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Adoption of Sustainable Land Management Practices in Mbulu District, a Semi-arid Area in Northern Tanzania

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Authors' contributions

This work was carried out in collaboration among all authors. Authors PTS and PMS jointly designed the study, and author PMS collected the data with significant input from author PTS. Authors DU and BNN prepared the manuscript and revised it to the final version of the manuscript. Finally, all authors collaboratively approved the final version of the manuscript.

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ABSTRACT

As an outcome of agricultural activities, land degradation causes detrimental impacts on the environment and soil. It requires sustainable measures to combat the problem that is becoming critical worldwide. Despite many technological improvement programmes in agriculture, especially

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on land conservation, adoption has remained low in many developing countries. This situation triggered a further investigation into potential factors influencing sustainable land management practices (SLMPs) adoption in Mbulu district, a semiarid area in northern Tanzania so as to determine and suggest appropriate measures that can promote greater adoption. A cross-sectional study was conducted, and data from 120 farmers was collected using semi-structured questionnaires. The adoption index was computed and determined the level of SLMPs adoption to be low. Probit regression analysis examined the factors influencing the adoption of SLMPs. Results show that gender, marital status, education, land size, and the distance to the extension office significantly influenced the adoption of SLMPs. Specifically, being male, widowed, having formal education, owning a larger size of land, and being closer to the extension office significantly increased the likelihood of the adoption. Also, being unmarried and unaware of SLMPs reduced the probability of the adoption. Awareness-raising programmes must be more targeted and effective to reach the intended audience. In addition, promoting sustainable land management practices that support income diversification and livelihood improvement is crucial in the study area. Furthermore, the adoption of sustainable land management practices requires supportive policy and institutional frameworks in the study area. Overall, addressing these factors requires a multi-faceted approach that involves collaboration between various stakeholders, including farmers, communities, the government, civil society organisations, and the private sector. By working together, these stakeholders can create an enabling environment that promotes SLMPs adoption and contributes to more sustainable livelihoods and income diversification in the study area.

Keywords: Adoption; adoption index; agricultural activities; land degradation; semi-arid areas; sustainable land management practices; probit regression analysis

1. INTRODUCTION

Agriculture is the fundamental source of the food supply in all underdeveloped, developing, or even developed countries. It is also a source of income and employment for populations globally [1]. Therefore, it is critical for transforming economies to reach development goals and achieve other essential pursuits. Agriculture's in-depth ties to the world economy, human communities, and biodiversity make it one of the most important aspects around the globe. However, even though agriculture is essential, it can hurt the land if it is not managed well. For example, it can lead to the loss of biodiversity and environmental damage in terms of soil fertility and land degradation [2].

Land degradation is the gradual loss or deterioration of a land's biological productivity, ecological sustainability, or human value [3]. Additionally, soil erosion, soil organic matter depletion, and land-use change linked to human and natural processes are all indicators of land degradation, according to Xie et al. [4]. Land degradation has become a global environmental problem and a major obstacle to achieving goals for sustainable development and reducing poverty. Numerous factors contribute to land degradation, including land clearing, poor farming practices, overgrazing, poor irrigation, urban sprawl, commercial development, and pollution from industrial waste and the quarrying of stone, sand, and minerals [5]. As a result, agriculture and the land may have a conflicting, win-lose, or win-win connection. For example, continued land use, like clearing forests to grow crops or raise animals, leads to degradation and a "win-lose" situation.

Land degradation has a serious impact on the environment, food security, ecosystems, vegetation, water quality and supply, sanitation, soil erosion, and landslides [3,4,6,7,8]. The wide-ranging effects of land degradation have become a significant environmental problem that has gotten much attention worldwide. Because of this, many international, regional, and local goals have been set up to combat land degradation and bring it back to health. These are such as the United Nations' Sustainable Development Goals [9], land degradation neutrality (LDN) in the UNCCD 2018–2030 Strategic Framework [10], the Comprehensive African Agricultural Development Programme (CAADP) in the Agenda 2063: [11] The Africa We Want, the Tanzania Village Land Act, 1999 [12], the Tanzania Forest Act, 2002 [13], the Tanzania Land Use Planning Act, 2007 [14], the Tanzania Mining Act, 2010 [15] (URT), and the Tanzania National Environmental Policy 2021 [16]. All these instruments target managing the environment to eliminate its detrimental effects. Furthermore, stakeholders' attention is

advocated when adopting reliable, sustainable land management measures relevant to tackling the problem.

Adopting sustainable land management practices (SLMPs) has become necessary to address the detrimental impact of land degradation. Sustainable land management measures are regarded as implementing land-use models that, via appropriate management techniques, allow land users to optimise economic and social gains from the land while conserving or increasing the ecological support functions of land resources [17]. In addition, these measures aim at preventing agricultural or environmental disasters, as well as the adverse effects of climate change and, in particular, land degradation [17,18]. Adopting sustainable land management practices is multifaceted, with several factors affecting land-use decisions and the practices adopted. Several studies on adopting SLMPs have been conducted, with land users either adopting them at a lower rate or not adopting them. The findings revealed that major influencing factors in the decision-making process of households towards various land conservation and management measures are age, household size, education level, and plot-level characteristics such as slope gradient and crop types [19-22]. In addition, other factors include mixed cropping, cover cropping, intercropping, mulching, and crop rotation [23]. Also, factors like farmers' age, land size, household size, years of schooling, extension service, farming experience, and technical know-how influenced the adoption of land conservation and management practices [24,22].

Additionally, Adetomiwa et al. [25] found that the adoption decision depends on factors like gender, marital status, farming experience, access to extension contacts, access to credit, and land ownership. Belachew et al. [26] also found that age, sex, level of education, size of household, number of animals, size of land, access to credit, access to extension services, and training all affected adoption. Oduniyi et al. [27] also found that the source of farm inputs, the availability of farm inputs, the frequency of extension, the source of water, and the marital status were all important for adopting SLMPs. Furthermore, Oduniyi [28] revealed that gender, years of schooling, farming experience, extension visits, and social organisation membership all affected the SLMPs adoption. Moreover, Kirui [29] determined that demographic and socioeconomic factors, including age and education level of the household head, family size, land size, membership in farmer cooperatives, savings and credit cooperatives, land tenure, access to credit, and proximity to markets, influenced the adoption of the SLMPs in East Africa.

Despite numerous international, regional, and local efforts to promote communities' adoption of the SLMPs, developing countries still have a low adoption rate, especially in rural areas with low adoption of agriculture technologies [30]. Tanzania is no exception as a developing country. Despite considerable efforts to promote land conservation programmes, the adoption of many recommended measures is minimal, and land degradation still accelerates [31,32]. Moreover, there is little empirical knowledge on the reasons for adopting sustainable land management practices, especially in the semiarid areas of Tanzania, hence the need for this study. Thus, the problem addressed by this study is the limited knowledge on the adoption of sustainable land management practices in Mbulu district, a semi-arid area in Tanzania, despite the documented benefits of such practices for the environment and the livelihoods of local communities.

The study examines the factors that influence the adoption of sustainable land management practices in Mbulu district and aims to understand how these factors interact to either facilitate or hinder the adoption of such practices. Specifically, the study addressed questions such as: What is the adoption index of sustainable land management practices in Mbulu district? What are the factors that influence the adoption of sustainable land management practices in Mbulu district? How do the factors interact to either facilitate or hinder the adoption of such practices? By answering these questions, the study provides insights into how sustainable land management practices can be promoted in the study area and other similar contexts, thus contributing to efforts to promote sustainable development and environmental conservation.

This study is significant for several reasons. These are- the study contributes to the existing knowledge on the enablers for the adoption of sustainable land management practices in Mbulu district. This knowledge can help policymakers and practitioners design and implement effective interventions to promote sustainable land management practices in the area. Also, the study raises awareness among farmers about

the importance of sustainable land management practices and their benefits. This encourages behaviour change and increases the adoption of sustainable land management practices in the area, leading to improved environmental conservation, increased resilience to climate change, and enhanced livelihoods.

Apart from that, the study gives policymakers, practitioners, and other stakeholders recommendations based on facts about how to promote sustainable land management practices in Mbulu district. These recommendations inform the development of policies and programmes that support the adoption of sustainable land management practices, such as providing technical support and extension services. Finally, the study serves as a model for similar studies in other regions facing similar challenges related to unsustainable land use practices. Thus, the findings of the study contribute to a broader understanding of the factors that influence the adoption of sustainable land management practices and inform efforts to promote sustainable development and environmental conservation in other regions.

2. MATERIALS AND METHODS

The study was conducted in Mbulu district in the Manyara region, a northern part of Tanzania. The area is comprised of five districts, and this is one of them. Karatu district borders it to the north, Babati district to the east, Hanang district to the south, and Iramba district to the west. The altitude of the district varies somewhere between 1000 and 2400 metres, and it is also located on the eastern side of Mbulu Highlands. It is between thirty-four and thirty-five degrees east of Greenwich and three and four degrees south of the equator. The district was selected because it consists of both dry and semiarid zones. In addition, the indigenous people's lifestyle, which is largely characterised by peasant and agropastoralist practices, disrupts the natural equilibrium of the environment, which makes the region more susceptible to land degradation.

The study used a cross-sectional design. The approach was chosen because it allows researchers to compare diverse factors simultaneously. In this study, characteristics such as age, gender, education degree, marital status, and economic activities were explored in the context of adopting sustainable land management practices. The study's target population was farmers, whereas the sampling unit was a farming household. The study used a multistage sampling approach. Mbulu district was purposefully selected, followed by randomly selecting four villages from a list of wards. A systematic sampling procedure was employed in determining the respondents from a list of villages. This study employed a cross-sectional approach. The design was used for the research because it allowed researchers to assess different variables simultaneously. Analogously, the investigation into the factors that influence adopting sustainable land management practices was conducted at a low cost. It focused on age, gender, educational level, marital status, the tenure system, land size, major economic activities, the slope of the terrain, and access to extension services.

The study used a sample size of 120 household heads involved in the data collection activity. Moreover, the close support of the Village Executive Officers facilitated the data collection exercise. Households were asked to complete semi-structured questionnaires, and regional and district environmental, livestock, and agricultural officers were interviewed in depth. In addition, community and local leaders participated in focus group discussion sessions within the selected wards. The Statistical Package for the Social Sciences (SPSS) software was used to manage datasets that were analysed through the STATA software package. Stata is extensively used for data analysis, including SLMPs adoption. It may be used for descriptive statistics and advanced statistical analyses. Overall, it is a useful tool for analysing SLMPs adoption data, providing valuable insights to inform policies and strategies aimed at increasing adoption rates.

Descriptive statistics analysed the dataset with regard to percentages, the frequency of farming household characteristics, and the adoption index of the SLMPs. Descriptive results provide a clear picture of the sample in the study area. On the other hand, the adoption index was computed to show the extent of adoption of the SLMPs among farmers in the study area. The probit regression model estimated the influence of the factors on adopting sustainable land management practices in the study area. The model is a multivariate technique appropriate for a dichotomous dependent variable. Further, the model explains a dichotomous dependent variable with the empirical specification formulated as a latent-response variable.

Furthermore, adopting sustainable land management practices required only two values

to indicate whether a farmer uses sustainable land management practices. In the probit model, it is assumed that the decision of the farmer to use sustainable land management practices or not depends on an unobserved index determined by explanatory variables in such a way that the larger the value of the index, the greater the probability of the farmer using the practices. Independent variables were determined based on the existing literature and survey questions. As a result, age, gender, education status, marital status, land size, awareness of sustainable land management practices, land slope, distance to the extension office, and main economic activities were included in the model.

The general specification of the model is mathematically given by Dimoso [33]. The model estimates with a standard maximum likelihood method, whereas the error terms are normally distributed with a zero mean and a variance of one. Equation (1) describes the model as follows;

$$Y_i^* = X_i\beta_1 + u_i,\ u_t \sim \text{N}(0, 1) \quad (1)$$

From Equation (1),

- Y_i^* is a latent variable 'adoption of sustainable land management practices,
- X_i is a vector of observed non-random explanatory variables,
- β is a coefficient estimate of the independent variable
- μ_i is an error term normally distributed with zero mean and a variance of one.

The dependent variable is unobserved. Therefore, it is sound to assume that the adoption is observed as described in Equation (2):

$$y_i = \begin{cases} 0 & If\ Y_i^* \leq 0 \\ 1 & If\ Y_i^* > 0 \end{cases} \quad (2)$$

The model estimated the probability of adopting sustainable land management practices for observation i. The marginal effects were used to interpret the results of the model. Each marginal effect was an average of the individual marginal effects for all the responses to the particular variable. It determined the average change in the probability obtained from a one-unit change in the independent variable [34]. Thus, the marginal effects indicated the average change in the response variable's probability when the indicator variable changed from zero to one [34]. The marginal effect estimates of the relative effect for independent variables are presented in Equation (3).

$$\frac{\delta A_i}{\delta X_{ij}} = \beta_{ij} * f(Z_i) \quad (3)$$

Where:

$f(Z_i)$ is an inverse of the cumulative normal function
β_{ij} are the parameter estimates.

Thus, with the assumption of Equation (2), the probit model is expressed as in Equation (4) when the variables are fitted.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \mu_i \quad (4)$$

Where:

- Y_i Binary response variable [Dummy; 0=Not adopted SLMPs, 1= adopted SLMPs]
- X_1 Age status of the household head [Continuous; the number of years: *Expected sign (+ve)*]
- X_2 Gender status of the household head [Dummy; 1 if the head is a male and 0 if otherwise: *Expected sign (+ve)*]
- X_3 Education status of the household head [Dummy; 0 - nonformal education, 1 – formal education: *Expected sign (+ve)*]
- X_4 Marital status of the household head [Categorical; 1 if married, two if not married, three if the widowed, four if divorced: *Expected sign (-ve)*]
- X_5 Land size [Continuous; a total number of acres: *Expected sign (+ve)*]
- X_6 Awareness of land conservation and management [Dummy; 1 if yes, 0 if otherwise: *Expected sign (+ve)*]
- X_7 Land slope [Categorical; 1 if flat, two if medium, three if steep: *Expected sign (+ve)*]
- X_8 Distance to the extension office [Dummy; 0 if ≤ 5 Km, 1 if > 5 Km: *Expected sign (-ve)*]
- X_9 Major economic activities [Dummy; 0 if peasant, 1 if agropastoralists: *Expected sign (+ve)*]
- β_0 A constant term
- $\beta_{1\ldots9}$ are the coefficient estimates of the independent variables affecting the SLMPs adoption
- μ_i Disturbance term

3. RESULTS AND DISCUSSION

3.1 Descriptive Analysis Results

The adoption of SLMPs in Mbulu district, a semi-arid area in northern Tanzania, was examined using nine (09) variables and 120 farmers. The descriptive results provide essential information about farmers' demographic, socioeconomic, and land-related variables in the study area. The variables include the adoption of SLMPs, age, gender, marital status, education level, main economic activity, the slope of the land, distance to the extension office, land size, and awareness of SLMPs.

The variable, age, had 120 observations with a mean of 43.942 years and a standard deviation of 11.56 years. The minimum age observed was 17 years, and the maximum was 65 years. It suggests that the farmers had a wide age range, with most falling in the 30–50 age range. Land size had a mean of 3.233 and a standard deviation of 2.321. This variable measured the size of the land the farmer used for farming, and the mean value indicates that the average farmer used a piece of land that was 3.233 acres.

The minimum land size in the studied sample was 0 acres, indicating that some farmers did not own land. However, the maximum land size was 9.5 acres, indicating that some respondents owned extensive land plots. Regarding gender, 80 farmers (or 80%) were male and 24 (or 20%) were female. Among the male farmers, 21.88% adopted land management practices, while only 8.33% of the female farmers did so. The chi-square test results show that there is no statistically significant relationship between gender and land management adoption practices ($\chi^2 = 2.273, p = 0.132$). Regarding marital status, most farmers (92.5%) were married, and 18.02% adopted land management practices. In contrast, only 40% of the farmers who were not married adopted such practices. The chi-square test results show no statistically significant relationship between marital status and land management adoption practices ($\chi^2 = 2.121, p = 0.548$). Regarding education level, 76.67% of farmers attended school, and 23.33% did not. Among those who attended school, 23.91% adopted land management practices, while only 3.57% of those who did not attend school did so. The chi-square test results show a statistically significant relationship between education level and adoption of sustainable land management practices ($\chi^2 = 5.733, p = 0.017$). Regarding economic activity, 84.17% of farmers were involved in agropastoral activities, while only 15.83% were peasants. The SLMPs adoption rates differed for the groups (21.05% for peasants and 18.81% for agropastoralists). The chi-square test results show a statistically insignificant relationship between major economic activities and sustainable land management adoption practices ($\chi^2 = 0.052, p = 0.820$).

Concerning slope, the farmers' land was categorised as flat, medium, or steep. The adoption rate of land management practices was highest for farmers with medium slope land (35.71%), followed by those with steep-slope land (21.43%), and flat-slope land (11.67%). The chi-square test results show that there is a statistically significant relationship between slope and land management adoption practices ($\chi^2 = 7.023, p = 0.030$). Regarding distance, 11.67% of farmers lived within 5 kilometres of the study area, while 88.33% lived farther away. The adoption rate of land management practices was higher for those who lived within 5 kilometres (35.71%) than those who lived farther away (16.98%). The chi-square test results show no statistically significant relationship between distance and land management adoption practices ($\chi^2 = 2.801, p = 0.094$). Finally, for the awareness variable, 88.33% of respondents were aware of land management practices, and 72.50% of them adopted such practices. In contrast, only 27.50% of the respondents who needed to be made aware of land management practices adopted them. The chi-square test results show that there is no statistically significant relationship between awareness and land management adoption practices ($\chi^2 = 0.123$, $p=0.76$). Therefore, descriptive analysis suggests that education level and slope are important factors in SLMPs. At the same time, gender, marital status, economic activity, distance, and awareness do not play a significant role in the adoption.

3.2 The Sustainable Land Management Practices Adoption Index Results

The adoption variable was used to figure out the SLMPs adoption index. This index shows the proportion of farmers who adopted the SLMPs in the study area. The study results show that only 23 farmers adopted SLMPs, of which 91.3% were male farmers and only 8.7% were female farmers. In addition, 97 farmers did not adopt any of the SLMPs. Therefore, this gave rise to

computing the adoption index given in Equation (5):

$$\text{SLMPs adoption index} = \frac{\text{SLMPs adopters}}{\text{Total number of farmers}} \times 100 = \frac{23}{120} \times 100 = 19.2\% \quad (5)$$

Equation (5) shows that only 19.2% of the sample used the SLMPs, which is a relatively low percentage. This rate of adoption is scary, and it can result in detrimental effects on the economy, society, and environment if not well addressed. From an environmental point of view, not managing land in a sustainable way can lead to soil degradation, loss of biodiversity, and less fertile soil, all of which can affect crop yields and agricultural productivity [35]. This can also hurt the quality and availability of water and add to climate change and greenhouse gas emissions [36]. From a social point of view, low adoption can hurt the way of life of farmers and people who live in rural areas where agriculture is a major source of income [35]. It can also cause disputes and conflicts over land rights and accelerate poverty and food insecurity [37]. Finally, from an economic perspective, the low adoption of sustainable land management practises can lead to reduced agricultural productivity and increased costs, as well as affect the long-term sustainability of agriculture and rural development [35].

3.3 Results for Factors Influencing SLMPs Adoption in the Study Area

The descriptive analysis results do not provide information on the factors that drive the adoption behaviour or the extent to which the variables are statistically significant predictors of SLMPs adoption. In addressing this gap, probit regression analysis was estimated the probability of adopting SLMPs based on a set of explanatory variables identified in Equation (4), as shown in Table 1. Thus, the probit regression model examined the factors influencing SLMPs adoption in the study area. The estimation results, on the other hand, explained the impact of factors on the probability of adoption while controlling other relevant factors.

The probit model specified in Equation (4) was used to analyse the factors of SLMPs adoption decisions. The dependent variable in this model is the dichotomous variable: to adopt or not adopt the SLMPs. The independent variables were determined based on the existing literature and survey questions. As a result, gender, age, marital status, education level, major economic activities, land size, the slope of the land, distance to extension offices, and awareness of sustainable land management and conservation were included in the model. The analysis was conducted using the STATA software package. Table 1 presents details on parameter estimates.

Table 1 shows that the probit model explains the SLMPs adoption decision well. A pseudo-R^2 of 0.224 indicates a good model fit, as supported by the recommendation of McFadden [38] that a range between 0.2 and 0.4 means a good fit for the model. Also, the chi-square value ($P<0.006$) was highly significant. Thus, these suggest that the model is good-fit and has a strong explanatory power. The results of the analysis revealed that several variables influenced the adoption of SLMPs. The variables significantly influencing the SLMPs adoption include gender, marital status, education, land size, and distance to the extension offices.

As expected, the coefficient of being a male was positive (0.935) and significant at $p<.1$, demonstrating that gender is an important factor that affects whether or not to adopt the SLMPs. Importantly, it implies that male-headed households favourably adopt SLMPs more than female-headed households. Furthermore, it means that being male, ceteris paribus, increases the chance of adopting the SLMPs by 15.6%, which is consistent with the findings of Adetomiwa et al. [25] and Oduniyi [28]. On the contrary, females are technically absorbed by domestic chores. Consequently, female-headed households need more time to adopt the SLMPs, even if they wish to.

Interestingly, the coefficient of marital status (widowed) was positive (1.932) and significant at $p<.1$, revealing that marital status is an essential factor determining the adoption of SLMPs in the study area. Further, the marginal effect value depicts that being widowed, ceteris paribus, increases the likelihood of SLMPs adoption for a particular farmer by 52.6%. It means that the widow is carefully taking all the necessary steps to ensure the family gains sustainability after losing the spouse, knowing the dangers that may result when the SLMPs are not well used to their premises. So, the adoption of the SLMPs prompts future prosperity within the family. The findings are backed up by Adetomiwa et al. [25] and Oduniyi et al. [27], which report marital status as an important variable when adopting land management practices in their study areas.

Table 1. Probit estimation results

Variables	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	dy/dx	Sig
Gender (BG: Female)								
Male	0.935	0.557	1.680	0.093	-0.157	2.026	0.156	*
Age	-0.001	0.014	-0.090	0.926	-0.029	0.026		
Marital status (BG: Married)								
Not married	0.706	0.772	0.910	0.361	-0.808	2.220		
Widowed	1.932	1.113	1.740	0.083	-0.249	4.113	0.526	*
Education (BG: Not attended)								
Attended formally	0.952	0.530	1.790	0.073	-0.088	1.991	0.163	*
Econ activity (BG: Peasant)								
Agropastoral	0.035	0.432	0.080	0.935	-0.810	0.881		
Land_Size	0.142	0.072	1.970	0.049	0.001	0.282	0.030	**
Slope (BG: Flat)								
Medium	-0.430	0.504	-0.850	0.393	-1.417	0.557		
Steep	0.366	0.554	0.660	0.509	-0.721	1.453		
Distance (BG: $\leq 5km$)								
$\geq 5km$	-0.922	0.424	-2.170	0.030	-1.753	-0.09	-0.235	**
Awareness (BG: No)								
Yes	-0.241	0.379	-0.630	0.526	-0.984	0.503		
Constant	-1.956	1.179	-1.660	0.097	-4.268	0.355		*
Mean dependent var	0.193		SD dependent var			0.397		
Pseudo r-squared	0.224		Number of obs			120		
Chi-square	26.167		Prob > chi2			0.006		
Akaike crit. (AIC)	114.677		Bayesian crit. (BIC)			148.026		

*** p<.01, ** p<.05, * p<.1*

Source: Stata output, 2023

Also, the coefficient of education was positive (0.952), as expected and significant at p<.1, implying that formal education influences the adoption of SLMPs in the study area. The marginal effect value shows that a one-unit increase in formal education, ceteris paribus, would result in a 16.3% increase in the probability of adopting the SLMPs. The results mean that education may enhance competence in learning new ideas, influencing farmers to adopt the SLMPs. Moreover, more access to formal education can enhance knowledge and promote investment in sustainable land management practices in the study area. This result is concurrent with the findings from Belay et al. [21], Kayode et al. [24], Etsay et al. [22], and Belachew et al. [26].

Aside from that, the coefficient for land size was positive (0.142), as expected, and significant at p<.05, indicating that land size influences SLMPs adoption positively. The marginal effect value suggests that a one-acre increase in land size, ceteris paribus, increases the probability of a farmer adopting the SLMPs in the study area by 3%. The results suggest that a farmer in the study area will likely adopt SLMPs if they own or cultivate an additional acre of land. Also, with more extensive land, the farmer could apply the SLMPs and afford the risks that may arise, such as a smaller plot of land after implementing the SLMPs, which can affect the harvest over the short run. The results are consistent with those of Kayode et al. [24], Kirui [29], Etsay et al. [22], and Belachew et al. [26].

Furthermore, the distance coefficient to extension offices was negative (-0.922), as expected, and significant at p<.05, indicating that an increase in distance to the extension offices reduced the possibility of a farmer adopting the SLMPs in the study area. The average marginal effect suggests that being farther than 5km from the extension offices, ceteris paribus, decreases the probability of SLMPs adoption by 23.5%. Further, it means that an increase in distance diminished the capability of the farmer-extension officer's contacts, thereby limiting the chance of acquiring expert advice on SLMPs. As a result, it constrained the likelihood of a particular farmer adopting the SLMPs. On the other hand, the shortest distance to the extension office guaranteed farmers easy access to up-to-date information from the extension officers, who could ultimately influence the adoption. The findings concur with the results of Etsay et al. [22], who report distance to agricultural extension services as an important indicator of sustained use of sustainable land management activities.

In summary, gender, marital status, education, land size, and distance to the extension offices were the main factors determining whether or not the farmers in the study area adopted the SLMPs. Therefore, these variables affected the adoption decisions in the study area significantly. By linking the descriptive results to the probit results, the study gained a deeper understanding of the factors that influenced the adoption behaviour so as to identify the most effective interventions for promoting sustainable land management practices [39].

4. CONCLUSION AND RECOMMENDATIONS

This study examined the factors influencing the adoption of sustainable land management practises (SLMPs) in Mbulu district, a semiarid area in northern Tanzania. A cross-sectional study was conducted, and data from 120 farmers was collected using semi-structured questionnaires. SPSS version 20 and STATA version 13 software packages were used for data analysis. Descriptive statistics provided essential information about farmers' demographic, socioeconomic, and land-related variables in the study area. The variables included the adoption of SLMPs, age, gender, marital status, education level, main economic activity, slope of the land, distance to the extension office, land size, and awareness of SLMPs.

On the other hand, the adoption index was used to figure out how widely SLMPs were used, and it shows that the level of adoption was low. A probit regression model examined the factors influencing the adoption. The findings suggest that being male, having a formal education, being widowed, having an extensive land size, and being closer to the extension offices, which ease access to information about sustainable land management practises, increased the likelihood of adopting sustainable land management practises. Meanwhile, age, marital status (except for being widowed), economic activity, the slope of the land, and awareness of land management had no significant effect. Overall, addressing these factors requires a multi-faceted approach that involves collaboration between various stakeholders, including farmers, communities, governments, civil society organisations, and the private sector. By working together, these stakeholders can create an enabling environment

that promotes the adoption of sustainable land management practises and contributes to more sustainable livelihoods and income diversification in the study area.

Aside from that, semi-arid areas need to use sustainable land management practises to keep the land healthy and productive in the long run. While progress has been made in the adoption of sustainable land management practises in the study area, there are still several areas for further research and action to improve their adoption and effectiveness. Some of these include: Outreach and education efforts should also emphasise targeting female-headed farmers, those with lower levels of education, and those farther than 5 km from the extension offices to increase adoption rates for SLMPs. Moreover, awareness-raising programmes must be more targeted and effective to reach the intended audience.

Livelihoods and income diversification in semi-arid areas are closely tied to the land. Therefore, promoting sustainable land management practises that also support income diversification and livelihood improvement is crucial. Further research is needed to identify the most effective strategies for promoting sustainable land management practises that also support livelihoods and income diversification in the study area.

5. POLICY AND INSTITUTIONAL FRAMEWORKS

The adoption of sustainable land management practises requires supportive policy and institutional frameworks. Further research is needed to identify the most effective policies and institutional frameworks for promoting sustainable land management practises in the study area and the factors that influence their implementation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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