work and extension visits. Farmers who are constantly in contact with extension services are likely to adopt soil conservation measures (SCS) than those who do not. The odds in favour of adopting SCSs increased by 2.71 ($p<0.01$) for those farmers who had access to extension services. In addition, farmers who are employed are less likely to adopt the soil conservation measures. The odds in favour SCSs, decreased by 0.65 ($p>0.1$) for farmers who had off-farm work. This could be attributed to the fact that farmers who had off-farm work spend most of the time away from the farm and may not have time to invest in soil erosion control measures.

CONCLUSIONS AND IMPLICATIONS

There is general perception that there is a declining maize production the Kenya. Farmer perceptions and district level statistics indicate that the general trend of maize yield in Trans Nzoia district is declining. Large-scale farmers are more efficient than SSFs and the key factors that significantly influence the maize efficiency were; area under maize, fertilizer rates, labour utilization, cost of farm machinery, farmer type (SSF and LSF), gender (sex), age, experience, farm size, time of planting (dry planting and planting after 3 weeks) pest control and maize variety grown which partly agrees with the results of work done [6, 20]. This demands developing and deploying cost effective soil improvement technologies suitable for Trans Nzoia and similar environments.

ACKNOWLEDGEMENT

The authors appreciate the Kenya seed company for funding the activity and Centre Director KARI Kitale for facilitating the running of the study. Special thanks also go to Prof Okalebo, Prof Othieno of Moi University and the entire team of TMC for their support. The team that directly and indirectly contributed to the successful completion of this work is fully recognized.

REFERENCES

1. Heisey, P.W. and W. Mwangi, 1996. Fertilizer Use and Maize Production in Sub-Saharan Africa Mexico, D.F.: CIMMYT, CIMMYT.
2. Mekuria, M., S. Waddington and S. Siziba, 2004. Breaking the "Fertilizer Poverty" and Food Insecurity Traps in Smallholder Maize Based Farming System in Southern Africa: Experiences and Lessons from Soil Fertility Network/Economics and Policy Working Group (EPWG). Paper submitted for presentation at the Inaugural Symposium of the Association of African Agricultural Economists (AAAE): Shaping the Future of African Agriculture for Development: The Role of Social Scientists 6-9 December 2004, Nairobi, Kenya, CIMMYT Southern Africa.
3. De Jaeger, A., F.M. Kariuki, M. Matiri, Odendo and J.M. Wanyama, 1998. Monitoring Nutrient Flows and Performance In African Farming Systems (NUTMON). Iv. Linking nutrient balance and economic performance in 3 Districts in Kenya. In Agriculture Ecosystems and Environmental J., 71: 81-92.
4. Onduru, D.D., A. De Jager, B. Wouters, F.N. Muchena, L. Gachimbi and G.N. Gachini, 2006. Improving soil fertility and farm productivity under intensive crop-dairy small holdings: Experiences from farmer field scholls in the highlands of Kiambu district, Central Kenya. Middle-east J. Scientific Res., 1(1): 31-49.
5. Ariga, J., T.S. Jayne and J. Nyoro, 2006. Factors Driving the Growth in Fertilizer Consumption in Kenya, 1990-2005: Sustaining the Momentum in Kenya and Lessons for Broader Replicability in Sub-Saharan Africa. Nairobi, Kenay, Tegemeo, pp: 1-59.
6. Green, G.H., 1991. Econometric analysis.
7. Omamo, S.W., 2003. Fertilizer Trade And Pricing In Uganda. Agrekon, 42(4): 310-324.
8. Xu, Z., T.S. Jayne and J.M. Govereh, 2006. Input Subsidy Programs and Commercial Market Development: Modeling Fertilizer Use Decisions in a Two-Channel Marketing System. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California.
9. Kenya, republic of, 2001a. Poverty reduction strategy paper for the period 2001-2004. Prepared by the people and government of Kenya. June 2001. Nairobi, Kenya, Government Printers.
10. Kenya, Republic Of, 2004b. Strategy for revitalizing agriculture 2004-20014. Nairobi, Kenya., Ministries of Agriculture, Livestock and Fisheries Development and Cooperative Development and Marketing.
11. Wangia, C., S. Wangia Hugo and De Groote, 2001. Review of maize markets in Kenya: Implementation and Impact of Liberalization, 1989-1999. In the proceedings of Seventh Eastern and Southern Africa Regional maize conference, 7- 2001 Nairobi, Kenya, pp: 12-21.
12. Ellis, F., 1993. Peasant economics Farm household and agrarian development. Cambridge, Great Britain, Cambridge University press.
13. Rogers, E.M., 2003. Diffusion of innovations. New York, Free Press, pp: 477.
14. Rogers, E.M., 1983. Diffusion of Innovations, Third Edition., The free press, Div. Macmillan publishing Col, Inc. New York.
15. Pyndick, R., S. and D.L. Rubifeld, 1998. Econometric Models and Econometric forecasts. McGraw-Hill International Editions.
16. Theil, H., 1979. Principles of Econometrics. Centre for Mathematical Studies and Economics. New York., The University of Chicago. John Wiley & Sons New York.
17. Maddala, G.S., 1983. Limited-dependent and qualitative variables in econometrics., Cambridge University press, New York.
18. Ouma, J.O., H. De Groote and G. Owuor, 2004. Determinants of Improved Maize Seed and Fertilizer use In Kenya: Policy Implications. Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, pp: 12-18.

19. Smaling, E.M.A., S.M. Nandwa and B.H. Jansen, 1997. Soil fertility in Africa is at stake. In: Buresh R .J. *et al.* Replenishment soil fertility in Africa." Soil Science Society of America Special Publication, 51: 47-61.
20. Hassan, R. and C. Nhemachena, 2008. Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. "AfJARE 2(1): 83-104.