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THE IMPACT OF POVERTY, TENURE SECURITY AND RISK ON SUSTAINABLE LAND MANAGEMENT STRATEGIES IN NORTH CENTRAL ETHIOPIA: ANALYSIS ACROSS THREE AGRO-ECOLOGICAL ZONES

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ABSTRACT
Designing appropriate policies and strategies in order to enhance adoption of sustainable land management strategies requires proper understanding and thorough analysis of major triggering factors. Given high population pressure, degrading farmlands and poverty, sustainable land management strategies become essential tools not only to enhance soil fertility but also to increase farmland productivity on a long-term basis. Although several studies have been conducted, our knowledge of major triggering factors of poor level of land management across different farming systems in Ethiopia is still inadequate. Thus, using survey data from 254 randomly selected farmers from north central areas of Ethiopia, this study examined the impact of poverty, entitlement failures and risk on adoption of land management strategies. Multinomial logit model was used for the analysis. Results reveal that human (population pressure, education), physical (livestock, land) and financial (credit, market access) assets positively and significantly affect adoption of land management strategies, whereas poverty, tenure insecurity and risk have a negative and significant impact. The findings suggest that future endeavors should focus on targeting poverty, land tenure insecurity, helping farmers build assets and envisaging risk-management strategies in order to mitigate land degradation and improve productivity gains.
Keywords: Land Management; Risk; Tenure Insecurity; Poverty; Ethiopia

BACKGROUND ISSUES AND THE RESEARCH PROBLEM

Land degradation, which manifests itself in the form of soil erosion and nutrient depletion, is a very serious problem many countries are grappling with. Bai, Dent, Olsson and Schaepman (2008) indicate that at globally nearly 1.9 billion hectare of land, which hosts about 1.5 billion people, is degraded. On average, 5-8 million hectare of land gets out of production annually (Scherr, 1999).

According to the estimates of Brady (1990), only 12% of African soils is “moderately fertile” or “well-drained”, (compared to 33% in Asia), while 88% is infertile covering an area of about 494 million hectare in the continent. Although soils in most of SSA have inherently low fertility, (Batjes, 2001) they do not receive adequate nutrient replenishment. A study by FAO (2001) shows that SSA has the lowest mineral fertilizer consumption, which is about 10 kg nutrients (N, P_2O_5, K_2O)/ha/yr leading to "*a net decrease in available nutrients and organic matter in the soil*" (Scherr, 1999). The corresponding nutrient use for the world in general is about 90 kilo gram/hectare/year. In the Near East and Asia, the amount of nutrient use is about 60 kg and 130 kg/ha/yr, respectively.

Land degradation is a fundamental cause of decline in per capita food production in poor countries (Grepperud, 1995; Sanchez, Sheperd, Soule, Place, Buresh, Izac, Mokwunye, Kwesiga, Ndiritu & Woomer 1997). In rural SSA, more than 66.7% of over 525 million people depend on agriculture as a livelihood (Diagna, 2003) but productivity of the sector has been disappointingly declining or staying stagnant for the last several decades (Muchena, Onduru, Gachini & de Jager, 2005).

Like many countries of SSA, Ethiopia suffers from problems of poverty, land degradation, and low productivity. What makes these problems rather challenging is that 85% of the country's 77 million people reside in rural areas (CSA, 2006) where land is a basic means of survival. Agriculture contributes 84% of employment, 90% of the export earnings and about 45% of the Gross Domestic Product (GDP) (Ethiopian Economics Association/EEA, 2004). Because rural people derive their livelihood mainly from traditional and subsistence agriculture, farmers in Ethiopia do not have access to the essentials for their existence (Fritzen, Byon, Nowakovski & Pallock, 2006). Besides, the fact that agriculture is subsistent and highly volatile exacerbates poverty in the country. It is also performing poorly, which has been exacerbated by land degradation (Holden, Shiferaw and Pender., 2006). These problems are very serious particularly in the northern areas of the country, which host most of the livestock and human population (Hurni, 1993; Shiferaw & Holden, 1998). Research works show alarming rates of degradation. On croplands, average soil loss rates reach 42 t/ha/yr in the country as a whole. In individual fields however, the rate may reach up to 300 t/ha/yr (Hurni, 1993), which by far exceeds the natural rate of regeneration (Shiferaw & Holden, 1999). In these areas, both land quality and welfare are deteriorating over time (Holden, Benin, Shiferaw & Pender, 2003).

In order to design appropriate policies and strategies to reduce these problems, proper understanding and thorough analysis of major triggering factors is essential. Several studies have been conducted in identifying the major determinants of adoption of land management strategies; however, most have approached it from a limited angle. While some consider only one type of strategy, for example, terracing (Amsalu & Graff, 2007), others consider only fertilizer use (Fufa and Hasan, 2006). Moreover, several previous studies considered land management practices as binary variable (Benin, 2006; Pender, Ssewanyana, Edward & Nkonya , 2004; Place & Otsuka, 2002). However, using bivariate models to analyze land management strategies obscures important information and results in biased estimates, as it omits useful information contained in the simultaneity of adoption decisions (Bekele & Drake, 2003). It is essential to consider land management adoption decisions as multivariate variables. Thus, the major departure of this research is that land management strategies are choice sets, not independently made. The objectives of this study are twofold: 1) to identify the major determinants of sustainable land management strategies and 2) to examine the extent to which poverty, tenure insecurity and risk determine farmers' decisions in using sustainable land management strategies.

CONCEPTUAL FRAMEWORK AND HYPOTHESES

The conceptual framework of this study draws principally from the theories of technical and institutional induced innovation, which argue that access to markets, agricultural potential and asset endowments affect farmers' decisions to use sustainable land management practices (Boserup, 1965; Hayami & Rutan, 1985). These theories also attribute institutional factors and local asset endowments to the poverty-environment nexus and the decisions of farmers to adopt sustainable land management strategies.

The conceptual framework adapted here further tries to simplify a very complicated set of interactions among local causal and conditioning factors, poverty, risk and uncertainty, and farmers' responses in managing their land sustainably. The assumption is that local causal and conditioning factors as well as institutional attributes affect both poverty and the use of sustainable land management strategies directly.

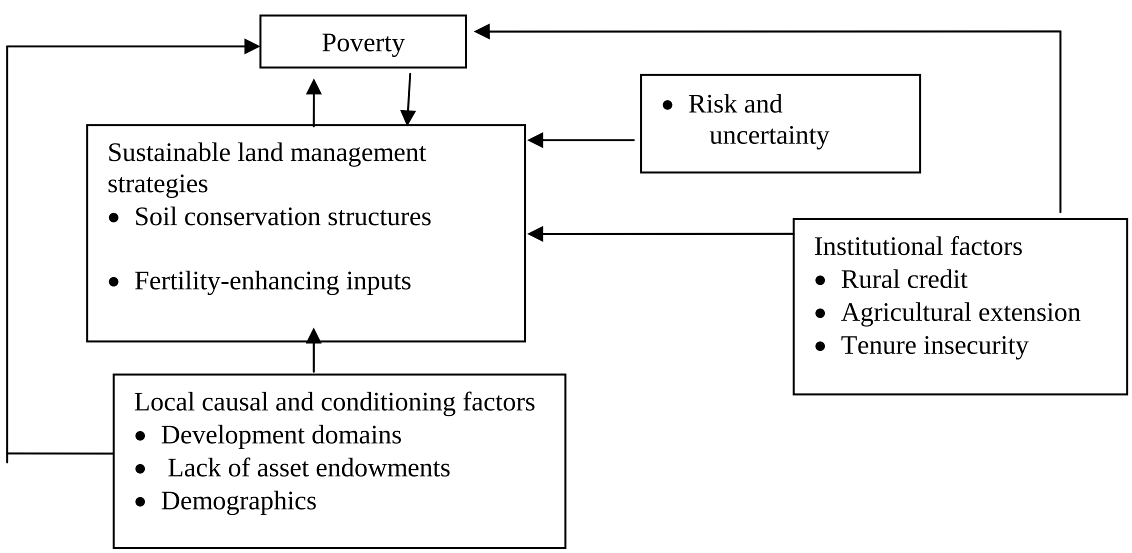

Figure 1: Schematic depiction of the conceptual framework

Source: Own construction

Based on the above-mentioned general assumptions, the study formulates the following three specific hypotheses:

i. Poverty negatively affects the use of sustainable resource management strategies such as soil structures, input use, and other proper land management practices,

ii. Risk and uncertainty is a major factor negatively influencing the use of sustainable resource management, and

iii. Tenure insecurity reduces the likelihood of adopting sustainable land management strategies.

DATA, SAMPLING AND METHODS

Data and sampling

This study was conducted in East Gojjam zone of the Amhara Regional State, which is located in the north-western part of Ethiopia. Sampling procedures involve multiple stages. First, three districts were purposively selected from East Gojjam zone namely; Debay Tilatgin, Enemay and Shebel Berenta and peasant associations in the three districts were grouped into three agro-ecological zones such as, *dega* (2300- 3200 m a.s.l) *woina dega* (1500-2300m a.s.l) and *kola* (500-1500m a.s.l). Second, a total of ten peasant associations/*kebeles* were randomly selected from all the districts. Third, 285 households were randomly selected from the chosen peasant associations. A detailed questionnaire was administered to household heads. Eventually, 254 questionnaires were used for the final analysis and the rest discarded due to their inadequate information. Data also stem from secondary sources, mainly from different government departments.

Model specification

A multinomial logit model is used for the analysis because the dependent variable is treated as a multivariate variable. In this study, we developed a model that takes into account the impact of poverty such that land management strategy LM is a function of poverty P and other factors X_i^{LM} .

Hence,

$$LM = f_1(P_i, X_i^{LM}) \quad (1)$$

On the other hand, poverty P is a function of land management strategies LM and other factors X_i^P . Thus,

$$P = f_2(LM_i, X_i^P) \quad (2)$$

Since poverty is endogenous in the LM equation, its predicted value from the first stage regression is used as explanatory variable for the second and final estimation. On the other hand, LM is treated as a choice set. Therefore, following the technicalities applied in Greene (2000) and Theil (1969) on modelling unordered choices, the use of sustainable land management strategies is linked to a random utility framework, where the i^{th} farmer faces k land management choice. In this case, the utility of land management strategy choice k is given by.

$$U_{ik} = \beta_k' X_{ik} + \varepsilon_{ik} \quad (3)$$

Where,

U_{ik} is the utility of household i derived from land management practice choice k

X_{ik} is a vector of factors that affect the decision to use a particular land management practice choice k ,

$\beta_k^{'}$ is a set of parameters that reflect the impact of changes in X_{ik} on U_{ik} ,

ε_{ik} is the disturbance term, which is assumed to be independently and identically distributed.

If farmers choose land management strategy k , then U_{ik} is the maximum among all possible utilities.

When each land management strategy is considered as a possible decision variable, farmers are expected to choose a strategy that maximizes their utility given the available alternatives (Greene, 2000; Theil, 1969). The choice of k depends on X_{ik} , which includes household demographic characteristics, socio-economic, institutional and policy-related variables. If Z_i is a random variable that indicates the choice made, then the multinomial logit form of the multiple choice problem, according to Maddala (1983) is given by:

$$\Pr ob(Z_i = k) = \frac{e^{\beta_k^{'} X_{ik}}}{\sum_{k=1}^{k} e^{\beta_k^{'} X_{ik}}}, k = 0,1,2,..., k \quad (4)$$

Estimating equation (4) provides a set of probabilities for $k+1$ land management strategy choices for a decision maker with characteristics denoted by X_{ik} . Assuming that $\beta_0 = 0$, equation (4) can be normalized and the probabilities can be estimated as:

$$\Pr ob(Z_i = k) = \frac{e^{\beta_k^{'} X_{ik}}}{1 + \sum_{k=1}^{k} e^{\beta_k^{'} Z_{ik}}} \quad (5)$$

and,

$$\Pr ob(Z_i = o) = \frac{1}{1 + \sum_{k=1}^{k} e^{\beta_k^{'} X_{ik}}} \quad (6)$$

Normalizing on any other probabilities yields the following log-odds ratio:

$$Ln\left[\frac{P_{ik}}{P_{il}}\right] = x_i^{'}(\beta_k - \beta_l) \quad (7)$$

The dependent variable is the log of one alternative relative to the reference alternative. The coefficients in a multinomial logit model are difficult to interpret (Greene, 2000). Therefore, the marginal effects of the explanatory variables on the choice of alternative land management strategies are derived as follows:

$$m_k = \frac{\partial P_k}{\partial X_i} = P_k\left[\beta_k - \sum_{k=0}^{k} P_l\beta_l\right] = P_k\left[\beta_k - \overline{\beta}\right] \quad (8)$$

According to Greene (2000), the marginal probabilities measure the expected change in the probability of a particular choice being selected with respect to a unit change in the independent variable.

DEFINITION OF VARIABLES

Table 1: Description of variables

Variable name	Description
Sustainable land management strategy (Dependent variable)	"1" = soil fertility-enhancing inputs (PES) only, "2" = soil conserving practices (RCP) only, "3" = both PES and RCP, and "4" = no conservation.
Poverty	"1" for poor and "0" otherwise
Age of household heads	A continuous variable measured in years
Education of household heads	"1" = educated in elementary and above, "0"= otherwise
Credit access	"1" for "yes" and "0" for those who do not have credit access
Land tenure insecurity	"1" for "secured" and "0" otherwise.
Gender	"1" for male and "0" otherwise
Non-farm activity	"1" for "yes" and "0" otherwise.
Livestock (TLU)	A continuous variable
Location in *kola* areas	"1" if households are located in *kola* (less-favored) areas and "0" otherwise
Location in *woina dega* areas	"1" if households are located in *woina dega* areas and "0" otherwise
Family-farm size ratio	A ratio variable adult equivalent units/ total farm size (ha).
Training in NRM	"1" if households get training on natural resource management and "0" otherwise.
Proximity to markets	A continuous variable expressed in km
Family size	A continuous variable (adult equivalent units)
Risk and uncertainty	"1" for good rain fall expectations and "0" otherwise.
Degradation perception	"1" for "yes" and "0" otherwise.

RESULTS AND DISCUSSION

Description of Land Management Practices

Farmers use different land management practices in the study area including grass strips, soil bunds, stone bunds, fertilizers, crop rotation, manure/compost, and crop residues with varying extent across agro-ecological zones. The most commonly used soil fertility-enhancing mechanism is crop rotation followed by fertilizer application. Crop rotation is applied by 83.3%, 85%, and 62.9% of the respondents in d*ega*, *woina dega*, and *kola* areas respectively, whereas fertilizer is used by a great deal of farmers in *woina dega* areas (84%) followed by *dega* agro-ecology (77%) and few in *kola* areas (7.5%).

There is a significant difference between the percentages of farmers who use these technologies in the study area. Chi-Square tests reveal that higher percentage of respondents use grass strips and soil bunds in *dega* areas (7.3% and 12% respectively). The respective figures for *woina dega* areas are 3% and 4%. In *kola* areas, only insignificant segment of the respondents use grass strips and soil bunds. Stone bunds are most commonly used in *kola* areas followed by *woina dega* and *dega* areas in the order of mention.

Table 2: Types of land management practices used by respondents

Variables (%)	*Dega (high lands)*	*W. Dega (middle altitudes)*	*Kola (low lands)*
Soil Bunds	12	4	1.2
Stone Bunds	2.5	27	76.4
Grass Strips	7.3	3	1.4
Fertilizer	84	77	7.5
Crop Rotation	83.3	85	62.9
Manure	2.4	1	0.5

Use of manure is very negligible in the study area; only a small number of households apply it. Even then, the percentage of households who use manure for land management clearly decreases as the altitude decreases. This means that most farmers use manure in *dega* areas followed by *woina dega* areas and that of *kola*. In *kola* and *woina dega* areas, most people use dung cakes for fuel, not for fertilizing farmlands. It should be made clear that higher opportunity costs for fuel might hamper the traditional use of dung for regenerating soil fertility in the study area.

Soil fertility-enhancing mechanisms also include mulching and the use of crop residues. However, the use of these land management practices is almost negligible in the study area. Even at worse, observations witness that farmers commonly graze their livestock on their farmland after harvest, a situation which exposes farmlands to wind and water erosion, and moisture loss due to evaporation.

Determinants of Land Management Practices

Results in Table 3 indicate that land tenure security positively and significantly affects the use of sustainable land management strategies in the study area. This implies that farmers, who feel secured, follow sustainable intensification. This is in line with the results of other empirical studies in Ethiopia (Demeke & Hunde, 2004). In fact, empirical evidences offer mixed results (Bekele & Drake, 2003; Mortimore, 1989). Mortimore (1989) finds evidence of small-scale farmers' willingness to forgo short-term income gains even under price and famine pressure to pursue long term sustainable management strategies. However, several studies cite land tenure insecurity as the primary reason for poor farmers' excessive cultivation of their land due to absence of vested interest in conserving an asset that they do not own (Mink, 1993).

According to conventional wisdom, farmers with limited human capital, such as low education level, are expected to follow unsustainable farming practices. In fact, it could be argued that when a farmer gets access to better education, then he or she may gain better opportunities outside the farm sector to pursue other income-earning ventures. Ultimately, this reduces labour availability for farm management activities in a household. However, the result in this study indicates that education status of household heads positively and significantly affects the probability of using land management strategies, which corroborates with Feder, Just and Zilberman (1985), and Asfaw and Admassie (2004).

Results also indicate that access to markets positively and significantly affects the likelihood of using productivity-enhancing strategies (PES) but significantly reduces the probability of adopting conservation structures (RCP). The assumption is that proximity to markets increases farmers' access to credit facilities and income-generating activities and also reduces transaction costs that enable them to buy and apply soil fertility-enhancing inputs in time.

Results further reveal that households with large families with respect to the size of their land holding, are more likely to undertake sustainable land management strategies. This is because areas with high population pressure are characterized by high scarcity of farmlands where households use their plots more intensively as compared with areas where there is relatively lower scarcity of land. This means that high population pressure increases the relative scarcity of land thereby increasing the incentives for efficient utilization of farmlands. With the consequential effect of population pressure on relative abundance of labor, land management may increase, as farmers will use soil fertility-increasing and yield-enhancing technologies (Boserup, 1965). This is evident in our study from the effect of the square of family size-farm size ratio on the probability of using different land management strategies (such as PES or both PES and RCP), which turns out to be positive and significant.

Table 3: Determinants of land management practices (Marginal Effects)

Explanatory Variables	RCP	PES	combined
Age of the household head	0.003 (0.011)	-0.007* (0.004)	-0.061* (0.036)
Education status (1 = literate/formal education)	0.099 (0.210)	0.038** (0.017)	0.012*** (0.000)
Tenure security (1 = yes)	0.052*** (0.001)	0.022* (0.013)	0.046* (0.025)
Proximity to markets (km)	-0.029* (0.017)	0.024** (0.013)	0.013 (0.029)
Degradation perception (1= perceived degraded)	0.015* (0.008)	-0.009 (0.027)	-0.001 (0.121)
Access to credit (1 = yes)	-0.035 (0.341)	0.028* (0.015)	0.016 (0.052)
Has taken training on natural resource management (1= yes)	0.027 (0.162)	0.066** (0.031)	0.057 (0.083)
Expected rainfall condition (1 = good)	0.021 (0.092)	0.031** (0.015)	0.052* (0.027)
Tropical Livestock Units	0.019 (0.086)	0.002** (0.001)	0.013 (0.061)
Family size-farm size ratio	-0.038 (0.067)	-0.026 (0.089)	-0.001 (0.028)
Family size-farm size ratio squared	0.010 (0.025)	0.004** (0.002)	0.008* (0.0047)
Poverty status (predicted value)	-0.017 (0.056)	-0.023*** (0.000)	-0.073** (0.038)
Non-farm activity (1 = yes)	-0.022* (0.013)	-0.032 (0.096)	-0.074 (0.064)
Gender of the household head (1 =male)	0.046** (0.021)	0.001 (0.042)	0.051 (0.039)
Dummy Woina Dega	0.029 (0.054)	0.033 (0.070)	0.059 (0.035)
Dummy Kola	0.048* (0.026)	-0.061** (0.031)	-0.061** (0.036)
Constant	1.508*** (0.000)	1.749*** (0.000)	1.571*** (0.000)

** No conservation is used as a comparison group*

Studies (Smidts, 1990; Mazid and Bailey, 1992; Paudel, Lohr & Martin, 2000) indicate that risk and uncertainty are one of the major determinants of technology adoption, production, and investment decisions of farmers. By constraining farmers from investing on their farmland, risks and uncertainties undermine agricultural intensification, increased productivity and sustainable livelihoods. In this study, interesting results emerge. To begin with, expected rainfall condition is used as a proxy for risk, which is found to be a very important determining factor of sustainable land management strategies in the study area. If expected rainfall is good, then farmers tend to apply more inputs such as fertilizer per hectare than in a situation where expected rainfall is bad. It should be noted that climatic uncertainties strongly influence traditional farming systems that are predominantly rain-fed. The unpredictable conditions, risk perceptions, and expected low returns determine the decisions farmers may make with regard to how much yield-enhancing inputs (fertilizers) to apply per unit area. This is because fertilizers are obtained on credit basis to be paid during harvest. During crop failure, farmers cannot pay loans back due to bankruptcy. To avoid this risk, most farmers consider expected rainfall condition as a decisive factor in deciding whether to take fertilizers on instalments.

Livestock ownership, training in natural resource management and access to credit have a positive and significant influence on the probability of using productivity-enhancing strategies (PES). Access to credit improves problems of liquidity and enhances use of agricultural inputs in production as it is often claimed in development theory. By relaxing the financial constraints, credit helps reduce the extent to which households discount the future and this would enable them to make more investment in land conservation (Pender & Kerr, 1998; Holden, Shiferaw & Pender, 2004).

Research works offer mixed results as regards the sign of age in affecting land management strategies (Baidu-Forson, 1999; Basnayake & Gunaratne, 2002; Bekele and Drake, 2003). While some indicate that age positively influences adoption (Amsalu & Graff, 2007), others indicate that age has negative impact. In our study, age is found to be negative and significant in affecting adoption of both fertility-enhancing strategies (PES) and a combination of PES and RCP.

Results (in Table 3) also reveal that while poverty negatively and significantly affects the use of PES and combined strategies (PES plus RCP), location in *Kola* areas facilitates the use of RCP, but impedes the use of PES and both PES and RCP. The negative sign for poverty shows that households whose basic needs income is very low are more likely to fall into long-term land degradation by cultivating their farmlands more frequently and improperly. This result supports the widely held view that poor farmers have a limited time horizon, and are bound to overexploit their land during their lifetime regardless of long-term consequences (Abdelgalil & Cohen, 2001). Besides, during droughts, poor people are induced to scavenge more intensively, seeking out wood, dung cake, and other organic fuels to sell so as to meet daily survival needs. As a result, the quantities of materials that are returned to the soil are reduced. This aggravates fertility decline of farmlands that are already under stress from continuous cultivation. The time-preference argument also suggests the presence of immediate and urgent needs to be satisfied in a situation where the poor face a trade-off between the immediate demands for fuel and manure for the land (Mink, 1993). On the other hand, the poor allocate their labor to less-productive activities such as fuel wood and dung cake collection (Kumar & Hotchkiss, 1988), which attract much of their labor, leaving very little time to be spent on their farm land management activities.

The impact of non-farm activities on land management practices is not clear beforehand. Some indicate positive results arguing that through non-farm work, farmers can relax their financial constraints so that they can buy inputs such as fertilizers (Holden, Shiferaw & Pender, 2004). Others contend that non-farm employment takes labor away from farm operation leading to little time devoted to land management. As a result, the relative importance of land conservation practices diminishes since it raises the opportunity cost of labor. Consequently, farmers have less incentive to undertake the necessary conservation measures on their farmlands. The result of our study is consistent with other empirical evidences (Shiferaw & Holden, 1998) showing that non-farm activities undermine land management efforts such as conservation structures.

The result of this study also confirms that the more a farmer perceives that there is a problem of land degradation in his or her farmland, the more the chances for him or her to engage in conservation activities such as stone bunds, soil bunds, and grass strips (RCP only).

CONCLUDING REMARKS

Ethiopia, like many countries of SSA, suffers from the problems of poverty, land degradation, and low productivity, which pose serious policy challenges for sustainable development. What makes these problems rather challenging is the overwhelming majority of the country's people reside in rural areas where land is a basic means of survival, a source of income and an object of utilization. It is to be noted that since rural people in the country derive their livelihood mainly from traditional and subsistence agriculture (which is not supported by technological back up), farmers do not have access to the essentials for their existence on a sustainable basis. Therefore, designing appropriate policies and strategies in order to enhance adoption of sustainable land management strategies requires proper understanding and thorough analysis of major triggering factors.

With the above-mentioned issue in mind, this study sought to) identify the major determinants of sustainable land management strategies and 2) examine the extent to which poverty, tenure insecurity and risk determine farmers' decisions in using sustainable land management strategies. Using a multinomial logit model, the study brings useful insights for policy formulation by suggesting that apart from supporting farmers with some sort of insurance or loans in order to help them adopt sustainable land management strategies. It is essential to help them in their pursuit of climate adaptation and mitigation mechanisms through targeted education and extension programs. Results also suggest that facilitating market information and developing road infrastructure would be helpful in the future to help farmers adopt sustainable land management strategies. On top of that, if desired outcomes are to be brought in sustainable land management strategies in Ethiopia so as to enhance sustainable development in general and agricultural development in particular, farmers should be given entitlement rights to manage their land on a long-term basis. However, further research is still needed to gauge the magnitude of land degradation using panel data and spatial models across different farming systems.

REFERENCES

Abdelgalil, E.A. & Cohen, S.I. (2001). Policy Modelling of the Trade-Off Between Agricultural Development and Land Degradation: The Sudan Case. *Journal of Policy Modelling*, 23, 847–874.

Amsalu, A. & Graff J. (2007). Determinants of Adoption and Continued Use of Stone Terraces for Soil and Water Conservation in an Ethiopian Highland Watershed. *Ecological Economics*, 61, 294-302.

Asfaw, A. & Admassie, A. (2004). The Role of Education on the Adoption of Chemical Fertiliser under Different Socioeconomic Environments in Ethiopia. *Agricultural Economics*, 30(2).

Bai, Z.G., Dent, D.L., Olsson, L. & Schaepman, M.E. (2008). Proxy Global Assessment of Land Degradation. *Soil Use and Management*, 24, 223–234.

Baidu-Forson, J. (1999). Factors Influencing Adoption of Land-Enhancing Technology in the Sahel: Lessons from a Case Study in Niger. *Agricultural Economics*, 20, 231-239.

Basnayake, B. & Gunaratne, L. (2002). Estimation of Technical Efficiency and Its Determinants in the Tea Small Holding Sector in the Mid Country Wet Zone of Sri Lanka. *Sri Lankan Journal of Agricultural Economics,* 4(1), 137-150.

Batjes, N.H. (2001). Options for Increasing Carbon Sequestration in West African Soils: An Explanatory Study with Special Focus on Senegal. *Land Degradation & Development,* 12, 131-142. International Centre and United Nations Environment Programme.

Bekele, W. & Drake, L. (2003). Soil and Water Conservation Decision Behavior of Subsistence Farmers in the Eastern Highlands of Ethiopia: A Case Study of the Hunde-Lafto Area. Ecological Economics, 46, 437–451.

Benin, S. (2006). Policies and Programs Affecting Land Management Practices, Input Use, and Productivity in the Highlands of Amhara Region, Ethiopia. In J. Pender, F. Place, and S. Ehui (Eds.), *Strategies for sustainable land management in the East African Highlands*. Washington, D.C.: International Food Policy Research Institute.

Boserup, E. (1965). *The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure.* Chicago: Aldine Publishing Co.

Brady, N.C. (1990). *The Nature and Properties of Soils: Tenth Edition*. New York: MacMillan.

Central Statistical Authority of Ethiopia (2006). Statistical Abstract, Addis Ababa.

Demeke, M. & Hunde, B. (2004). *Population Pressure and Intensification of Agricultural Production in Ethiopia: The Will and Cost of Overcoming Malthusian Trap.* Faculty of Business and Economics, University of Addis Ababa, Mimeo.

Diagana, B. (2003). *Land Degradation in Sub-Saharan Africa: What Explains the Widespread Adoption of Unsustainable Farming Practices.* Mimeo: Montana State University, Bozeman.

Ethiopian Economics Association (EEA). (2004). Report on the Ethiopian Economy: Transformation of the Ethiopian Agriculture: Potentials, constraints and suggested intervention measures. Ethiopian Economic Association, 4.

FAO, 2001. The economics of soil productivity in Sub-Saharan Africa, Rome.

Feder, G., Just, R.E. & Zilberman, D. (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change,* 33, 255–297.

Fritzen, A., Byon, H., Nowakovski, A., & Pallock, A. (2006). Ethiopia: A Risk Assessment Brief. Based on CIFP Risk Assessment Methodology.

Fufa, B. & Hasan, R.M. (2006). Determinants of Fertilizer Use on Maize in Eastern Ethiopia: A Weighted Endogenous Sampling Analysis of the Extent and Intensity of Adoption. *Agrekon,* 45(1).

Greene, W.H. (2000). *Econometric analysis: Fourth edition.* Prentice Hall, New Jersey.

Grepperud, S. (1995). Soil Conservation and Government Policies in Tropical Areas: Does Aid Worsen the Incentives for Arresting Erosion. *Agricultural Economics,* 12, 129–140

Hayami, Y. & Ruttan, V.W. (1985). Agricultural Development: An International Perspective, Revised Edition. Baltimore, MD: Johns Hopkins University Press.

Holden, S., B. Shiferaw, and J. Pender (2006). Policies for Poverty Reduction, Sustainable Land Management, and Food Security: A Bioeconomic Model with Market Imperfections. In Strategies for Sustainable Land Management in the East African Highlands, eds. Place, F., J. Pender and S. Ehui, International Food Policy Research Institute, Washington, D.C.

Holden, S., Shiferaw, B. & Pender, J. (2006). Policies for Poverty Reduction, Sustainable Land Management, and Food Security: A Bioeconomic Model with Market Imperfections. In F. Place, J. Pender, and S. Ehui (Eds.), *Strategies for Sustainable Land Management in the East African Highlands.* Washington, D.C.: International Food Policy Research Institute.

Holden, S.T., Benin, S. Shiferaw, B. & Pender, J. (2003). Tree Planting for Poverty Reduction in Less-Favored Areas of the Ethiopian highlands. *Small-Scale Forest Economics, Management and Policy* 2 (1): 63–80.

Holden, S.T., Shiferaw, B. & Pender, J. (2004). Off-Farm Income, Household Welfare and Sustainable Land Management. *Food Policy,* 29, 369–392.

Hurni, H. (1993). Land Degradation, Famines and Resource Scenarios in Ethiopia. In D. Pimental (Ed.), *World Soil Erosion and Conservation* (pp. 27-62). Cambridge: Cambridge University Press.

Kruger et al., 1996. Creating and inventory of indigenous soil and water conservation measures in Ethiopia, in Scoons *et al*, *Sustaining the Soil: Indigenous Soil and Water Conservation in Africa*, Earthscan, London.

Kumar S. and Hotchkiss. D. (1988). Consequences of Deforestation for Women's time allocation. Agricultural Production and Nutrition in Hill Areas of Nepal. IFPRI Research Report No. 69, October.

Maddala, G.S. (1983). Limited Dependent and Qualitative Models in Econometrics. New York: Cambridge University Press.

Mazid, A. *&* Bailey E *(*1992). Incorporating risk in economic analysis of agronomic trials: fertilizer use on barley in Syria, *Agricultural Economics*

Mink, S. (1993). Poverty and the Environment. *Finance and Development,* 30(4), 8-10

Mortimore, M. (1989). *Adapting to Drought: Farmers, Famines and Desertification in West Africa.* Cambridge: Cambridge University Press.

Muchena, F., Onduru, D., Gachini, G., & de Jager, A. (2005). Turning the Tides of Soil Degradation in Africa: Capturing the Reality and Exploring Opportunities. *Land Use Policy,* 22, 23–31.

Paudel, K.P., Lohr, L., & Martin, N.R. (2000). Effect of Risk Perspective on Fertilizer Choice by Sharecroppers. *Agricultural Systems*, 66, 115-128.

Pender, J. & Kerr, J. (1998). Determinants of Farmers' Indigenous Soil and Water Conservation Investments in India's Semi-Arid Tropics. *Agricultural Economics,* 19, 113–125.

Pender, J., Ssewanyana, S., Edward, K., & Nkonya, E. (2004). Linkages Between Poverty and Land Management in Rural Uganda: Evidence from the Uganda National Household Survey, 1999/2000. Environment and Production Technology Division Discussion Paper No. 122. Washington, D.C.

Place, F & Otsuka, K. (2002). The Role of Tenure in the Management of Trees at the Community Level: Theoretical and Empirical Analyses from Uganda and Malawi. In R. Meinzen-Dick, A. Knox, F. Place, and B. Swallow (Eds.), *Innovation in Natural Resource Management: The Role of Property Rights and Collective Action in Developing Countries* (pp. 73-99). The Johns Hopkins University Press, The Johns Hopkins University Press, Baltimore, Maryland, U.S.A.

Sanchez, P.A., Sheperd, K.D., Soule, M.J., Place, F.M., Buresh, R.J., Izac, A.-M.N., Mokwunye, A.V., Kwesiga, F. R., Ndiritu, C.G., & Woomer, P.L. (1997). Soil Fertility Replenishment in Africa: An Investment in Natural Resource Capital. In R.J. Buresh (Ed.), Replenishing Soil Fertility in Africa, SSSA Special Publication No. 51, America.

Scherr, S.J. (1999). Soil Degradation: A Threat to Developing-Country Food Security by 2020. International Food Policy Research Institute, Food, Agriculture and the Environment, Discussion Paper, February27.

Shiferaw, B. & Holden, S. (1999). Soil Erosion and Smallholder's Conservation Decisions in the Highlands of Ethiopia. *World Development*, 27(4), 739-752.

Shiferaw, B. & Holden, S.T. (1998). Resource Degradation and Adoption of Land Conservation Technologies in the Ethiopian Highlands: A Case Study in Andit Tid, North Shewa. *Agricultural Economics,* 18, 233–247.

Smidts, A. (1990). Decision Making Under Risk: A Study of Models and Measurement Procedures with Special Reference to the Farmer's Marketing Behavior. Wageningen Economic Studies No. 18, Pudoc, Wageningen University.

Theil, H. (1969). A Multinomial Extension of the Linear Logit Model. *International Economic Review*, 10, 251-259.

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