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Factors influencing smallholder Farmer's willingness to adopt sustainable land management practices to control invasive plants in northern Tanzania

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ABSTRACT

Efforts to mitigate the effects of invasive plant species (IPS) have not produced the desired results due to poor adoption of land management practices developed by scientists and introduced to the community through a top-down approach. Little is known about adoption of Sustainable Land Management (SLM) practices that have been co-developed by a diverse group of local stakeholders through a participatory process. In this study, we assessed factors influencing the willingness of smallholder farmers to adopt SLM practices for the control of *Lantana camara, Clidemia hirta, Pteridium acquilinum,* and *Prosopis juliflora* in northern Tanzania. A semi-structured questionnaire was used to collect information from 240 heads of households from eight villages affected by the four IPS. Binary logistic regression was applied to model the probability of factors that influence smallholder farmers' willingness to adopt the SLM practices. We found that farming experience, household income and conservation awareness were positively associated with the willingness for adoption of SLM practices. Surprisingly, the invasive species cover was negatively associated with the willingness for adoption of SLM practices for control of the IPS. We recommend that the extension service providers to continue raising awareness and education among farmers with low farming experience and income, and those with fields heavily infested with IPS.

1. Introduction

In agricultural settings, presence of invasive plant species (IPS) leads to significant consequences, including decreased agricultural production, reduced cash income derived from crop production, heightened farming expenses, compromised food security due to competition for light, water, nutrients and displacement of crops caused by the toxins produced, hindrance to the growth of other plants, heightened vulnerability of livelihoods, and increased public expenditure (Drechsler et al., 2016; Kilawe et al., 2017; Ngondya et al., 2017; Witt, 2010).

Once an IPS population has taken place in the environment, tasks of cutting, uprooting and recurrent weeding in agricultural lands become costly, this leads to diminished returns on the initial investments made during the initial phase of crop production, or even the abandonment of crop production altogether. It has been estimated that global impact and expense associated with managing invasive alien species amount to an overwhelming US$1.4 trillion annually, or equivalent to 5% of global gross domestic product (Witt, 2010). The presence of IPS continues to disrupt ecosystems globally, often leading to undesirable changes in their functioning (Keller, 2011).

The desired outcomes of addressing IPS have not been achieved due to low rate of adoption of land management practices among smallholder farmers, hindering efforts to reduce IPS effects. Practices for land management that have been introduced to the community through a top-down approach have not been accepted by farmers. These practices lacked social acceptance as they were developed without engaging local stakeholders (Schwilch et al., 2012). The involvement of local communities in the definition and selection of land management practices has been suggested to enhance the adoption rate of these practices. This is attributed to the fact that when communities are engaged and have a sense of ownership in the process, they are more likely to embrace and implement the practices (Schwilch et al., 2012). Nevertheless, there are limited research examining the factors linked to the willingness for adoption of SLM practices. In the present study, the SLM practice was co-developed through a participatory process by a diverse group of local stakeholders and test implemented for two years (2019 and 2020) by 12

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farmers. The SLM practice was developed based on the methodology originally created for the EU DESIRE project, but it was adjusted to fit the specific conditions in northern Tanzania (Bachmann et al., 2007; Schwilch et al., 2009; Nkombe et al., 2018). The SLM practices encompass a holistic approach that incorporates social, economic, ecological and environmental considerations to achieve production objectives that are socially acceptable. These practices consist of tailored measures and techniques designed to suit both the biophysical and socio-economic conditions. Their primary goals are to safeguard, conserve and sustainably utilize resources such as water, soil and biodiversity; additionally, to restore degraded natural resources and their critical ecosystem functions in the environment (FAO/FESLM, 1993; Liniger et al., 2011; Liniger and Studer, 2019).

According to the Technology Acceptance Model (TAM), which is revised version of the Theory of Reasoned Action (TRA), an individual's willingness to adopt or utilize a system or technology is predominantly determined by their perception of its utility, which is directly shaped by their perception of its simplicity in usage (Abdullah et al., 2016). The model anticipates the level of acceptance for a tool and identifies the necessary adjustments to the system in order to enhance its acceptability among users (Venkatesh and Davis, 2000). Empirical evidence highlights how individuals within a community, having access to credit, sufficient household labor and enough land tend to exhibit a greater willingness to engage in land management practices (Adimassu et al., 2012; Kansanga et al., 2020). Farmers display a greater inclination towards embracing innovation when the innovation is directly linked to their past activities. Furthermore, the level of interest varies among different socioeconomic groups, and over time, certain new agricultural technologies have gathered significant acceptance; in contrast, other technology enhancements in agriculture have been embraced by only a restricted group of farmers (Feder et al., 1985).

The aim of the current paper is to determine factors associated with adoption of SLM practices for control of IPS *L. camara, C. hirta (Miconia crenata)* and *P. juliflora*, as well as the native weed *P. acquilinum*. Factors which were considered in this study included farming experience, household income, IPS cover, household size, farm size, gender, credit access and conservation awareness. To ensure sustainable management of IPS and broader implementation of land management practices across the landscape, it is crucial to understand the factors that influence the willingness for adoption of SLM practices in the community.

2. Methodology

2.1. Description of study area

The research was conducted in two areas of the northern Tanzania: Kahe ward, Moshi Rural District, and Amani ward, Muheza District (Fig. 1). Kahe ward is situated between 3° 26′ to 3° 37′ S and 37° 21′ to 37° 30’ E, approximately 23 km southeast of Moshi Urban. It encompasses semi-arid lowland areas characterized by scattered trees, particularly Baobab (*Adansonia digitata* L.) trees (Meta, 2016). The annual rainfall ranges from 17.2 mm to 221.2 mm, with an average of 100.4 mm. The temperature varies from 14 °C 35 °C with an average of 28 °C (de Bont et al., 2019). The primary economic activities in the district revolve around crop cultivation and livestock keeping. Maize (*Zea mays* L.), beans (*Phaseolus vulg*aris L.), and tomatoes (*Solanum lycopersicum* L.) are the main food crops grown, while livestock consists of cattle (*Bos taurus* L.), sheep (*Ovis aries* L.), and goats (*Capra aegagrus hircus* L.).

In Kahe, a variety of non-native plant species have been introduced but among them *P. juliflora* has emerged as the most troublesome (Table 1). This particular species invades both agricultural and grazing lands (Kilawe et al., 2017). It forms dense thickets that hinder the movement of people and animals and its thorns pose risks to the eyes and hooves of animals (Tessema et al., 2009). Furthermore, it encroaches on uncultivated agricultural fields, leading to increased labor requirements and higher production costs for crop (Kilawe et al., 2017).

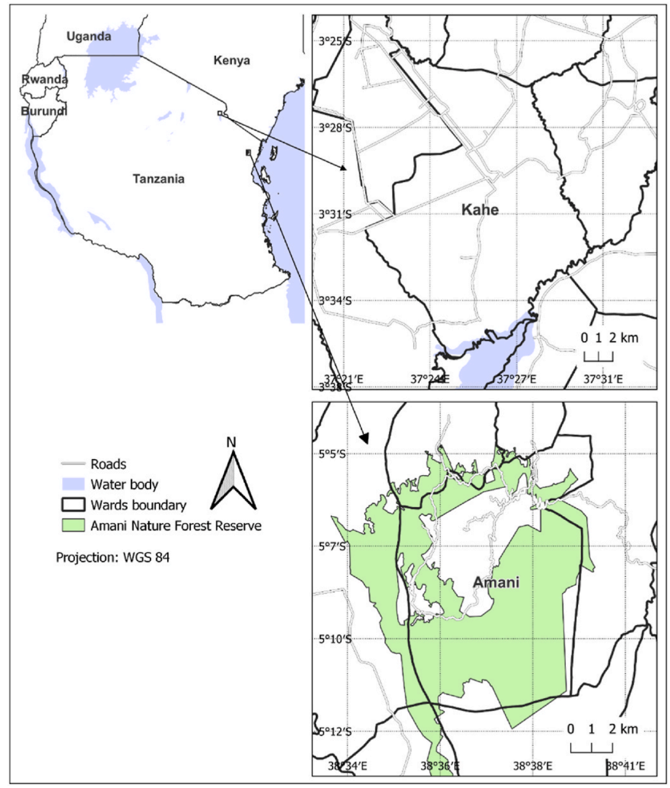

Fig. 1. Location of the study areas – Amani and Kahe wards in Northern Tanzania.

Utilizing a deliberative multi-criteria decision support tool (Schwilch et al., 2012), members of the local implementation group jointly opted for the implementation of the continuous removal of IPS and intensive cultivation practice for test implementation to address the issue of *P. juliflora* infestation in Kahe. This practice involved cutting and uprooting *P. juliflora* during land preparation for crop cultivation. The larger trees (diameter at breast height (dbh) > 5 cm) were utilized for firewood or charcoal production, while the smaller branches were repurposed for fencing farmland. Farmers took the responsibility of removing emerging *P. juliflora* seedlings through weeding after planting their crops. The land was intended to be under continuous cultivation without fallowing as determined by the farmers. The anticipated outcome of this practices was a reduction in the density of *P. juliflora*, while simultaneously enhancing farmers' livelihoods by reclaiming the land for continuous crop cultivation.

Amani ward is situated in the Tanga Region, approximately 70 km west of Tanga City. Covering an area of around 91.2 km^2, it is positioned between 5^0 04′ to 5° 11′ S and 38° 35′ to 38° 40′ E at an elevation of approximately 900 m above sea level. The average annual rainfall in Amani ranges from 1,918 mm to 2,262 mm, while the mean annual temperature is recorded as 20.6 °C (Mpanda et al., 2011). The hottest season occurs in January–February, while the coolest months are May–July. Amani's nature reserve forests are vital water catchment areas and serve as source of traditional medicine, and various non-timber forest products. The majority of the natural forest areas are designated as protected zones, primarily as community forest reserves, with some also designated as village forest reserves (VFR) (Engh, 2011; Vihemäki, 2009).

In Amani, the socio-economic activities of rural communities primarily revolve around subsistence agriculture and livestock keeping. Smallholders largely engage in food production, while both smallholders and large-scale farmers (including public and private institutions) participate in cash crop cultivation. The main food crops cultivated in terms of land coverage include maize (*Zea mays*), cassava

Table 1
Description of the study species.

Species name	Species origin	Year of introduction to the study area	Purpose of introduction in the area	Socio-economic effects of the species in the area
Prosopis juliflora	Costa Rica, Ecuador, El Salvador, Colombia, Guatemala, Honduras, Mexico, Nicaragua, Panama and Venezuela.	1988	Provision of fuelwood, timber, fodder, charcoal, windbreaks and rehabilitation of degraded landscapes.	Limits the freedom of movement for both people and animals. The thorns pose risks to the well-being of animals' eyes and hooves. Encroaches fallow agricultural fields, making crop production labour intensive and increasing its overall cost.
Clidemia hirta (*Miconia Crenata*)	Native to much of tropical America.	1930	Ornamental plant	Invasion on agricultural fields and forests. Increased land preparation costs, weeding and reduced overall productivity.
Lantana camara	Bahamas, Colombia, Costa Rica, Cuba, Hispaniola, Jamaica, Mexico and Venezuela.	1930	Hedging plant, Ornamental plant.	Invasion on agricultural fields and forests. Rise in expenses related to land preparation and weeding, leading to decreased overall productivity.

(*Manihot esculenta* Crantz), sweet potatoes (*Ipomoea batatas* L.), bananas (*Musa paradisiaca* L.), bean (*Phaseolus vulgaris*), and rice (*Oryza sativa* L.). Significant cash crops in the region consist of tea (*Camellia sinensis* L.), sugarcane (*Saccharum officinarum* L.), cardamom (*Elettaria cardamomum* (L.) Maton), coconut plantations (*Cocos nucifera* L.), cinnamon (*Cinnamomum verum* J. Presl), cloves (*Syzygium aromaticum* (L.) Merr. and L.M. Perry), and black pepper (*Piper nigrum* L.). Livestock rearing involves cattle (*Bos taurus*) and goats (*Capra aegagrus hircus*). Dairy farming and poultry keeping are widespread practices within the Amani ward.

The agricultural landscapes of Amani face challenges primarily from three main species: *L. camara, P. acquilinum and C. hirta (Miconia crenata)*. *L. camara* was initially introduced as an ornamental plant in the Amani Botanical Garden (Table 1). However, due to inadequate management, forest disturbance and unsustainable farming practices, *L. camara* spread beyond control, invading agricultural fields and forests (Nkombe et al., 2018). Presently, it adversely affects both small-scale farmers and large-scale private plantations like the East Usambara Tea Company, increasing costs associated with land preparation and weeding, while also reducing overall productivity.

The selected SLM practice in Amani ward is the *slash and uprooting of invasive plant species*, aimed at controlling the density of *L. camara, P. acquilinum and C. hirta (Miconia crenata)*. The SLM practice involves the following steps: (a) slashing of all vegetation in the field using a machete, (b) performing deep tillage and uprooting the entire IPS including rootstock using a hand hoe, (c) evenly spreading the slashed materials as a mulch on the field, (d) planting cassava and (e) conducting weeding every three months to consistently remove emerging IPS from the soil seed bank. Crop planting takes place at the beginning of the rainy season (April–May, and October–December).

2.2. Sampling procedure and data collection

Kahe and Amani wards were purposively chosen due to the presence of SLM practices that have been implemented for control of IPS over a two-year period. Four villages were randomly selected from each Ward using the lottery method. The villages selected in Amani Ward were Mlesa, Shebomeza, Mbomole, and Mkwinini while in Kahe Ward the selected villages were Oria, Mtakuja, Chekereni, and Mawala. In each village, 30 respondents were randomly chosen to participate in the study. Data regarding socio-economic factors associated with the willingness to adopt the proposed SLM practices for controlling *P. juliflora* in Kahe Ward and L. *camara*, *C. hirta* and *P. acquilinum* in Amani Ward were collected using a semi-structured questionnaire. Each interview lasted approximately 30 min and a team of five trained enumerators assisted in conducting the household surveys. Before the interviews, a detailed description of the SLM practice was presented to familiarize the farmers with their implementation, advantages and disadvantages.

The selection of eight variables that can influence farmers' willingness to adopt SLM practices was informed by a literature review on the subject. Table 2 provides a detailed description of these variables and their selection is justified as follows:

1. Farming experience: The experience gained from farming has been shown to impact the land management decisions made by farmers. In Tanzania, it is suggested that young individuals are more open to embracing new technologies while older individuals tend to adhere to traditional farming methods (Gilbert, 2013). Further research indicates that as farmers accumulate experience over the years, they gradually evolve from traditional agricultural technologies to enhanced technologies, driven by their observations of performance and learning through practical experience (Ainembabazi and Mugisha, 2014).
2. Income: The perception of improved household wealth status indicates an enhanced ability to access, utilize and diversify input resources required for embracing new agricultural technology. The perception fosters a sense of economic security enabling investments and facilitating the understanding of the advantages associated with adopting new agricultural technology (Sunding and Zilberman, 2001).
3. Invasive plant species cover: When an adopter perceives and acknowledges a changing environment, it signifies an awareness of the adverse impacts of environmental degradation on poverty and food security. The presence of weed cover influences the intention and attitude towards agricultural practices and the environment. The introduction of new technologies holds the promise of addressing poverty and ensuring food security within the household, offering a transformative solution (Jha et al., 2019).
4. Farm size: Farmers who possess extensive land holdings are more inclined to embrace new technologies, as they have the capacity to

Table 2
Description of variables used in a binomial logistic regression model.

Variable	Label	*Description*
Y	Y	Household head willingness to adopt SLM practice (1 = Yes; 0 = No)
Constant	X	
Farmexp	X_1	Household head farming experience (Years spent on crop cultivation)
Income	X_2	Household head income (Tanzania Shillings, TZS)
HHsize	X_3	Household composition (Number of individuals living in one house)
Credaccess	X_4	Credit access (1 = Yes; 0 = No)
IAScover	X_5	On farm invasive plant species cover (Percent (%))
Conseawar	X_6	Household head awareness on conservation (1 = Yes; 0 = No)
Farmsize	X_7	Farm size owned by the household (Size in acres)
Gender	X_8	Gender of household head (1 = Male; 2 = Female)

allocate a portion of their land for experimentation and implementation of novel agricultural practices. In contrast, farmers with smaller land sizes face limitations in terms of available land for trying out new technologies (Uaiene, 2011). In the context of input-intensive innovations like labor-intensive or land-saving technologies, small farm sizes can actually serve as an incentive for technology adoption. This is because the limited land available on small farms creates a heightened motivation to adopt such technologies in order to maximize productivity and efficiency (Uaiene, 2011; Udimal et al., 2017).

5. Household size: The human capital of a farmer is believed to play a crucial role in determining their willingness to adopt new technologies. A large household, with its surplus labor, has greater capacity to engage in farming and other household tasks. Additionally, the availability of labor can be advantageous during the implementation of new technologies (Udimal et al., 2017).
6. Gender: Numerous studies have investigated the relationship between the gender of the household head and the adoption of agricultural innovations (Salaisook et al., 2020). It is generally observed that male-headed households are more willing to embrace new agricultural technologies compared to their female-headed counterparts (Van Song et al., 2020).
7. Credit access: Farmers who have access to public programs and funding are more prone to adopting agricultural technologies. The availability of public funds and programs facilitates the initial adoption process and establishes a network for exchanging information as well as providing institutional support. These public programs and funds not only offer economic assistance but also have the potential to shape attitudes towards the adoption of technologies in agriculture (Jha et al., 2019).
8. Education level and Conservation awareness: The capacity to read and write signifies a level of reasoning that enables individuals to effectively acquire, process and analyze information from diverse sources such as media, the internet and organizations. Therefore, it is anticipated that there exists a positive correlation between literacy skills and the adoption of new agricultural technologies (Jha et al., 2019).

2.3. Data analysis

The study utilized both descriptive and inferential statistical analyses to examine the willingness to adopt proposed Sustainable Land Management (SLM) practices and the factors that influence farmers' willingness to adopt these practices for controlling invasive plant species (IPS). Binary logistic regression was employed to determine the probability of factors that impact smallholder farmers' willingness to adopt the jointly selected SLM practices for IPS control. A backward elimination procedure was conducted on the binary logistic regression model to mitigate the risk of multicollinearity among variables and adjust for potential confounding variables. This iterative process resulted in final model for identifying predictors of willingness to adopt SLM practices.

2.4. Correlation of candidate variables for the regression model

To select independent variables for the regression model, correlations among variables were computed, as the backward elimination procedure necessitates the abundance of multicollinearity among the potential variables (Chatterjee and Hadi, 2009). According to Garson (2006), a general guideline suggests that an inter-correlation among independent variables exceeding $r > 0.80$ indicates the presence of multicollinearity. Appendix 1 demonstrates that none of the correlations exceed 0.80, indicating the absence of multicollinearity issues among the candidate variables (Garson, 2006).

3. Results and discussion

3.1. Respondents characteristics

According to the findings of the household survey, it was discovered that 70.8% of the households surveyed in Amani and Kahe ward expressed a willingness to embrace SLM practices with the aim of preserving the environment and minimizing the negative effects of invasive species, particularly in agricultural contexts. On the other hand, the remaining 29.2% of the respondents expressed their reluctance, citing reasons such as lack of initial capital to invest in invaded farmland, insufficient water for irrigation to sustain continuous cultivation and the inability to engage in farm activities due to advanced age. The majority of the respondents who were interviewed were male (53.8%) while female occupied 46.2%. The major occupations that were practiced by the respondents included farmers, pastoralists, agropastoralists, business people and employed ones. Among the interviewed occupations only the employed ones were completely unwilling to adopt SLM because they are not directly facing the challenges posed by IPS.

In this study, the majority of respondents had farming experience ranging from less than 18 to above 60 years, with a peak in willingness to adopt SLM practices for control of IPS observed at 18 to 30 years of farming experience, followed by 31 to 45 years of farming experience (Fig. 2).

In this study, respondents' ages were divided into four major categories: Category one (18 to 30 years), Category two (31 to 45 years), Category three (46 to 60 years), and Category four (above 60 years). Category three had the highest number of individuals willing to adopt SLM practices for the control of IPS, followed by Category two (Fig. 3).

One of the key factors that was assessed among respondents or households which were interviewed on willingness to adopt SLM practices for control of IPS was average income per month. Household average income per month (Tanzania Shillings, TZS) was divided into five categories; Category one (0 to 50,000 TZS), category two (50,001 to 100,000 TZS), category three (100,001 to 200,000 TZS), category four (200,001 to 300,000 TZS) and category five (over 300,000 TZS). It was observed that the majority of the respondents had an average income of 50,001 to 100,000 TZS per month followed by less than 50,000 TZS (Fig. 4).

3.2. Factors influencing adoption of the SLM practices

The final model for assessing willingness for adoption of SLM prac-

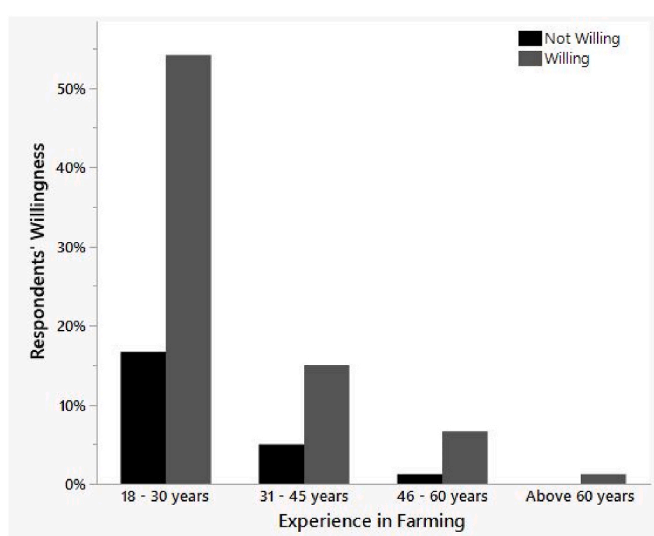

Fig. 2. Relationship between percentage respondents' willingness for adoption of SLM practices and farming experience (N = 240).

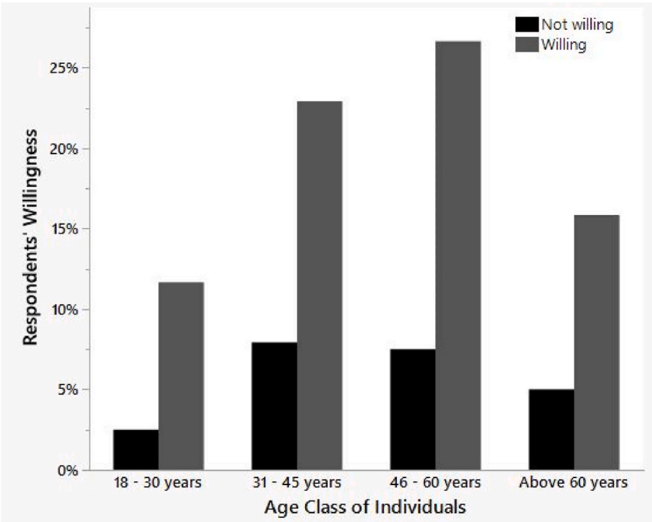

Fig. 3. Percentage respondents' willingness for adoption of SLM practices separated by age class (N = 240).

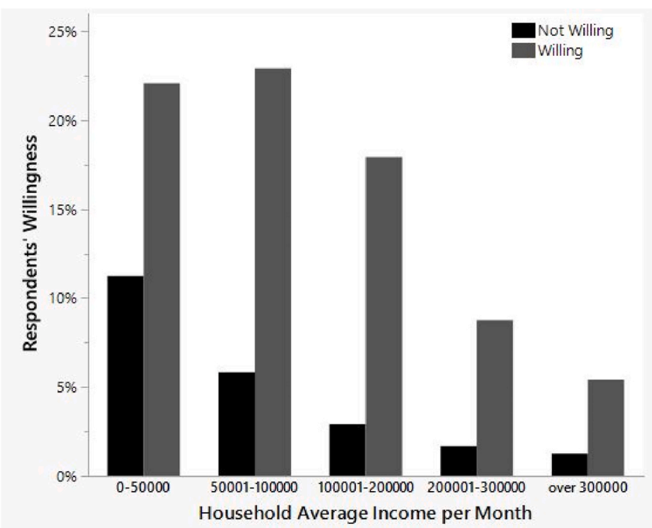

Fig. 4. Percentage respondents' willingness for adoption of SLM practices separated by income per month (TZS), (N = 240).

tices for both Amani and Kahe wards was:

$$Y = -0.277 + 0.034X_1 + 0.000004X_2 - 0.019X_5 + 0.795X_6 + 0.577X_8$$

Following descriptors remained in the model: farming experience (X_1), household income per month (X_2), IPS cover on the farm (X_5), and conservation awareness (X_6) as indicated in Table 3.

The model with descriptors (PAC = 73.8) outperformed the null model (PAC = 70.8), as indicated by statistical analysis (χ^2 (5 d.f) = 33.815, $p < 0.0005$). The assessment of goodness-of-fit, conducted through the inferential test (Hosmer and Lemeshow (H-L) statistic), demonstrated that the model fits the data well (χ^2 (8 d.f) 7.472, $p > 0.05$). Moreover, the descriptive measures of goodness-of-fit, such as Cox and Snell R^2 (0.131) and Nagelkerke R^2 (0.187), further supported the model's ability to fit the data well.

According to the findings of the Binary Logistic Model, the willingness to adopt SLM practices exhibited a significant and positive correlation with farming experience, household income and conservation awareness (Table 3). Conversely, the adoption of SLM showed a significant and negative association with the IPS cover.

4. Discussion

In this study, an investigation was conducted to analyze factors that impact smallholder farmers' willingness to adopt SLM practices for controlling IPS. The findings revealed that household farming experience, household income, on-farm invasive plant species cover and conservation awareness of household head significantly influence smallholder farmers' willingness to adopt jointly selected SLM practices for managing IPS.

The findings of this study indicated a positive correlation between household farming experience and willingness of smallholder farmers to adopt proposed SLM practices for managing invasive species. This implies that farmers with wide experience in agriculture are more willing to embrace SLM practices. These results align with a study conducted by Burton (2014), which confirmed that personal characteristics such as age, gender, experience and education influence individuals' decision-making processes and behaviors, providing understandings into how a specific group of farmers might respond to particular circumstances. It is commonly observed that farmers with prior experience in agri-environmental schemes exhibit a higher likelihood of engagement or increased participation in new schemes (Coyne et al., 2021; Taylor and Van Grieken, 2015). This greater experience can lead to a deeper understanding of spatial variability in the field and operational efficiency, as farmers learn through practical application (Tey and Brindal, 2012). Interestingly, these findings contrast with research conducted by Atari et al. (2009) who suggested that higher levels of experience in a specific type of farming might decrease the likelihood of changing production methods. However, experience is believed to enhance skill and knowledge in a particular practice, thereby improving its efficiency (Jongeneel et al., 2008). Farmers who have had positive prior experience with environmental schemes tend to develop favorable attitudes toward new environmental measures (Vanslembrouck et al., 2002). In an agricultural context, it is argued that experience increases reliance on intuitive decision-making rather than strictly planned approaches (Fountas et al., 2006). Given the significance of farming experience in influencing farmers' willingness to adopt and learn new technologies in agriculture, it is recommended to enhance awareness through demonstration farms, workshops and training programs focused on SLM practices and environmental conservation. By providing such resources, farmers can further benefit and effectively adapt to sustainable practices in agriculture.

The findings indicate a significant positive relationship between income of individual farmers and their willingness to adopt SLM practices. As farmers' monthly income increases, the probability of their willingness to adopt SLM practices also rises. This can be attributed to the fact that income provides farmers with financial means to engage in essential farm management activities that require monetary inputs such as land preparation, Prosopis stump removal, weeding and fertilizer application. These results align with a study conducted by Sardar et al. (2019) which highlighted that financial resources play a positive role in determining the adoption of climate-smart agriculture (CSA) practices. A farm household with a favorable financial condition resulting from higher income is more capable of allocating additional funds towards adopting CSA practices. It is often challenging to secure external capital for investments with higher risks. Therefore, farmers with greater capital resources possess financial capacity to embrace SLM practices (Tey and Brindal, 2012).

Unexpectedly, we discovered that presence of on-farm invasive plant species (IPS) cover on farmers' land has a significant negative impact on their willingness to adopt SLM practices. As the cover of invasive plant species increases, the likelihood of farmers being willing to adopt SLM practices decreases. One potential explanation for this finding is that management practices chosen by LIG (Local Implementation Group) members were primarily focused on manual control methods. When faced with a high IPS cover, especially for respondents with large farm sizes, effectiveness and implementation of SLM practices may be limited.

Table 3
Binary logistic regression model results examining factors that influence the willingness to adopt SLM practices in Amani and Kahe wards (n = 240 households).

		B	S.E.	Wald's χ^2	df	Sig.	Exp (β)	95% C.I. for EXP(β)	
								Lower	Upper
Step 1	*Farmexp*	0.037	0.011	11.623	1	0.001	1.037	1.016	1.059
	Income	0.000004	0.000002	6.607	1	0.010	1.000	1.000	1.000
	HHsize	0.003	0.053	0.003	1	0.958	1.003	0.905	1.111
	Creditacc	0.351	0.331	1.124	1	0.289	1.420	0.743	2.717
	IAScover	−0.019	0.006	10.489	1	0.001	0.981	0.969	0.992
	Conseawar	0.798	0.334	5.713	1	0.017	2.221	1.154	4.273
	Farm size	−0.028	0.042	0.453	1	0.501	0.972	0.895	1.056
	Gender	0.558	0.320	3.042	1	0.081	1.747	0.933	3.269
	Constant	−0.364	0.512	0.505	1	0.447	0.695		
Step 2	*Farmexp*	0.037	0.011	11.619	1	0.001	1.037	1.016	1.059
	Income	0.000004	0.000002	6.610	1	0.010	1.000	1.000	1.000
	Creditacc	0.353	0.328	1.161	1	0.281	1.424	0.749	2.707
	IAScover	−0.020	0.006	10.620	1	0.001	0.981	0.969	0.992
	Conseawar	0.799	0.333	5.764	1	0.016	2.224	1.158	4.271
	Farm size	−0.28	0.042	0.451	1	0.502	0.972	0.895	1.056
	Gender	0.558	0.320	3.048	1	0.081	1.747	0.934	3.269
	Constant	−0.352	0.458	0.590	1	0.442	0.704		
Step 3	*Farmexp*	0.035	0.011	11.275	1	0.001	1.036	1.015	1.057
	Income	0.000004	0.000002	6.299	1	0.012	1.000	1.000	1.000
	Creditacc	0.354	0.328	1.170	1	0.279	1.425	0.750	2.710
	IAScover	−0.020	0.006	11.262	1	0.001	0.980	0.969	0.992
	Conseawar	0.794	0.333	5.704	1	0.017	2.212	1.153	4.245
	Gender	0.568	0.319	3.172	1	0.075	1.765	0.945	3.298
	Constant	−0.391	0.455	0.739	1	0.390	0.676		
Step 4	*Farmexp*	0.034	0.010	10.691	1	0.001**	1.035	1.014	1.056
	Income	0.000004	0.000002	6.243	1	0.012*	1.000	1.000	1.000
	IAScover	−0.019	0.006	10.403	1	0.001**	0.981	0.970	0.993
	Conseawar	0.795	0.333	5.714	1	0.017*	2.215	1.154	4.252
	Gender	0.577	0.318	3.287	1	0.070	1.781	0.954	3.324
	Constant	−0.277	0.443	0.392	1	0.531	0.758		

Tests Model evaluation (overall):	χ^2	df	P. value
Likelihood ratio test	33.815	5	<.0005
The goodness of fit test			
H-L statistic	7.472	8	0.487

* Statistically significant at α = 0.05; ** Statistically significant at α = 0.01.
*** Statistically significant at α = 0.001.
Notes: PAC: Null model = 70.8; Model with descriptors = 73.8; Cox & Snell R^2: 0.131; Negelkerke R^2: 0.187; Sample size used in the analysis (n) = 240.

This is supported by a study conducted by Abdulahi et al. (2017) which revealed that manual control practices alone often struggle to completely eradicate large-scale infestations. While alternative methods such as mechanical control with bulldozers, chemical control, or biological control exist for IPS management, the primary challenge for farmers lies in the initial costs associated with removing the IPS cover. However, if farmers are provided with incentives, adoption of SLM practices may improve, as long-term maintenance costs of SLM practices against IPS are generally lower than the expenses incurred during the initial clearing phase.

Finally, our study provides convincing evidence that conservation awareness of individual farmers positively influences their willingness to adopt SLM practices. This aligns with findings from other studies that indicate conservation awareness plays a significant role in shaping environment behavior by influencing attitudes toward change (Ardoin et al., 2020) and enhancing understanding of complex environment issues, thereby providing a clear rationale for promoting environmentally-friendly behavior (Nilsson et al., 2020). As a result, it is widely accepted that farmers with higher levels of conservation awareness are more likely to engage in environmental programs and adopt sustainable approaches to agriculture (Burton, 2014).

Conservation awareness is believed to enhance effectiveness of farm management by improving technical skills and familiarity required to operate new technological innovations (Du et al., 2019; Liu et al., 2018). Researchers have observed that farmers with conservation awareness exhibit different behaviors compared to those with a general education when it comes to adopting both conventional agricultural technologies and environmentally-friendly management techniques (Murphy et al., 2011). Consequently, it is crucial to enhance conservation awareness among farmers to increase their willingness to adopt SLM practices.

5. Conclusion and recommendations

Willingness to adopt SLM practices to manage invasive plant species is affected by several factors including household head farming experience, household income, on-farm invasive plant species cover and conservation awareness of household head. Given these findings, the study proposes implementation of government interventions aimed at promoting SLM practices on a larger scale. This can be achieved through conservation training programs to increase awareness of invasive plant species (IPS) and establishment of demonstration farms. These initiatives will help increase knowledge and skill of individuals in applying effective and efficient SLM practices.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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APPENDICES.

Appendix 1. Correlation matrix of candidate variables for the regression model

	Farmexp	Income	HHsize	Creditacc	IAScover	Conseawar	Farmsize	Gender
Farmexp	1	−0.033	−0.040	−0.094	0.095	0.004	0.209	−0.034
Income		1	0.068	−0.006	−0.176	0.106	0.132	−0.224
HHsize			1	0.158	−0.072	0.028	0.123	0.020
Creditacc				1	0.101	0.007	−0.023	0.041
IAScover					1	0.207	0.137	0.021
Conseawar						1	0.073	−0.045
Farmsize							1	−0.080
Gender								1

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