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Research Article

Factors Affecting Household Participation Decision in Adoption of Rural Land Management Technologies in Wombera Woreda of Benishangul Gumuz Region

Urji Argeta*, Abdulsemed Abanega

Department of Agricultural Economics and Agribusiness Management, Jimma University, Jimma, Ethiopia

Abstract

One of the main effects of environmental issues leading to low agricultural production in smallholder farming is land degradation. However, because of inadequate agricultural methods and soil degradation, its production is still low. Converting all past conventional farming to Sustainable Agricultural Practices may be the suggested remedy for land degradation. This study aimed to examine the decisions made by households regarding their participation in the adoption of rural land management technologies in Wombera district. Primary and secondary sources of data were used to gather quantitative and qualitative data. 187 samples of respondents were chosen from five kebeles using multistage sampling approaches. Key informant interviews, focus groups, and survey questionnaires were used to collect data. The data were analyzed using descriptive statistics and econometric models, with a binary logistic model specifically used to assess the factors affecting households' participation in the adoption of rural land management technologies. The results of the Binary logistic model showed that variable like marital status, education level, farming experience, access to extension service, tropical livestock unit were positively and significantly affect household participation decision adoption of rural land management technologies, whereas distance of farm land was negatively affect household participation decision adoption of rural land management technologies in the study area. So, policy and development interventions should focus on factors that help farmers improve their livelihoods by participating in the adoption of rural land management technologies.

Keywords

Adoption, Ethiopia, Logistic Model, Land Management Technology

1. Introduction

According to [1, 2], land degradation is a process of change in the chemical, physical, and biological characteristics of land that results in the loss of its biological, economic, and quality qualities. It is caused by deforestation, desertification, erosion, loss of organic matter, soil acidity, compaction, and other factors that render agricultural land unsuitable for crop cultivation. Land degradation is a significant global environmental issue, causing millions of hectares of highlands to be damaged annually and causing 24 billion tons of productive soil loss [3, 4].

According to [5], Climate change and human activity-induced land degradation in the Ethiopian highlands have

*Corresponding author: urjiaregeta@gmail.com (Urji Argeta)

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been a momentous challenge. Approximately 50% of the highlands are already significantly degraded, with around 27 million hectares affected. Of this area, 14 million hectares suffer from severe erosion. If the current trend of land degradation continues, per capita income in the highlands could decline by 30% over the next 20 years. Land degradation problems are among the most serious consequences of climate change [6].

In Ethiopia, land degradation has led to a sharp drop in agricultural productivity, which has now beyond a household's subsistence level [2] . Degraded lands, in turn, bring about a significant reduction in agricultural productivity because they are directly associated with land, one of the basic inputs in agriculture. According to [7], Agriculture contributes 32.4%to the GDP of Ethiopia, three-quarters of the employment, and generates 75% of foreign currency. As seen by the persistent issues of famine and destitution, soil erosion in Ethiopia's highlands has contributed to low agricultural output, food insecurity, severe poverty, and hunger [8, 9].

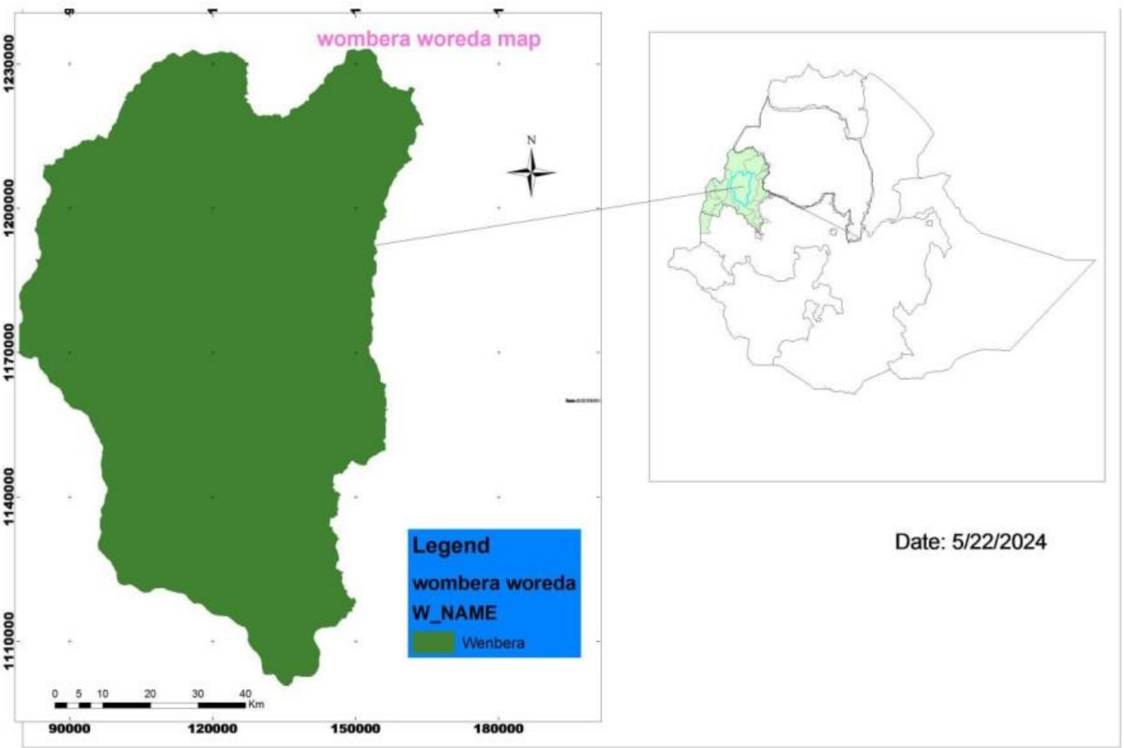
The adoption of integrated land management technology (ILMT) potentially reduces soil erosion, which preserves land and its invaluable ecosystem services [10]. ILMT also emphasizes soil health by way of an increase in soil organic matter to create enhanced agricultural productivity. There have also been a number of programs aimed at combating land degradation [10]. These programs target rehabilitating land that has been degraded and limiting land degradation from occurring in the first place through soil loss and water runoff management, and improved management of soil fertility, as well as reforestation for the restoration and protection of land [8, 11, 12].

To the best of the researcher’s knowledge, no studies have examined the determinants of household decision-making towards the participation in the adoption of rural land management technologies. Hence, this study aims to examine the determinants of household decision-making towards participation of adoption of rural land management technologies in Wombera district, Metekel zone, Benshangul region, Ethiopia.

2. Research Methodology

2.1. Description of the Study Area

Wombera district is in the Metekel Administrative Zone of the Benishangul-Gumuz Region, located 658 km from Addis Ababa. In terms of topography, it is mostly undulating, and elevation rises from 576 to 2615 meters above sea level. This range of elevation creates three agro-ecological zones: lower, middle, and higher landscapes. Climate zones also vary with altitude, with significant variation in temperature and rainfall across elevations. Annual rainfall ranges from 1210 mm (lower) to 1942 mm (higher). Average temperature ranges begin at 15.9℃ (higher) to 25.7℃ (lower). The vegetation type is generally considered a dry type of Afromontane vegetation at higher elevations.



Source: sketch by own manipulation from the Ethiopia map using Ethio-GIS

Figure 1. Map of the study area.

2.2. Research Design, Data Sources, Data Types, and Methods of Data Collection

The study employed a cross-sectional research design to analyze data and gather sufficient information from the respondents at one time in the study area. The study obtained both quantitative and qualitative data from primary and secondary sources through structured interviews, focus group discussions, and key informant interviews. Qualitative data were obtained through focus group discussions, key informant interviews, and secondary data were obtained from wombera Woreda agricultural development and natural resource offices, Benishangul Gumuz regional state agriculture and natural resource bureau, and CSA of Ethiopia.

2.3. Sampling Procedures and Sample Size Determination

Multistage sampling methods were used to choose the sample households in the study area.

Twelve of the 36 kebeles in the Wombera district were purposefully chosen for the first stage because they are watersheds with a significant and pervasive land degradation issue. Five (5) of the twelve possible kebeles were chosen in the second stage using a simple random sampling method. In the third step, a sample of households was chosen from each sample kebele using the probability proportional to sample size technique (Table 1). Then, using a straightforward random sampling technique, a predefined sample size of households from each sample kebele was chosen and interviewed.

A sample size of sampled households was determined by using the following Yamane formula (1967) to get a representative sample for proportions.

$$n = \frac{N}{1+N(e^2)} = \frac{2100}{1+2100(0.07^2)} = 187$$

A 7% precision level was selected for this study due to time and financial constraints, as a lower precision would significantly increase the sample size, cost, and duration. Consequently, 187 sample households were interviewed.

Table 1. *Proportional distribution of sample households in each kebele.*

Sample of kebeles	Number of households	Proportion (%)	Sample size (n)
Gocher	950	45.2	85
Kitar	747	35.5	67
Ambifeta	183	8.7	16
Senkora	115	5.4	10
Gawulla	105	5.2	9
Total	2100	100	187

Source: (own computation, 2025) based on data from the agriculture and natural resource office

2.4. Methods of Data Analysis

Achieving the aims of this study required descriptive statistics and econometric data analysis models. STATA version 14.0, SPSS version 20.0 software, and an Excel sheet were used for entering and analyzing data.

Descriptive analysis

Descriptive statistics such as percentages and frequencies were used to analyze the demographic, socio-economic, and institutional characteristics of the households.

Econometric analysis

Model specifications

In this study, a binary logistic regression model was used to factor affecting household participation decision adoption of rural land management technologies in the study area. The main point is that since the dependent variable is binary (1= adopted; 0 = did not adopt), we want a model that is built for binary outcomes. When using a model specifically designed for binary outcomes, it had two options - the logit model or the probit model. Both will constrain our predicted probabilities to logically exist between 0 and 1. The main distinction between the two is their different distributional assumptions - the logit model uses a logistic distribution, the probit model uses a normal distribution. Overall, logit and probit models perform similarly; they will typically yield very similar results. Logit model because of how straightforward the mathematics are, and more importantly, because the data set contains a mix of continuous and categorical predictor variables. The logistic regression formula, which estimates the probability of an event occurring, is expressed as:

$$(p) = \beta o + \beta 1X1 + \cdots + \beta iXi\varepsilon i$$

Where

Logit(P)= factor affecting household participation decision, adoption of rural land management technologies

βo= constant coefficients

βi= coefficients of independent Xi variables

Xi= factors or independent variables

εi = error term / disturbance term

3. Results and Discussion

3.1. Descriptive Analysis

Table 2. *Participation of households in the adoption of land management technologies.*

Adoption of land management technologies		
Items	**Frequency**	**Percentage**
No	61	32.62
Yes	126	67.38

Source: Own computation from survey result, 2025

All relevant information that was collected through questionnaires was analyzed, and a detailed description and explanation of each part of the information from the different respondents were presented. The table below shows that the adoption of land management technology among 187 respondents, revealing that 126 (67.38%) of households adopted the technology, while 61 individuals (32.62%) of households did not adopt the technology. This indicates a significant majority of the participants are utilizing land management technology, highlighting a positive trend towards its adoption within the surveyed group.

3.2. Econometric Analysis

Factors affecting household participation decision in the adoption of rural land management technologies

Data analysis for this study, utilizing a logit model to analyze the adoption of rural land management technologies, included a number of important data tests. First, a Variance Inflating Factor (VIF) was calculated to avoid inaccurate results due to multicollinearity (high correlation between independent variables). The VIF mean of 1.28 was sufficiently below the critical value of 10 meaning multicollinearity was not a critical concern.

Second, the Hosmer Lemeshow test was used to test the model's goodness of fit; this test checks that the logit model sufficiently represents the data. The Hosmer-Lemeshow test resulted in a p-value greater than 0.05 and the LR chi2 statistic calculation (153.06 with P=0.0000) was statistically significant, meaning the logit model is a good fit to the data. The analysis was followed by the estimation of marginal effects to explain how each of the independent variables influenced the probability of adoption.

Table 3. *Logit estimate for determinants of participation decision in adoption of rural land management technologies.*

Adilandmgt	**Coef.**	**St. Err.**	**p-value**	**Marginal effect**
Sex	0.226	0.725	0.755	0.042
Martial	1.442**	0.648	0.026	0.292
Age	-0.040	0.117	0.731	-0.007
Edu level	0.491*	0.274	0.073	0.088
Fsize	0.160	0.418	0.703	0.029
Disfaland	-0.523**	0.215	0.015	-0.094
Fexp	0.472***	0.168	0.005	0.085
Acclimateinfo	0.870	0.749	0.245	0.172
Acexco	1.186*	0.655	0.07	0.230
Actrain	0.499	0.734	.0496	0.095
Acred	0.958	0.700	0.171	0.188
TLU	0.602**	0.259	0.02	0.108
Land size	0.124	0.260	0.631	0.022

Adilandmgt	Coef.	St. Err.	p-value	Marginal effect
Constant	14.092	13.507	0.297	
Mean dependent var	0.674	SD dependent var	0.470	
Pseudo r-squared	0.648	Number of obs	187	
Chi-square	153.058	Prob > chi2	0.000	
Akaike crit. (AIC)	111.107	Bayesian crit. (BIC)	156.342	

Note: **, and * indicate statistical significance at 5, and 10% respectively.
Source: Own compute from survey result, 2025

Marital Status of household head had a positive and significant impact on the probability of the household participation decision to adopt rural land management technologies at 5% significance level. The positive coefficient indicates that married people are more likely than unmarried people to adopt land management technologies. Possibly the unified capacity of both married partners to pool resources, collaborate to make decisions, adds to remarkably improve their ability to adopt new technologies. The marginal effect reveals that marriage increases the probability of household participation in the adoption of rural land management technologies by approximately 29.2%.

Education level: The education level of the household head positively and significantly influenced the probability of adoption of rural land management technologies at statistically significant by 10%. For every additional year of education, a household's probability of adopting these technologies increases by 8.8%. This is because education helps farmers better understand the benefits and impacts of new technologies, improves their ability to communicate with stakeholders, and enables them to make more informed decisions. An educated individual is more likely to recognize both the potential gains and the potential challenges of adoption, making them more proactive in implementing new practices compared to their less educated counterparts. This result is supported by the findings of [13] found that the age of farmers positively affects probability of adoption of rural land management technologies.

Distance of land farm from residence: The probability of household adopting land management technologies was negatively and significantly influenced by distance to the farm land at a significance level of 5%. The results indicated that as the distance increases, households may face greater challenges in accessing resources and implementing new practices. This may be due to increased transportation costs, time constraints, or reduced engagement with agricultural support services. As a result of the marginal effect, the education level of household heads increases by one year, the likelihood of adopting land management technologies supposedly decreases by 9.4% as the distance to farm land far away by one minute's walk. The result is contrast to the findings of [13] it found positively affects probability of adoption of rural land management technologies.

Farming experience: farming experiences had a positive and significance influence on the likelihood of participation of households in the adoption of land management technologies at 1% significance level. The positive coefficient suggests that greater experience in farming is associated with a higher likelihood of adopting land management technologies. More experienced farmers may be more open to trying new methods and technologies, likely due to their familiarity with agricultural practices and their understanding of the potential benefits. Farmers' experience increases household adoption of land management technologies, suggesting they are more aware of new technologies and confident in implementing them. The marginal effect of farming experience implied that the probability of household participation in the adoption of land management technologies increases by 8.5%, as farming experience increases by one year. This positive relationship suggests that experienced farmers are more confident and open to adopting new practices, likely due to their deeper understanding of agricultural processes and the benefits of innovative technologies. Their familiarity with farming challenges and solutions may also facilitate a more proactive approach to integrating land management strategies, making them more inclined to embrace changes that can enhance productivity and sustainability.

Access to extension contact: The probability of a household in adopting land management technologies is positively and significantly influenced by access to extension contact at a significance level of 10%. Access to extension contact implies that farmers who frequently contact with extension agents during the land management technologies were technically more efficient in adopting land management technologies. The marginal effect of access to extension contact implied that the probability of household participation in adopting land management technologies increases by 23%, as the household head has access to extension contact. This significant increase suggests that extension services play a crucial role in providing farmers with valuable information, training, and support. Access to expert advice can enhance farmers' understanding of new practices, improve their skills in implementing technologies, and increase their confidence in making changes. Consequently, the presence of extension contact serves as a vital resource that fosters innovation and encourages the adoption of effective land management strategies. This result is supported by the findings of [13, 14, 16] it positively affects probability of adoption of rural land management technologies.

TLU: tropical livestock unit positively and significantly influenced the probability of participation of households in adopting land management technologies at 1% significance level. This implies that farmers who have higher tropical livestock units were more likely to adopt land management technologies, possibly due to increased financial resources, better information about purchasing technology, and labor in the study area. As the TLU of the household increased by one, the probability of participation in adopting land management technologies increased by 10.8% as all other variables are constant. This positive relationship suggests that households with greater livestock holdings may have more resources and capital to invest in new technologies. Increased TLU often correlates with enhanced farm productivity and income, which can provide the necessary financial capacity and motivation to adopt innovative land management practices. Thus, higher livestock numbers may enable households to be more proactive in seeking out and implementing beneficial agricultural strategies This result is supported by the findings of [13, 15], it positively affects probability of adoption of rural land management technologies.

4. Conclusions and Policy Implications

Land degradation is one of the primary consequences of environmental problems that lowers agricultural output in smallholder farming. The results of the Binary logistic model showed that variables like marital status, education level, farming experience, access to extension service, tropical livestock unit, and distance from farm land were key factors affecting household participation decision the adoption of rural land management technologies in the study area. This finding showed that the probability of adopting land management technologies was positively and significantly influenced by the education level. The Wombera Education Office could enhance the adoption of sustainable land management practices by emphasizing agricultural education and training. This could include the incorporation of sustainable land management into school programmes, and offering hands-on workshops and training. By educating and training current and future farmers about sustainable land management, the Wombera Education Office can ensure that more farmers will be ready to adopt new technologies. Farming experience has a significant positive influence on the probability of adopting land management technologies. To leverage this, the agricultural office and extension services should focus on initiatives like mentorship programs, which pair experienced farmers with newer ones to facilitate knowledge transfer. By providing platforms for seasoned farmers to showcase successful techniques, they can motivate and encourage less-experienced peers to adopt sustainable practices. The adoption of land management technologies is positively impacted by the provision of extension services. The Agricultural Office should provide the opportunity to use this by giving regular follow-up attention to farmers through its work. It is necessary to hold community workshops and field trips to give farmers the opportunity to experience and demonstrate the advantages of these technologies. Strengthening these services through the office will have a significant impact on encouraging sustainable practices, leading to an increase in agricultural productivity and resilience.

Abbreviations

Acclimateinfo	Access to Climate Information
Acexco	Access to Extension Sevice
Acred	Access to Credit
Actrain	Access to Training
Adilandmgt	Adoption of Land Management
CSA	Centeral Statistical Agency
Disfaland	Distance Farm Land
Edu	Education Level
Fexp	Farming Expirence
Fsize	Family Size
GIS	Geographic Information System
ILMT	Integrated Land Management Technology
LR	Likehood Ratio
SPSS	Statistical Package for the Social Sciences
TLU	Tropical Livestock Unit
VIF	Variance Inflation Factor

Author Contributions

Urji Argeta: Writing – original draft
Abdulsemed Abanega: Data curation

Conflicts of Interest

The authors declare no conflict of interest.

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