International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

LANDHOLDERS' CHOICE TO ADOPT IMPROVED WATERSHED MANAGEMENT IN THE LOWER BLUE NILE BASIN, ETHIOPIA

[1*]Befikadu A. Legesse and [2]Osei-Agyeman Yeboah

[1]Environmental Economist (Ph.D.), L.C. Cooper, Jr. International Trade Center, College of Agricultural and Environmental Sciences, North Carolina A&T State University, A-29, C.H. Moore Agricultural Research Station, 1601 East Market Street, Greensboro, NC, 27411-1011, USA

[2]Professor Ph.D., Director of L.C. Cooper, Jr. International Trade Center, College of Agricultural and Environmental Sciences, North Carolina A&T State University, A-25, C.H. Moore Agricultural Research Station, 1601 East Market Street, Greensboro, NC, 27411-1011, USA

*Corresponding Author

ABSTRACT

Watersheds are tremendously degraded worldwide, largely in developing countries especially in the Blue Nile Basin in Ethiopia. The degradation is due to several factors including pressure from land use and economic development. The degradation might be characterized by poor water quality, irregularity in water quantity, heavy floods that destroy life and property, sediment deposition in streams and irrigation canals; and sediment deposition on dams etc. Studies have suggested different watershed management interventions to end these problems, especially in developing countries. They include reforestation; construction of stone terrace; soil bunds; water harvesting technologies; and crop residue management. However, most landholders are not adopting these recommended technologies mainly due to socio-economic, institutional and policy-related issues. This paper empirically examines existing factors that are perceived to affect landholders' decisions for adopting improved watershed management intervention technologies in the Blue Nile Basin in Ethiopia. A multi-stage probability sampling techniques were used to sample 300 respondents and a binary Logit model was applied to the data. Results indicate that education, age, farm size, farmers' day/field visit, distance to nearest market, tropical livestock unit, farmers' preference/attitude towards watershed management and fertilizer application are found to be significant factors that influence downstream landholders' decision to adopt improved watershed management technologies.

Keywords: Adoption behavior, improved watershed management, soil bunds, downstream landholders, binary logit model.

1. INTRODUCTION

Watershed encompasses environmental and natural resources, which sustain diversified ecosystem services (Randhir *et al*., 2001) as well as economic and recreational benefits (Alemayehu *et al*., 2008; Legesse 2014). Studies show that watersheds have been extremely degraded in developing countries (Kosoy *et al*., 2006; Engel *et al*., 2008; Legesse, 2014) due to erosion, changes in farming systems, overgrazing, deforestation, pollution etc. (Alemayehu *et al*., 2008; Darghouth *et al.,* 2008; Wunder *et al*., 2008). The degradation has caused adverse impact on water quality, irregularity of water quantity, heavy floods, sediment deposition etc. especially in developing countries like Ethiopia (Pagiola *et al*., 2007; Wunder and Albán, 2007; Setegn, 2008; Darghouth *et al.,* 2008; Asquith *et al.,* 2008; Ashagre, 2009; Legesse, 2009; Mengstie, 2009). The Blue Nile Basin is one of the endangered Basins in Ethiopia due to the degradation. Studies suggest various watershed management[1] interventions to end these problems. These include soil conservation practices, preservation of hydrologic services, rehabilitation of degraded lands through physical and biological measures etc. (World Bank, 2006; Alemayehu *et al*., 2009; MOA-SLM, 2013). Also exist, are various improved watershed management technologies recommended for the downstream stratum that differ from the upper stratum of the Basin (BOA, 2012; MOA-SLM, 2013). These practices include construction of soil bunds, grass strips plantation, crop rotation, intercropping, strip cropping, manure/compost, inorganic fertilizer application, multi-storage gardening and farm ponds construction (Alemayehu *et al*., 2009; BOA, 2012; MOA-SLM, 2013). Among these measures, soil bund has been practiced for a couple of decades in the lower stratum of the Basin. However, this measure is not adopted by downstream landholders due to various reasons (BOA, 2012; Legesse, 2014). This paper examines determinants of landholders' adoption behavior towards soil bunds as a management practice that contributes to a pollution-free watershed. This study was done in the lower stratum of Koga watershed of the Blue Nile Basin through interviewing 300 respondents. The sampled respondents were selected using multi-stage probability sampling techniques. We employed a binary logit model to the data.

2. THE STUDY AREA

Kog watershed is located in eastern part of the Blue Nile Basin, Ethiopia, between 11°8' North to 11°25' North latitude and 37°2' East to 37°20' East longitude with a total drainage area of 299 km^2 (Bitew and Gebremichael, 2011; Legesse, 2014) (see Figure 1). The watershed's elevation ranges from 1,800 to 3,200 m. a. s. l. with an average annual rainfall of 1,560 mm and average daily temperature between 16°C to 20°C (Alemie, 2009; Kassahun, 2009; Legesse, 2014).

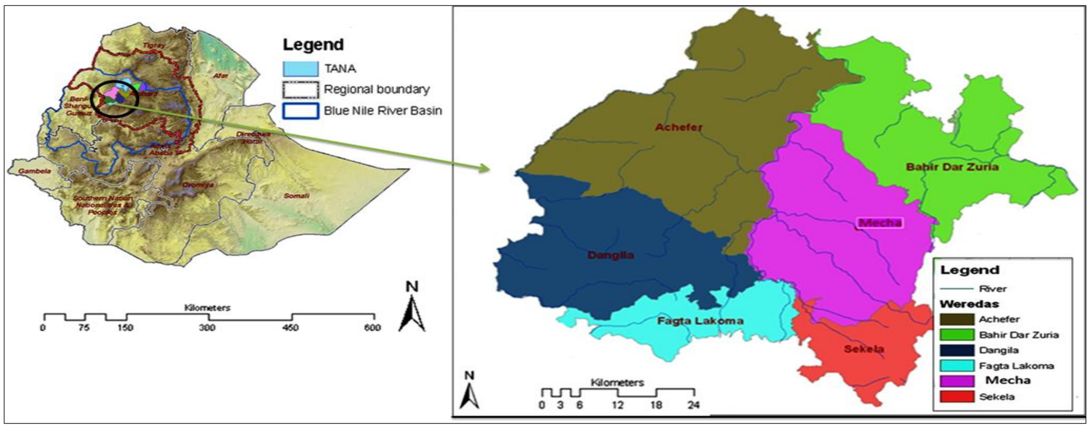
[1] Watershed management refers to integrated measures that have been put into practice to secure sustainable provisions of watershed services (Kaledhonkar *et al*., 2007).

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

According to the district agro-ecological[2] zones classification, the downstream part is characterized by wide flat to gently sloping topographies (Legesse, 2014). The watershed has high rainfall during July to September with highest mean monthly rainfall in July and highest evapotranspiration in May (Alemayehu *et al*., 2008).

Figure 1: Map of the study area



Source: ILRI – IPMS, 2012 and adopted by Legesse, 2014

3. METHODOLOGY

3.1 Data collection and sampling techniques

Data was collected from sampled farmers by employing structured questionnaires. The questionnaires were used to collect socio-economic, demographic, behavioral and institutional information. Experienced enumerators administered the data collection with close supervision. The survey data was augmented with secondary data from Central Statistical Agency, Ministry of Agriculture and District Bureau of Agriculture to obtain general information about the study area.

The study employed multi-stage probability sampling techniques to select respondents: in the first stage, *Koga* watershed was selected purposively. In the second stage, five *Kebeles* (the lower local administrative region next to district) were selected based on simple random sampling procedure. In the third stage, *Gottes* (the lower local administrative region next to *Kebele*) were selected based on proportional random sampling procedure. In this stage, the *Gottes* in each sampled *Kebele* were stratified into three groups depending on their distance (nearby, moderate, far away) from the center of local administration office. Following, six *Gottes* from each *Kebele* (at the rate of two *Gottes* from each stratified groups) were selected based on

[2] Agro-ecological zones classified based on rainfall patterns, temperature, soil types, altitude and other physical landscapes (Alemu *et al*., 2009).

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

random sampling procedures. Finally, the sampled farmers were selected from sampled *Gottes* based on systematic random sampling procedures. The lists of farmers and *Gottes* were obtained from development centers and local administrative offices of the respective *Kebeles*. A total of 300 downstream farmers were selected for this study.

3.2 Theoretical Framework

Binary logit and Probit models are quite comparable and have the same S-shaped curves that bound in an interval from 0 to 1 (Pindyck and Rubinfeld, 1981; Gujarati, 1995; Alemayehu, 2007). The logit model has slightly flatter tails and assumes cumulative logistic probability function. Whereas, the Probit model is associated with cumulative normal distribution (Pindyck and Rubinfeld, 1981; Gujarati, 1995; Alemayehu *et al.* 2010; Legesse, 2014). This study employs binary logistic regression over Probit due to the following advantages: binary logit model transforms problem of predicting probabilities within (0, 1) interval to problem of predicting the odds of an event occurring within actual condition (Pindyck and Rubinfeld, 1981), simple to work, flexible and straightforward (Hosmer and Lemeshew, 1989; Alemayehu 2007).

The dependent variable in the binary logit is a dummy variable (binary), which takes a value zero or one depending on whether downstream farmers adopt[3] soil bunds. However, explanatory variables are either continuous or dummy variables. According to Pindyck and Rubinfeld (1981), Gujarati (2004) and Alemayehu *et al*. (2010), the cumulative binary logistic probability function is specified below:

$$P_i = F(Z_i) = F\left(\alpha + \sum_{i=1}^{m} \beta_i \chi_i\right) = \left(\frac{1}{1+e^{-\left[\alpha + \sum_{i=1}^{m} \beta_i \chi_i\right]}}\right) \quad (1)$$

$$Z_i = \alpha + \sum_{i=1}^{m} \beta_i \chi_i \quad (2)$$

Where: e is the base of natural logarithms,

X_i is the i[th] explanatory variable,

P_i is the probability of adopting the intervention, and

α and β_i are parameters to be estimated

Interpretation of coefficients could be easier if the binary logistic model reformulates in terms of the odds and log of odds (Hosmer and Lemeshow, 1989; Gujarati, 1995). The odds ratio implies

[3] Farmers are considered as adopters of soil bunds if they have implemented the technology at least for five years.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

a ratio of the probability that an individual would choose an alternative (P_i) to the probability that she/he would not choose it (1- P_i), which is defined below:

$$(1-P_i)=\left(\frac{1}{1+e^{Z_i}}\right) \tag{3}$$

Using equations (1) and (3), the odds ratio presented by equation 4.

$$\left(\frac{P_i}{1-P_i}\right)=\left(\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right)=e^{Z_i} \tag{4}$$

Alternatively,

$$\left(\frac{P_i}{1-P_i}\right)=\left(\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right)=e^{\left(\alpha+\sum_{i=1}^{m}\beta_i\chi_i\right)} \tag{5}$$

Taking the natural logarithms of equation 4 and 5 give the binary logit model that can be presented as below:

$$Z_i=\ln\left(\frac{P_i}{1-P_i}\right)=\alpha+\beta_1\chi_{1i}+\beta_2\chi_{2i}+---+\beta_m\chi_{mi} \tag{6}$$

The binary logit model can be presented as follows if the disturbance term, u_i, is considered.

$$Z_i=\alpha+\beta_1\chi_{1i}+\beta_2\chi_{2i}+----+\beta_m\chi_{mi}+u_i \tag{7}$$

Equation (7) was estimated using iterative maximum likelihood estimation procedure, which is consistent with utility maximization theory. This estimation procedure yields unbiased, efficient and consistent parameter estimates, particularly for large sample size (Legesse, 2014). We employed SPSS for Windows to estimate the logit model.

Prior to the model estimation, Variance Inflation Factor[4] (VIF) and Contingency Coefficients[5] (CC) techniques were employed to detect multi-collinearity among continuous and dummy

[4] Studies recommend to omit variables with a VIF value of 10 and more from the analysis in order to avoid serious multicollinearity problem (Healy, 1984; Adugna, 2005; Alemayehu *et al*., 2010; Beshir *et al*., 2012; Beshir, 2014; Legesse, 2014).

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

explanatory variables respectively. The mathematical form of VIF and CC are given by equation 8 and 9, respectively (Gujarati, 2004; Andren, 2007; Alemayehu *et al*, 2010; Legesse, 2014).

$$VIF(X_i) = (1 - R_i^2)^{-1} \tag{8}$$

Where: R_i^2 is the squared multiple correlation coefficient and X_i is the i^{th} explanatory variable.

$$CC = \sqrt{\frac{\chi^2}{n + \chi^2}} \tag{9}$$

Where: χ^2 is Chi-square and n is total sample size.

4. RESULTS AND DISCUSSIONS

Results show that about 34 percent of downstream landholders are likely to be adopters of soil bund practice. The explanatory variables used in the model are *Age, Education, Farm Size, Farmers day/ field visit, Fertilizer Application, Distance to Nearest Market, Tropical Livestock Unit*[6]*, Informal Local Institution (Debo*[7]*), Cooperative, Farmers' preference/attitude towards watershed management and Agricultural credit.*

The VIF values for continuous explanatory variables were found to be small, which were less than 10. The CC values for dummy explanatory variables were found to be small, which were less than 0.75. The chi-square value of the result shows the overall goodness of fit of the model at less than 1% probability level (Table 1). The R Square goodness of fit employed based on the theory that an event may not occur if estimated probability of an event is less than 0.5 and otherwise it may occur (Maddala, 1989; Alemayehu *et al*., 2010).The i^{th} respondent was considered to be adopter if and only if the computed probability value greater or equal to 0.5 otherwise non-adopter of the intervention (Legesse, 2014). The model correctly predicts 93

[5] CC, which ranges between 0 to 1, measures the degree of correlation between discrete variables based on chi-square measure of association. CC value with 0.75 or more shows a strong degree of association between discrete variables (Healy, 1984; Adugna, 2005; Alemayehu *et al*., 2010; Beshir *et al*., 2012; Beshir, 2014; Legesse, 2014).

[6] TLU is commonly taken to be an animal of 250 kg live weights (Storck *et al*. 1991), TLU conversion factors that used in this study which is presented in Appendix Table 1.

[7] Informal local institutions employ traditional rules and customs that govern human behavior but not codified by state law (Joireman 2001 cited in Degefa, 2010). "Debo" is one of the traditional local institutions in the study area that established by the community as labor sharing pulling system, where the person requiring labor typically provides food and drink in exchange for labor.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

percent of the total observed values. The sensitivity of the model shows the proportion of correctly predicted downstream landholders as adopters of improved soil bund practice is 88.2 percent. The specificity of 94.9 percent indicates the proportion of correctly predicted downstream landholders as non-adopter of the intervention. Therefore, the model predicts both groups adequately.

As presented in Table 1, eight explanatory variables included in the analysis are found to have a significant impact on farmers' adoption behavior with less than 10% probability level. These variable include *Education, Age, Farm size, Farmers' day/field visit, Distance to nearest market, Tropical livestock unit, Farmers' preference/attitude towards watershed management and Fertilizer application*. A brief discussion on the statistically significant explanatory variables is provided below:

Education: Education enhances agricultural productivity through improving farmers' cognitive skills in a rapidly changing technological environment (Dasgupta, 1989; Närman, 1991, Weir, 1999; Chomba, 2004; Yehzbalem, 2005). Educated farmers incline to spend more time and money in soil conservation measures (Shiferaw, 2002, Abdulai and Huffman, 2014), however, uneducated farmers are most reluctant to adopt agricultural technologies (Sharma, 2010). This variable is found to be significant at ($P<0.01$) and has a positive association with landholders' choice to adopt improved soil bund practice. This result coincides with Okoye (1998), Gould *et al*. (1989) Bekele and Drake (2003), Anley *et al*. (2006), Bienabe and Hearne (2006), Ojeda *et al*. (2007), Chukwuone and Okorji (2008), Yoo *et al*. (2008), Deressa *et al*. (2009) and Stithou and Scarpa (2012) who reported a positive influence of education on farmers' adoption behavior. The odds ratio of this variable indicates that educated farmers' decision to adopt the measure will increase by a factor of 5.40 as compared to uneducated ones, ceteris paribus.

Farm size: Farm size is a wealth indicator and a proxy for social status (Zegeye *et al.*, 2001; Asfaw *et al*., 2011; Beshir *et al*., 2012). Famers who have large farm size are more likely to adopt the technology (Norris and Batie, 1987). This variable affects farmers' adoption behavior positively and found to be significant at ($P<0.01$). Sureshwaran *et al*. (1996), Sangkapitux *et al*. (2009), Adugna (2005), Ndetewio *et al*. (2013), Oladele (2008), Abu *et al*. (2011) and Kwayu *et al*. (2013) also reported a positive correlation between farm size and farmers' choice to adopt watershed management interventions. The odds ratio of the variable implies that large farmers' choice to adopt the measure increases by a factor of 1.41 as compared to small farmers, ceteris paribus.

Fertilizer application: It is one of the biological management measures used to minimize runoff through infiltration of rainfall and also improves crop yields (Nkonya *et al*., 2005; Alemayehu et al., 2008; Zelleke, *et al*., 2010; Spielman *et al*., 2011; MOA, 2012; Getnet and MacAlister, 2012;

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

Minot and Sawyer, 2013). Farmers who apply fertilizers are most enthusiastic to adopt watershed management technologies (Legesse, 2014). This variable correlates positively with farmers' adoption behavior and found to be significant at (P<0.01). The odds ratio of the variable shows that landholders who apply fertilizer are more likely to adopt the measure by a factor of 17.36 as compared to those who do not use fertilizer, ceteris paribus. Alemayehu *et al*. (2009) and Schmidt and Tadesse *et al*. (2012) also reported a positive association between fertilizer application and adoption of watershed management interventions.

Tropical livestock unit: This variable is significant at (P<0.10) and has a positive association with farmers' adoption behavior. Livestock serves for income or wealth, wealthy farmers are less risk averse and are more likely to adopt first than less wealthy ones. Sambrook and Akhter, (2001), Tesfaye *et al*. (2001), Alemayehu *et al*. (2008) and Banks and Dagher (2012) also reported a positive influence of TLU on farmers' adoption behavior. Downstream landholders' choice to adopt the measure will increase by a factor of 1.25 as for this variable increases by one additional TLU, ceteris paribus.

Table 1: Parameter estimates for binary logit model

Explanatory Variables	Coefficients	Odds Ratio	Wald Statistic	Significance Level
Constant	-7.143	0.001	13.408	0.000***
Education	1.685	5.390	8.431	0.004***
Age	-0.049	0.952	3.227	0.072*
Farm size	0.345	1.413	8.777	0.003***
Farmers day/Field visit	1.038	2.823	3.121	0.077*
Distance to nearest market	-0.289	0.749	9.958	0.002***
Tropical livestock unit	0.227	1.255	3.675	0.055*
Informal local institution	0.949	2.582	1.841	0.175
Cooperatives	0.349	1.418	0.131	0.717
Preference/attitude towards watershed management	3.243	25.603	6.140	0.013**
Fertilizer application	2.854	17.364	11.876	0.001***
Agricultural credit	0.783	2.189	1.162	0.281
Chi-square				277.836
-2 Log likelihood				106.785
R Square [a]				0.84
Overall prediction				93.0
Sensitivity [b]				88.2%
Specificity [c]				94.9%
Sample size				300

***,** and * Shows significance at 1%, 5% and 10% probability levels

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

[a] Based on a 50-50 probability classification scheme
[b] Correctly predicted adopters
[c] Correctly predicted non-adopters

Source: Model analysis, 2016

Distance to the nearest market: We considered this variable as a proxy indicator for market accessibility. A market in the nearest distance saves time, reduces transportation costs and increases access to information (Beshir et al., 2012; Legesse, 2014). This variable is found to be significant at ($P<0.01$) but associates negatively with farmers' adoption behavior. This result suggests that landholders' decision to adopt the measure most likely declines with distant from the central market. The reason is that farmers' chance of accessing information reduces the further away from the central market. This result agrees with what is stated in Chirwa (2005), Langyintuo and Mekuria (2005), Maddison (2006), Mariara (2007), Bittinger (2010), Cavatassi et al. (2011) and Tedla (2011). The odd ratio of the variable implies that farmers' decision to adopt the measure will decline by a factor of 0.75 as this variable increases by a single kilometer, ceteris paribus.

Age: The impact of age might be taken as the composite effect of experience and planning horizon (Zegeye et al., 2000). Young farmers might have longer planning horizon so that they might be most likely inclined to adopt watershed management interventions (Amsalu and Graaff 2007; Legessse, 2014). This variable has a significant adverse effect on farmers' adoption behavior at ($P<0.10$). This result coincides with findings of Bekele (2004), Amirnejad *et al*. (2006), Torgler and Valiñas (2007), Saz-Salazar *et al*. (2009), Ayuya, *et al*. (2011), Niringiye and Omortor (2010), Madureira *et al*. (2011), Ogunniyi *et al*. (2011), Presa (2011) and Mahieu *et al*. (2012) who reported a negative effects of age on farmers' adoption behavior. The odds ratio of the variable indicates that that as the age of the landholders increased by a year, then their choice to adopt the measure may decrease by a factor of 0.95, ceteris paribus.

Farmers' day/field visit: Field demonstration encourages interactions among farmers, extension agents, researchers and other stakeholders through information, experience and knowledge sharing (Awulachew, 2010). This variable is significant at ($P<0.10$) and has a positive association with farmers' adoption behavior. The odds ratio of the variable implies that the odds ratio in favor of adopting soil bunds increases by a factor of 2.82 as compared to those who did not participate in farmers' day/field visit, ceteris paribus. The reason is that field visit may advance farmers' access to information (Legesse, 2014). This result coincides with findings of Sidibe (2005), Graaff *et al*. (2008), Petros (2010), Nkegbe *et al*. (2012) and Dessie *et al*. (2013) who reported the same result.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

Farmers' preference/attitude towards watershed management: Farmers' preference/attitude towards improved watershed management interventions influence their decision to adopt the measures (Bekele, 2006). Those farmers who have a positive attitude towards agricultural technologies are more likely to adopt first (Asfaw *et al*., 2011). The result shows that this variable has a positive significant association with farmers' decision to adopt soil bunds at ($P< 0.05$). Wikstrom (2003), Bewket (2007), He *et al*. (2007) and Wauters *et al*. (2010) also reported a positive association between farmers' attitude and adoption of improved land management interventions. The odds ratio shows that the likelihood of adopting the intervention increases by a factor of 25.60 than those who could not develop positive preference/attitude towards watershed management, ceteris paribus.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The results of the study show that education, age, farm size, farmers' day/field visit, distance to nearest market, tropical livestock unit, farmers' preference/attitude towards watershed management and fertilizer application are found to influence a landholder's decision to adopt the technology. Farmers' level of education has a positive and significant impact on their decision to opt the measures. This implies that educated farmers understand the problems and are more likely first to adopt the measures. This result suggests providing education and training services to farmers to improve adoption of the technologies. Farm size is one of the important factors that has a positive influence on farmers' adoption behavior. Farmers with large farms are more likely to adopt the technology than farmers with small farms. This implies that policy makers should give attention to large farmers first so that the technology can reach other farmers through a farmer-to-farmer way of information dissemination. The study also shows a positive significant impact of fertilizer on farmers' adoption behavior. This result suggests enhancing the provision and accessibility of fertilizers to improve the adoption level. Tropical livestock unit has a significant positive association with farmers' adoption behavior. The reason is that livestock serves for income and wealthy farmers are more likely to adopt the technologies.

The study shows that farmers' preference/attitude towards watershed management has a positive impact on farmers' adoption behavior. The reason is that farmers might commonly opt to adopt a technology that coincides with their preference/attitude. In addition, farmers' day/field visit has a positive influence on farmers' adoption behavior. This is due to the fact that field demonstration strengthens interactions and information dissemination among farmers and all stakeholders. Distance to nearest market has a significant negative impact on farmers' adoption behavior. The reason is that farmers' chance of accessing information decreases the further away from the central market. Age has also a significant negative impact on farmers' adoption behavior. This might be due to farmers' planning horizon in which old farmers may have a shorter planning horizon that might discourage them to adopt the intervention.

Based on findings of the study, the following points need to be considered by policy makers in order to improve adoption of improved watershed management interventions: (i) there is a need to incorporate educational and field demonstration components in watershed management policies; (ii) improving farmers' livelihood is an essential element to boost their capacity to invest in improved watershed management measures. To achieve this responsibility, all concerned stakeholders such as the Ministry of Agriculture, Agricultural Research Centers, NGOs and others need to collaborate through designing appropriate systems that enhance farmers' income; (iii) there is a need to increase the number of local markets, improve existing rural marketing system and integrate farmers with the existing marketing system; and (iv) there is a need to target young farmers first in watershed management interventions.

REFERENCES

Abdulai A. and Huffman, W., 2014. The Adoption and Impact of Soil and Water Conservation Technology: An Endogenous Switching Regression Application. Land Economics, vol. 90 no. 1 pp, 26-43.

Adugna, G., 2005. Determinants of Land Degradation in the Lake Tana Basin and its Implications for Sustainable Land Management: The Case of Angereb and Gish-Abbay Watersheds. Thesis Presented to the School of Graduate Studies of Alemaya University, Ethiopia, pp 134.

Alemayehu, B., 2007. Policy and Institutional Analysis of Smallholder Cattle Production in Dano District of Western Showa, Ethiopia: Thesis Presented to the School of Graduate Studies of Alemaya University, pp 116.

Alemayehu, B., Bogale, A., Wollny, C., and Tesfahun, G., 2010. Determinants of choice of market-oriented indigenous Horo cattle production in Dano district of western Showa, Ethiopia. Tropical Animal Health Production, 42, pp 1723–1729.

Alemayehu, B., Hagos, F. and Haileslassie, A., 2008. Prospect of Payments for Environmental Services in the Blue Nile Basin: Examples from Koga and Gumera Watersheds, Ethiopia, pp 27.

Alemayehu, F., Taha, N., Nyssen, J., Girma, A. Zenebe, A., Behailu, M., Deckers,S and Poesen J., 2009. The impacts of watershed management on land use and land cover dynamics in

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

Eastern Tigray (Ethiopia). Resources, Conservation and Recycling, Volume 53, Issue 4, pp 192–198.

Alemie, T.C., 2009. The Effect of Eucalyptus on Crop Productivity and Soil Properties in the Koga Watershed, Western Amhara Region, Ethiopia. Thesis Presented to the School of Graduate Studies of Cornell University, pp 48.

Alemu, B.A, Nuppenau, E.A. and Bolland, H., 2009. Technical Efficiency across agro-ecological zones in Ethiopia: The Impact of Poverty and Asset Endowments. Agricultural Journal, Volume 4, 202-207.

Andren, T., 2007. Econometrics. Ventus Publishing ApS, pp 141.

Asfaw, S., Shiferaw, B., Simtowe, F. and Haile, M.G., 2011. Agricultural technology adoption, seed access constraints and commercialization in Ethiopia. Journal of Development and Agricultural Economics, Volume 3 (9), pp 436-447.

Ashagre, B.B., 2009. SWAT to Identify Watershed Management Options: (Anjeni Watershed, Blue Nile Basin, Ethiopia). Thesis Presented to the Faculty of the Graduate School of Cornell University, pp 103.

Asquith, N.M., Vargas, M.T. and Wunder, S., 2008. Selling two environmental services: In-kind payments for bird habitat and watershed protection in Los Negros, Bolivia. Ecological economics, pp 675-684.

Banks, K. and Dagher, A., 2012. Valuation of Soil Conservation Practices in Adwa Woreda, Ethiopia: A Contingent Valuation Study. American Journal of Soil and Water, Volume 2 (3), pp 2568-5457.

Beshir, H., 2014. Factors Affecting the Adoption and Intensity of Use of Improved Forages in North East Highlands of Ethiopia. American Journal of Experimental Agriculture 4 (1), pp 12-27.

Beshir, H., Emana, B., Kassa, B. and Haji, J., 2012. Determinants of chemical fertilizer technology adoption in North eastern highlands of Ethiopia: the double hurdle approach. Journal of research in economics and international finance, Volume 1 (2), pp 39-49.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

Bienabe, E. and Hearne, R.R., 2006. Public preferences for biodiversity conservation and scenic beauty within a framework of environmental services payments. Forest Policy and Economics, 9, pp 335–348.

Bitew, M.M. and Gebremichael, M., 2011. Assessment of satellite rainfall products for streamflow simulation in medium watersheds of the Ethiopian highlands. Hydrology and Earth System Science, 15, pp 1147–1155.

BOA, 2012. Socio economics and demographic characteristics of Amhara region. District bureau of agriculture, (Amahric version) unpublished, Merhawe, Ethiopia, pp 60.

Chen, H., 2010. Ecosystem Services from Low Input Cropping Systems and the Public's Willingness to pay for them. A thesis submitted to Michigan State University in partial fulfillment of the requirements for the degree of Master of Science. Agricultural, Food and Resource Economics, pp 154.

Chomba, G.N., 2004. Factors Affecting Smallholder Farmers' Adoption of Soil and Water Conservation Practices in Zambia. Thesis Presented to Michigan State University, USA, pp 118.

Chukwuone, N.A. and Okorji, C.E., 2008. Willingness to pay for Systematic Management of Community Forests for Conservation of Non-Timber Forest Products in Nigeria's Rainforest Region. Implications for poverty alleviation. Springer, pp 21.

Darghouth, S., Ward, C., Gambarelli, G., Styger, E. and Roux, J., 2008. Watershed Management Approaches, Policies, and Operations: Lessons for Scaling Up. World Bank: Water Sector Board Discussion Paper Series Paper no.11, pp 164.

Dasgupta, S., 1989. Diffusion of Agricultural Innovations in Village India. Department of Sociology and Anthropology, University of Prince Edward Island. Canada. 74-86p

Degefa, M.Y., 2010. How Informal Institutions Strengthen Sustainable Management of Common Pool Resources in Tigray, Ethiopia? A Thesis Submitted in Partial Fulfilment of the Requirements for the Doctorate in Agricultural Sciences. Centre for Development Research, University of Natural Resources and Applied Life Sciences, Vienna, pp 140.

Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecological Economics 65, pp 663–674.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

FDRE, 2005. Federal Democratic Republic of Ethiopia: Rural Land Administration and Land Use Proclamation, Addis Ababa, Ethiopia, pp 12.

Getnet, K. and MacAlister, C., 2012. Integrated innovations and recommendation domains: Paradigm for developing, scaling-out, and targeting rainwater management innovations. Ecological Economics 76, pp 34–41.

Gould, B.W., W.E. Kangasniemi and R.M. Klemme, 1989. Conservation tillage: the role of farm and operator characteristics and the perception of soil erosion, Land Econom., 65 (2): 167-182.

Gujarati, D.N., 1995. Basic Econometrics. 3rd Edition. McGraw-Hill, Inc., pp 1001.

Gujarati, D.N., 2004. Basic Econometrics. 4th Edition. McGraw-Hill, Inc., pp 1002.

Healy, F.J., 1984. Statistics: a tool for social research. Wadsworth Publishing Company, California, USA, pp 21.

Hosmer, D.W. and Lemeshew, S., 1989. Applied Logistic Regression. A Wiley-Inter Science Publication, New York, pp 375.

ILRI – IPMS, 2012. GIS Section: International Livestock Research Institute, Improving productivity and Market success project, Addis Ababa, Ethiopia.

Kaledhonkar, M.J., Gupta, S.K., Bundela, D.S. and Singh, Gurbachan (2007), On-Farm Land and Water Management. Central Soil Salinity Research Institute, Karnal, India, pp 178.

Kassahun, H.T., 2009. Payment for Environmental Service to Enhance Resource Use Efficiency and Labor Force Participation in Managing and Maintaining Irrigation Infrastructure, the Case of Upper Blue Nile Basin. Thesis Presented to the School of Graduate Studies of Cornell University, pp 13.

Kosoy, N., Martinez-Tuna, M., Muradian, R., Martinez-Alier, J., 2006. Payments for environmental services in watersheds: insights from a comparative study of three cases in Central America. Ecological Economics 61 (2–3), pp 446–455.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

Legesse, B.A., 2014. Payments for improved watershed services for improved watershed management in the Blue Nile Basin, Ethiopia. A dissertation submitted to the Faculty of Environmental Sciences and Process Engineering at the Brandenburg University of Technology in Cottbus-Senftenberg in partial fulfillment for the award of the academic degree of Doctor of Philosophy (Ph.D) in Environmental Sciences, pp 234.

Legesse, E.S., 2009. Modeling Rainfall-Runoff Relationships for Anjeni Watershed in the Blue Nile Basin. A Thesis Presented to the Faculty of the Graduate School of Cornell University in Partial Fulfillment of the Requirements for the Degree of Master of Professional Studies, pp 54.

Maddala, G.S., 1989. Limited Dependant and Qualitative Variables in Econometrics. Cambridge University press, United States of America, pp 401.

Mengstie, F.A, 2009. Assessment of Adoption Behavior of Soil and Water Conservation Practices in the Koga Watershed, Highlands of Ethiopia: Master of Professional Studies Thesis Presented to the Faculty of the Graduate School of Cornell University, pp 75.

Minot, N., and Sawyer, B., 2013. Input use in Ethiopia: Results of the 2012 ATA Baseline Survey. International Food Policy Research Institute, Washington, DC, pp 27.

MOA-SLM, 2013. Sustainable Land Management (SLM) Knowledge: Technologies. Monistry of Agriculture Ethiopia. (http://www.slmethiopia.info.et/slmknowledge/).

Närman, A., 1991. Education, training and agricultural development in Zimbabwe. Issues and methodologies in educational development: an IIEP series for orientation and training. International Institute for Educational Planning, UNESCO, pp 103.

Nkonya, E., Kaizzi, C. and Pender, J., 2005. Determinants of nutrient balances in a maize farming system in eastern Uganda. Agricultural Systems, 85, pp 155–182.

Noma, D., 2012. What are the main drivers behind Ethiopian farmers' soil and water conservations practices? Leuven-La-Neuve, Belgium: Catholic University of Leuven.

Norris, P.E., Batie, S.S., 1987. "Verginia Farmers' Soil Conservation Decisions". An Application of Tobit Analysis. *Southern Journal of Economics* 19, 79-90.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

Ojeda, M.I., Mayer, A.S. and Solomon, B.D., 2007.Economic valuation of environmental services sustained by water flows in the Yaqui River Delta. Ecological Economics 65, pp 155-166.

Okoye, C., 1998. Comparative analysis of factors in the adoption of traditional and recommended soil erosion control practices in Nigeria. Soil and Tillage Res., 45: 251-263

Oostendorp, R.H. and Zaal, F., 2011. Understanding Adoption of Soil and Water Conservation Techniques: The role of new owners. CSAE Working Paper WPS/2011-05, pp 36.

Pagiola, S., Ramírez, E., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ruíz, J.P., 2007. Paying for the environmental services of silvopastoral practices in Nicaragua. Special Issue on Ecosystem Services and Agriculture, Ecological Economics 64 (2), pp 374–385.

Pindyck, R.S. and Rubinfeld, D.C., 1981. Econometric Models and Econometric Forecasts, 2nd Edition, Mcgraw-Hill Book Co. New York, pp 292.

Randhira, T.O., Connorb, R.O., Pennerc, P.R. and Goodwin, D.W., 2001. A watershed-based land prioritization model for water supply protection. Forest Ecology and Management 143 (2001), pp 47-56.

Sambrook, B. and S. Akhter, 2001. Social and gender analysis: Findings from the inception phase. Domestic Roofwater Harvesting Research Program, RN-RWH02. Hambantota, Srilanka. 34-36p.

Sangkapitux, C., Neef, A. and Polkongkaew, W., 2009. Willingness of upstream and downstream resource managers to engage in compensation schemes for environmental services. International Journal of the Commons. Volume 3 (1), pp 41–63.

Setegn, S.G., 2008. Hydrological and Sediment Yield Modelling in Lake Tana Basin, Blue Nile Ethiopia. Trita-Lwr.Lic 2042, pp 44.

Sharma, P., Necessity of education and awareness in farmers: the basis of agricultural progress in developing and underdeveloped nations. *Agriculture and Biology Journal of North America*. ISSN Print: 2151-7517, pp 4.

Shiferaw, P.A., 2002. Determinants of Farmers' Willingness to Participate in Soil Conservation Practices in The Highlands of Bale: The Case of Dinsho Farming System Area. Thesis Presented to the School of Graduate Studies of Alemaya University, Ethiopia, pp 131.

Southgate, D. 1988. The Economics of Land Degradation. Environmental Department. Working Paper, No. 2, World Bank, Washington, D.C.

Spielman, D.J., Kelemwork, D. and Alemu, D., 2011. Seed, Fertilizer, and Agricultural Extension in Ethiopia. Ethiopia Strategy Support Program II (ESSP II). ESSP II Working Paper 020, pp 40.

Stithou, M. and Scarpa, R., 2012. Collective versus voluntary payment in contingent valuation for the conservation of marine biodiversity: An exploratory study from Zakynthos, Greece. Ocean & Coastal Management, 56, pp 1-9.

Storck, H., Emana, B., Adnew, B., Borowiecki, A. and Woldehawariate, S., 1991. Farming systems and farm management practices of small holders in the hararghe highlands: Farming systems and resources economics in the tropics. Wssenshaftsver lag vauk, Kiel, Germany. 11, pp 41-48.

Sureshwaran, S. R. Londhe and P. Franzier, 1996. "A Logit Model for Evaluating Farmer Participation in Soil Conservation Programs": Slopping Agricultural Land Technology on Upland Farms in the Philippines. *Journal of Sustainable Agriculture*, 7(4), pp 52-69.

Weir, S., 1999. The Effects of Education on Farmer Productivity in Rural Ethiopia. Centre for the Study of African Economies, Department of Economics, University of Oxford. WPS99-7, pp 51.

World Bank, 2006. Watershed Management Approaches, Policies, and Operations: Lessons for Scaling Up. Water Sector Board Discussion Paper, 11. Washington, DC, pp 164.

Wunder, S and Albán, M, 2007. Decentralized payments for environmental services: The cases of Pimampiro and PROFAFOR in Ecuador. Ecological Economics 65, pp 685-698.

ISSN: 2455-6939

Volume:03, Issue:03 "May-June 2017"

Wunder, S., Engel, S. and Pagiola, S., 2008. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. Ecological Economics, 65, pp 834 – 852.

Yehzbalem, M.T., 2005. Farmers' Response and Willingness to Participate in Water Harvesting Practices: A Case Study In Dejen District / East Gojam Zone

Yoo, S.H., Kwak, S.J. and Lee, J.S., 2008. Using a choice experiment to measure the environmental costs of air pollution impacts in Seoul. Journal of Environmental Management, 86, pp 308–318.

Zegeye, T., Taye, G., Tanner, D., Verkuijl, H., Agidie, A., and Mwangi, W., 2001. Adoption of Improved Bread Wheat Varieties and Inorganic Fertilizer by Small-scale Farmers in Yelmana Densa and Farta Districts of Northwestern Ethiopia. International Maize and Wheat Improvement Center (CIMMYT), Mexico, pp 29.

Zelleke, G., Agegnehu, G., Abera, D. and Rashid, S., 2010. Fertilizer and Soil Fertility Potential in Ethiopia: Constraints and opportunities for enhancing the system. International Food Policy Research Institute, pp 42.

Appendix Table 1: Conversion factors used to estimate tropical livestock unit

Animal Category	Total TLU	Animal Category	Total TLU
Calf	0.25	Donkey (adult)	0.70
Weaned calf	0.34	Donkey (young)	0.35
Heifer	0.75	Camel	1.25
Cow and ox	1.00	Sheep and goats (adult)	0.13
Pigs	0.20	Sheep and goats (young)	0.06
Horse	1.10	Chicken	0.013

Source: Storck *et al*. 1991; Alemayehu, 2007; Legesse, 2014.

