



# Determinants of Crop Land Management Practices: The Case of North Gondar Zone, North West Ethiopia

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## ABSTRACT

Land management problems like soil erosion; overgrazing and deforestation have steadily increased in Ethiopia including the study area North Gondar Zone. Thus, the main objective of this study is to assess the determinants of crop land management practices in north Gondar zone. Both qualitative and quantitative types of data were collected from primary and secondary sources. In this study, to get representative sample from different agro ecologies a stratified simple random sampling technique was employed to select sample household heads. Finally, a total of 120 household heads were drawn through simple random sampling technique proportionally to size from the sample kebeles. To analyze the determinants of land management practices multinomial logit model was used. The findings of this study indicated that from the total variables included in the model only six variables are found to significantly affect the choice of crop land management strategies. The significant variables include age of the household head, education level, access to mass media, amount of income, farm distance and the frequency of extension contact. Thus, any concerned bodies should strengthen rural households' mass media coverage and advisory services.

**Key words:** Crop land management, Determinant, Ethiopia, Strategies North Gondar.

## INTRODUCTION

The African continent over the decades, witnessed increased population growth rate. This led to unprecedented population pressure on land, which resulted to agricultural expansion, intensification and inappropriate farming practices by farmers (Fakoya, 2001; Madu, 2001). The inappropriate farming techniques triggered the problem of land degradation commonly evident on almost all farming areas. In turn land degradation contributed to low agricultural productivity and sedimentation of reservoirs. These further threaten the achievement of sustainable development goals.

Land management problems like soil erosion, overgrazing and deforestation have steadily increased in Ethiopia despite there are numerous interventions (SARDP, 2010). The nutrient loss from lost soils in terms of phosphorus and nitrogen was 1.1 million metric tons in 1995 and 1.3 million metric tons in 2005. The monetary value of productivity loss is estimated at about 639million ETB, in 1995 and 766 million in 2005 (Backteman, 2010). Therefore, unless the present land management practices are reversed (Kumela, 2007), large areas of the nation's farm land will deteriorate and it will become increasingly difficult to maintain even the present low level of production.

The poor depend on the environment, especially natural resources, for the satisfaction of their basic needs. The rural poor generally live off the land on which they grow crops for subsistence and sale, graze their livestock, collect water and obtain wood for cooking, lighting and construction of houses. Land is considered important for production and food sufficiency. As land deteriorates in quality, the poor become poorer. Hence, farmers in North Gondar Zone have been exposed to various land management practices such as contour ploughing, terracing and agro forestry practices among

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others. However, not all farmers are able to apply them despite the recognition that their land is increasingly degraded.

Therefore, the assessment of the determinants to farmers' use of sustainable crop land management practices would provide a direction of action for government in trying to boost farmers involvement in suitable land management practices, reveal areas of inadequacy and where the farmers need improvement. Hence, the objective of this study is to assess the determinants of crop land management practices in the study area.

## MATERIALS AND METHODS

### Description of the study area

**Location:** North Gondar zone is one of the eleventh zones

of the region, which has 23 districts. The boundaries of the North Gondar Zone adjoin Tigray region to the North, Ageawee zone and West Gojam zone to the South, Waghimra zone and South Gondar zone to the East and Sudan to the West.

North Gondar has a population density of 63.76. While 462,700 or 15.79% are urban inhabitants, a further 2,148 or 0.07% are pastoralists. A total of 654,803 households were counted in this Zone, which results in an average of 4.47 persons to a household and 631,509 housing units. The main ethnic group reported in North Gondar was the Amhara (97.84%); all other ethnic groups made up 2.16% of the population. Amharic was spoken as a first language by 98.32%; the remaining 1.62% spoke all other primary languages reported. 95.38% practiced Ethiopian Orthodox Christianity and 4.29% of the population said they were Muslim (Ethiopian Population and Housing census. 2007).

### Research approach

The researchers employed mixed (qualitative and quantitative) research approaches. The qualitative data were obtained from Key Informant Interviews (KIIs) and observations. Quantitative data were obtained from household survey. The reason for adopting both research approaches can be justified with three reasons as per Miles and Huberman (1994). Firstly, greater confirmation of data through triangulation; secondly, to elaborate or develop analysis on the bases of rich details and thirdly, to initiate new lines of thinking through attention to surprises or paradoxes, turning ideas around and providing fresh insight.

### Source and method of data collection

The data were collected from both primary and secondary sources. Primary data were collected through household head interviews. The interview schedule was pre tested among the 10 non sampled rural households having similar socio economic backgrounds with sample respondents but from different area. Then the necessary modifications were done based on the pre tested questionnaire. Qualitative data were gathered by using key informants interviews in each district and field observations. Secondary data were collected from government annual reports, official statistical abstracts and research results undertaken in the area.

### Sampling procedures and techniques

In this study a stratified simple random sampling techniques was employed to select sample household heads from the study area. Accordingly, North Gondar zone was stratified on the bases of agro-ecology to create homogeneous stratum for the selection of districts. Next to this, the districts were grouped into Dega, Woyina dega and Kola. Then after, Gonder zuria district selected from the Woyina dega, Dabat district from dega and West Belesa district from the kola/ low land were selected randomly to have representative districts in North Gondar. Again, two representative rural kebeles were selected randomly from each sample district.

Finally, a total of 120 sample household heads were drawn from the updated list of sampling frame through simple random sampling technique in proportion to the total population of each sample kebele.

### Method of data analysis

To analyze the collected data the multinomial logistic model was used to assess the determinants of crop land management practices. To strengthen the quantitative data, the qualitative information was interpreted through explanations. Management and analysis of the data were undertaken by using Statistical Product and Service Solutions SPSS version 20 and STATA version 16 computer software packages.

### Econometric model specifications

In this study four mutually exclusive crop land management strategies were identified. These include using furrows only; using furrows and mulching; using a combination of furrows, mulching and terracing; and using furrows, mulching, terracing and tree planting together at the same time. Multinomial logit model is a widely used technique in the applications that analyze polytomous response categories in different areas of economic and social studies. Thus, to identify the determinants of rural households' decision to choose suitable crop land management strategy; the multinomial logit model was used. The assumption is that in a given period, a rational household head should choose among the four mutually exclusive crop land management strategies that could offer the maximum utility.

Following Greene (2003), suppose for the  $i^{\text{th}}$  respondent faced with  $j$  choices, the utility choice  $j$  can be specified as:

$$U_{ij} = Z_{ij}\beta + \varepsilon_{ij} \quad (1)$$

If the respondent makes choice  $j$  in particular, then  $U_{ij}$  is the maximum among the  $j$  utilities. So the statistical model is derived by the probability that choice  $j$  is made, which is:

$$\text{Prob}(U_{ij} > U_{ik}) \text{ for all others } K \neq j \quad (2)$$

Where;  $U_{ij}$  is the utility to the  $i^{\text{th}}$  respondent from crop land management strategy  $j$ ; and  $U_{ik}$  is the utility to the  $i^{\text{th}}$  respondent from crop land management strategy  $k$ . Thus, the  $i^{\text{th}}$  household's decision can be modeled as maximizing the expected utility by choosing the  $j^{\text{th}}$  crop land management strategy among  $J$  discrete crop land management strategies, i.e.:

$$\text{Max}_j = E(U_{ij}) = f_j(x_i) + \varepsilon_{ij}, \quad j=0, \dots, J \quad (3)$$

In general, for an outcome variable with  $J$  categories, let the  $j^{\text{th}}$  crop land management strategy that the  $i^{\text{th}}$  household chooses to maximize its utility could take the value 1 if the  $i^{\text{th}}$  household choose  $j^{\text{th}}$  crop land management strategy and 0 otherwise. The probability that a household with characteristics  $x$  chooses crop plan management strategy  $j$ ,  $P_{ij}$  is modeled as:

$$P_{ij} = \frac{\exp(X'_{ij}\beta_j)}{\sum_{j=0}^J \exp(X'_{ij}\beta_j)}, \quad j=0 \quad (4)$$

With the requirement that  $\sum_{j=0}^J P_{ij} = 1$  for any  $i$

Where

$P_{ij}$  = probability representing the  $i^{\text{th}}$  respondent's chance of falling into category  $j$ ;

$X_i$  = Predictors of response probabilities and  $\beta_j$  = Covariate effects specific to  $j^{\text{th}}$  response category with the first category as the reference. A convenient normalization that removes indeterminacy in the model is to assume that  $\beta_1 = 0$  (Greene, 2003). So that  $\exp(X_i \beta_1) = 1$ , implying that the generalized equation (4) above is equivalent to:

$$Pr(y_i = j | X_i) = P_{ij} = \frac{\exp(X_i \beta_j)}{1 + \sum_{j=1}^J \exp(X_i \beta_j)}, \text{ for } j = 0, 1, \dots, J \text{ and}$$

$$Pr(y_i = 1 | X_i) = P_{i1} = \frac{1}{1 + \sum_{j=1}^J \exp(X_i \beta_j)} = \quad (5)$$

Where;  $y$  = A polytomous outcome variable with categories coded from 0.....  $J$ .

Note: The probability of  $P_{i1}$  is derived from the constraint that the  $J$  probabilities sum to 1. That is,  $P_{ij} = 1 - \sum_{j=1}^J P_{ij}$ . So similar to binary logit model it implies that we can compute  $J$  log-odds ratios which are specified as:

$$\ln \left[ \frac{P_{ij}}{P_{i0}} \right] \times' (\beta_j - \beta_0) = \times' \beta_j, \text{ if } J=0 \quad (6)$$

The independent variables that expected to affect the choice of suitable crop land management strategy of rural households in the study area are farm experience of the household head, sex of the household head, family size, education level of the household head, land size of the household, livestock holding size of the household, access to irrigation, credit use, membership to cooperatives, extension contact, farm plot distance, access to mass medias, distance to the road and income.

## RESULTS AND DISCUSSION

### Discussion of the Econometric Model Results

In this section, it has been tried to estimate and present findings on factors that determine the choices of different crop land management strategies. Multinomial logit model regression shows the determinant variables for each category versus the base category. Accordingly, the base category is the household who choose crop rotation as a land management strategy. Hence, this strategy is used as a reference category.

The maximum likelihood method was employed to estimate the relative importance of predictor variables on the farmers' decision to choose suitable crop land management strategies. The STATA version 16 was used to generate the parameter estimates. The parameter estimates of the multinomial logit model give only the direction of the effect of explanatory variables on the dependent variable, but the estimates neither stand for the actual size of change nor the probabilities (Chilot, 2007). However, the marginal effect measures the expected change in the probability of a

given choice that has been made in relation to the unit change in the explanatory variable. Thus, the predicted probabilities are better interpreted using the marginal effects of the multinomial model (Greene, 2003).

The multinomial logit model analysis shows that out of the total thirteen explanatory variables entered into the model seven variables including age of the household head, education level of household, land holding size (ha), access to mass media, total household income and plot/farm distance in minutes were the significant determinants of the choice of land management strategies up to 10% level of significance.

### Age of the household head

It is found to be a significant variable at 5% level of significance in choosing a combination of Bunds, diversion ditches, inorganic fertilizer and counter plowing with respect to the base category crop rotation. The positive relationship indicates that as the age of the household head increases the experience and exposure to know different land management strategies increases.

### Education level of the household

It has a positive and significant effect on the decision of households to choose land management strategies at 5% level of significance. Farm household heads that have opportunity to study in formal educational institutions for a long period acquire more knowledge in relation to different land management strategies. In the study area, the majority of the respondents attended their education at least at primary school level. Therefore, there is a tendency to increased adoption of technologies with increased schooling period of farm household heads. Better educated farmers are aware of several kinds of land conservation measures through their good personal contacts with agencies involved in land management. Illiterate and low educated farmers cannot get such opportunities, which inhibit them from the adoption of conservation technologies.

### Land size of the household

It has a significant and positive influence on land management. Land size is positively and significantly related to choosing bund and fertilizer, counter plowing and diversion ditches and combination of bund, ditch, fertilizer and counter plowing at less than 1% level of significance. As the size of the farm land increases farmers choice of strategies also increases as the farmers can have a surplus portion of land for crop production.

### Farm plot distance

The farmers' decision of the choice to use bund and fertilizer on their plot is significantly and positively dependent on the location of the plot (farm distance) and total land holding size at less than 5% level of significance. Chemical fertilizer application has positive relationship with number of livestock and distance respectively. With increasing distance the application of chemical fertilizer is high because there is less probability to use organic fertilizer. This is because

**Table 1:** Multinomial logit model estimates of households' choice of land management strategies.

Variables	Households land management strategy choices					
	Bund+ Fertilizer		Counter plwg + Ditch		Bund+ Ditch+ fertilizer+ Cntplw	
	Coef (SE.)	Marg.effct	Coef (SE.)	Marg.effct	Coef (SE.)	Marg.effct
Sex	2.610 (1.309)	0.547	0.276 (1.348)	0.111	0.291(1.265)	0.184
Aghhs	0.053 (0.036)	0.004	0.048 (0.032)	0.003	0.053** (0.032)	0.005
Edction	0.057**(0.690)	0.001	0.139** (0.602)	0.018	0.060*** (0.591)	0.001
Family	0.506 (0.727)	0.070	0.239 (0.790)	0.070	0.320 (0.739)	0.048
Livestock	0.156 (0.384)	0.026	0.117 (0.379)	0.025	0.211 (0.337)	0.050
Land	2.779*** (0.724)	0.219	2.194*** (0.719)	0.153	2.259*** (0.701)	0.190
Extension	0.255 (0.233)	0.040	0.140 (0.220)	0.033	0.019*** (0.216)	0.001
Farmdist	0.280*(0.252)	-0.001	0.591 (0.235)	0.064	0.480 (0.236)	0.046
Masmedia	1.194** (0.667)	0.112	0.026* (0.610)	0.099	1.261** (0.595)	0.177
Credit	0.938 (0.767)	0.093	0.513 (0.633)	0.036	0.354 (0.630)	0.005
Market	-1.523 (0.659)	0.139	-0.729 (0.620)	0.013	1.098(0.597)	0.100
Income	0.0002*** (0.001)	0.001	0.001** (0.001)	0.699	0.001* (0.001)	0.311
Road	-0.408 (0.142)	-0.033	-0.233(0.125)	-0.005	-0.385 (0.127)	-0.042
Const	-2.930(1.918)		-2.001(1.791)		-2.421(1.717)	
Number of obs.		120				
LR chi2(48)		108.19				
Prob > chi2		0.000***				
Log likelihood		-159.758				
Pseudo R2		0.253				

increasing the number of livestock and nearer is the farm plot leads farmers to minimize the proportion of chemical fertilizers application due to the more organic fertilizers likely to serve as dominant soil fertilizing inputs.

#### Access to mass media

Household head access to mass media enables them to adopt different land management strategies at different level of significance. The household who have media exposure are most likely to have knowledge in different land management practices.

#### Access to extension

It has a positive and significant effect on the choice of land management strategies at less than 1% level of significance. When farmers have the chance to attended extension trainings they are most likely to use a combination of bund, Ditch, fertilizer application and counter ploughing. This indicates that extension training improves one's ability to understand and assimilate information about new agricultural technologies and implement different land management technologies.

## CONCLUSION AND RECOMMENDATION

The multinomial logit model was used to determine the probabilities of choosing land management strategy for a unit change in independent variables. The choice of the land management to be used on a farmers' plot was found to be significantly affected by the age of the household head, years spent in school by the household head and mass media exposure of the household head.

Adult education and Extension training need to be strengthened to increase awareness and improve land management practices. Training and extension services need to focus on the best practices to use based on the slope gradients of plots.

To facilitate adoption and implementation of new technology better management techniques recorded in the form of visual images can be viewed for farmers every where needed to be applied. Lastly yet importantly, any concerned body should strengthen mass media exposure of rural households through expanding infrastructures like roads, networks and light.

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