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Article

Farmers' Willingness to Accept Afforestation in Farming Land and Its Influencing Factors in Fragile Landscapes Based on the Contingent Valuation Method

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Abstract: Afforestation (AF) in farmland has been widely used as an alternative and sustainable land-use practice to address socioeconomic and environmental challenges. The aim of this study is to estimate farmers' willingness to accept (WTA) compensation and land, both of which are equally significant for policymakers to ensure the effective implementation of AF and achieve desired outcomes. This topic has not been sufficiently explored in previous research. This study focused on areas characterized by insecure farming conditions, backward economies, and fragile landscapes, where farmers are generally unfamiliar with AF or compensation for ecosystem services under payment for ecosystem services programs. It assessed their attitudes towards the WTA AF, compensation, and land as an alternative practice, which remains under-researched. This is crucial for designing effective AF programs in the future to improve livelihood and enhance the quantity and quality of the environment. This study used the contingent valuation method to estimate the minimum WTA compensation and maximum land for the forgone loss and alternative land-use practices. A questionnaire survey was conducted in Hupsekot municipality, Nepal, with 232 farmer households. The ordinal logistic regression model was used to analyze influencing factors of WTA compensation and land. The result showed that farmers' average WTA compensation was NPR 1268.67 (USD 9.76)/Kattha/year, with 2.64 Kattha land available for AF. The factors, including socioeconomic characters and attitudes toward the environmental situation and forests, significantly influenced WTA values and provided potential target factors to achieve maximum AF land within a lower budget.

Keywords: afforestation; fragile landscape; sustainable land-use; contingent valuation method; willingness to accept; ordinal logistic regression model

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1. Introduction

The need to reverse environmental degradation and deforestation and promote forest landscapes is receiving increasing national and international attention for sustainable development [1]. While alternative land-use practices such as afforestation (AF) in agricultural land or private forest or forest farming may not offer the complete range of ecosystem services (ESSs) provided by natural forests, they can still serve as sustainable land-use practices that improve productivity, livelihood, and biodiversity [2,3]. It is one of the anthropogenic factors affecting vegetation dynamics by increasing forest cover, controlling deforestation, mitigating climate change and disaster risk, reducing carbon dioxide emissions, affecting water regulation and supply, and increasing livelihood resilience in fragile ecosystems (ESs) [4–6]. Different countries have intended to achieve specific purposes of AF policy implementation, such as enhancing ESS provision [7], environmental greening [8,9], mitigating net carbon dioxide emissions [10], and soil and water conservation [11]. This policy also considered micro- and macro-level economic benefits by saving a huge proportion of property taxes or income sources of landowners and estimating the net benefit of planted forests in the AF program [12].

However, alongside the multiple benefits of AF, there are challenges in implementing the AF program and its continuity which are associated with the estimation of compensation and land availability for forest farming. Since AF is a long-term investment, small farmers who depend on ESSs for their livelihood feel insecure or hesitate to lose forgone services and bear the forest management cost [13,14]. This may be further aggravated by the different goals of land ownership that do not consist of such land-use practices [15]. AF implementation, under the payment for ecosystem services (PES) program, has been considered "the most promising innovation in conservation since Rio 1992", and is largely applied to forests and other ESs [16]. It is a market-based environmental policy, designed and carried out to balance the costs of ES protection in which the landowners are compensated for their forgone loss, maintaining and increasing the ES that provides services to the beneficiaries [17–19]. However, several studies show that estimating the payment or incentive without a proper understanding of ES value, the PES for AF, or other land-use changes has often failed to address landowners' needs, which can reflect landowners' willingness to participate in producing ESs at socially preferred levels [20,21]. For sufficient monetary incentive, it is important to assess landowners' willingness to accept a compensation value and the socioeconomic and environmental factors that impact the willingness to accept (WTA) value. Further, AF implementation also needs to estimate possible forest land cover size, which depends on the availability of previously unforested land for planting [22,23]. This is a limited resource with competing uses. Since landowners have the right to determine whether and how much to change their land practices [24], their WTA level for alternative land-use practices can vary based on their needs and goals even if they are willing to participate in AF. However, none of the studies have linked farmers' land-use acceptance with their WTA AF. Thus, this study comprised landowners' WTA compensation and land-use change, which are equally significant for policymakers to ensure the effectiveness of AF implementation with possible available land to achieve socially preferred levels of ESs.

The contingent valuation method (CVM) is mostly adapted to estimate the socially preferred level of ESs or ESSs and their economic value [25,26]. It is enormously flexible and can be used to estimate the economic value of virtually anything, such as total economic value, use or non-use value, existence value, option value, and bequest value, by conducting various questionnaires [27,28]. In this study, the CVM analyzed individuals' answers to hypothetical questions about their preferences, such as maximum willingness to pay (WTP) for marginal improvement in environmental quality or access to specific ESSs [25,29] and the minimum WTA amount offered to sell a good or service or for losing or compromising the alternative opportunities or bearing a negative externality [26,30]. Thus, this method estimated the WTA level for AF implementation. Previous studies that applied the CVM to estimate the WTP or WTA for ESs extended values and participation based on socioeconomic and multidimensional environmental factors. Some studies found farmers' socioeconomic factors, such as income, age, gender, family members, education, occupation, family involvement in farming, and land holding, as significant factors in estimating WTA and WTP values [20,21,31–33]. However, some studies found environmental factors, such as environmental risk or disaster, the importance of ESs and satisfaction, and the importance of forests, as significant factors for WTA and WTP [21,33,34]. Nonetheless, studies have not examined how these factors impact and relate to determining farmers' WTA for land size or value while accepting compensation. Further, studies focused on areas inhabited by insecure farming, backward economies, and fragile landscapes, where farmers are not familiar with AF programs as alternative land-use practices or compensation mechanisms for ESs, and assessing their impact on WTA to implement AF programs, remain limited.

The Chure land (the youngest mountain) in Nepal, which covers about 12.78% of the total country land, is geologically and ecologically fragile [35]. It is rich in biodiversity and provides ESSs to millions of people in the Nepal Terai and India. Forest resources in Chure land are considered instrumental for socioeconomic development, reducing environmental degradation, biodiversity conservation, and the adaptation of human ESs in a changing environment [35]. However, it is facing extreme human pressure, such as infrastructure development and human settlement, overgrazing, forest land fragmentation, the extraction of firewood and timber, continued encroachment for the mining of sand or boulders, and increasing cultivation activities in slope areas [36]. The insecurity scenario in land ownership in the entire Chure landscape has also been observed, such as insufficient crop production and inability to survive on available land, due to the highly fragile soil for cereal crop production, and moisture deficiency [37]. To conserve this landscape and mitigate deforestation, the Nepal government introduced different programs involving local participation, such as community-based forest or leasehold forestry programs in some areas. However, these policies have failed to achieve environmental equitability, improve farming ESs, decrease unwanted agricultural land-use in slope areas, and address the various needs and interests of the farmers whose livelihoods depend on forest resources [36,37]. Information on potential AF implementation and a cohesive framework to assess the need for compensation and available land to improve this fragile farming landscape remains unanswered. This information is urgently needed to understand the possibility of sustainable land-use practices and to guide efforts in estimating the applicable budget and extending forest-covered land.

This study aims to analyze farmers' socioeconomic factors and attitudes toward the current ESs of Chure land, apply the CVM to assess their WTA compensation and land based on their participation in AF implementation, and comparatively analyze the impact of socioeconomic and environmental factors to estimate the standard value of both WTA compensation and land.

2. Materials and Methods

2.1. Study Area

This study conducted its survey in Hupsekot rural municipality in Chure region, within Nawalpur District of Gandaki province, Nepal (Figure 1). This area is located between 27°35′ to 27°45′ EW and 84° to 84°15′ NS, elevated between 179 and 761 m above mean sea level, and covers about 24.2 kilometers from upstream to downstream of the Narayani mainstream river. June to August is the monsoon period and annual precipitation ranges from 1959 to 2276 mm. The temperature ranges from 47 °C (maximum) to 5 °C (minimum). The area spans 189.21 km^2, with a total population of 26,583 according to the 2021 Nepal census. The population in the upstream area is very low as compared to the downstream area, which is 140.5/km^2. The Chure landscape is made up of geologically young sedimentary rocks, such as mudstones, shale, sandstones, and conglomerates. The hills are extremely fragile and sensitive to losses of vegetation cover [38]. The Nawalpur district has long been affected by landslides, flash floods, vegetation loss [22], encroachment [36,39], and increasing cultivation activities on the slopes [40]. It is an extremely complex landscape, heavily sculptured by fluvial erosion, with a catastrophic production of sediment and the development of badland topography. The narrow valley faces sudden flash floods, which create high-speed run-off downstream, heavy soil erosion and river cutting in river mouth areas (Kerung River), and excessive stream downcutting. Due to deforestation and environmental degradation, this area has been facing hydrological challenges, such as lower water levels, rivers drying up during the dry season, and increasing durations of the dry season.

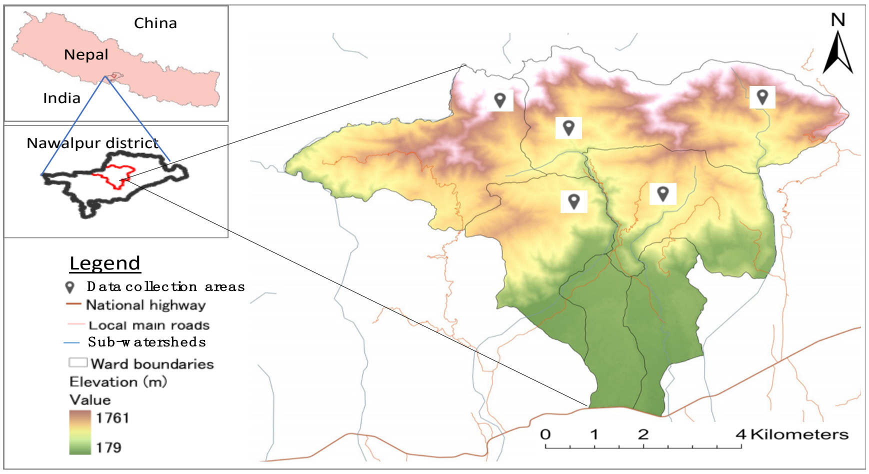

Figure 1. Data collection sites within the upstream area of Hupsekot rural municipality.

The Hupsekot upstream area is one of the remotest areas of the district and most of the population are from the ethnic Magar community. These people lag economically, socially, and politically. Their livelihoods depend on agriculture, livestock rearing, wage labor, and forest resources. More than 70% of the households are only able to produce food for six months because of unproductive land, irrigational inaccessibility, and increasing drought durations [37]. The livelihoods of the economically backward people depend on forest ESSs, including cutting the forest for multiple purposes, grazing, and shifting cultivation. To improve the ESs in this area and the Chure landscape, the Nepal government declared this area a "Chure Environment Protection Area" under the "Rastrapati Chure-TeraiMadhes Conservation and Development Board", and handed over the forest to community-based management (CBM). However, it has not been very successful in achieving deforestation goals, forest product flow, and equitability or in addressing the needs of the people whose livelihoods depend on forest resources [36,37]. Further, this area also represents the situation that inhabitants had never received any proposal or heard about afforestation in agricultural land and PES for other forest management.

To improve vegetation in crown cover, generate income, and control shifting and unwanted cultivation in rangeland slope areas, a leasehold forestry program for degraded forest was introduced involving pro-poor farmers. However, the handover of the forest to the community was ineffective. Hence, suggestions were made for compensation mechanisms, the clear role of local people, proper benefit sharing [37,41], and the new formation of agricultural land-use practices [42]. With the Hupsekot upstream as our study area, we explored local farmers' socioeconomic situation and awareness of the environmental situation, needs of the forest, and satisfaction, and analyzed their WTA regarding AF implementation and its impact factors.

2.2. Questionnaire Design and Field Survey

This study conducted a face-to-face questionnaire survey in December 2023 in two phases, carried out by local research teams consisting of two graduate students. Ethical considerations and approval were obtained, along with permission from local authorities and informed consent from each respondent. In the first phase, after defining the area for data collection, we held discussions with local government members (Hupsekot Rural Municipality Office, Forest and Disaster Management Department), schoolteachers, local leaders, and farmers and collected pre-information regarding the local socioeconomic agricultural and environmental situation.

Data collection areas were selected mainly based on landscape, areas that had not implemented AF programs as alternative land-uses or any compensation mechanisms for existing forests, and other socioeconomic development and environmental circumstances. On that basis, we selected the remotest upstream areas around the sub-watersheds (Kerung, Pathar, and Giruwa Rivers), which are known for heavy flash floods and river cutting. Finally, data were collected from five areas from ward numbers 5, 6, 4, and 2 (border of ward numbers 5 and 6), and 50 respondents (households) were randomly selected from each area in a total sample size of 250 as a representative group of the Chure region.

The questionnaire was based on the CVM [20,21] and analyzed individuals' answers to hypothetical items about their preferences. The CVM entails the use of questionnaires as the primary tool, which can offer minimum WTA compensation for losing or compromising the alternative opportunities of ESSs [25,29]. The same method can determine the maximum value, such as WTP for the provision of non-market goods or services [30]. Hence, this study developed the questionnaire to estimate landowners' maximum WTA land-use changes to implement an AF program.

The pre-questionnaire survey was conducted including farmer households, local stakeholders, teachers, and leaders to improve and develop the final questionnaire. We asked WTA questionnaires including forgone economic loss of cultivated land from main crop production so that we could develop and evaluate the WTA bid value options, especially for compensation based on the economic loss of cultivated land from main crop production in a year if they are willing to accept AF as alternative land-use practice, measured in Kattha (1 Kattha is equal to 0.0126 hectares and is a basic measurement of agricultural land in Nepal). The questionnaire was as follows: "Assume that the government will implement a program to promote AF in upstream farming land. For this, the government will make payments for 5 years. Would you participate in this program? If yes, how much will be the minimum acceptable annual compensation and the maximum acceptable land area that you are willing to change for afforestation?"; "How much is the approximate amount of crop production (per Kattha per year) land that you are going to change into forest?"

The final questionnaire was developed and improved based on the pre-questionnaire survey. We collaborated with local social workers and schoolteachers during the survey and engaged in ongoing discussions to gain the trust of the locals, obtain in-depth information about the areas, and reduce bias in the contingent valuation method (CVM). The questionnaire language was Nepali, and the design was semi-structured. Amongst the total respondents, 232 questionnaires were valid.

The questionnaire was split into four parts. In the first part, we explained the survey objective. In the second part, we explained the local environmental and farming situation, and the need for AF for maximum forest cover by showing local maps and pictures (see Appendix A Figures A1 and A2). We discussed forest services, the compensation mechanism for accepting AF as an alternative land-use practice of crop production, and the necessity for them to accept to implement AF on their maximum land. We also highlighted the forgone loss and emphasized the long-term benefits of forest cover. Providing proper information to respondents is important because limited information and inexperience with compensation or AF under the payment system can influence WTA values and trust in surveys [43,44].

The main contents of the questionnaires related to the impact factors and WTA AF, comprising the third and fourth parts, are presented in Table 1. In the third part, we measured farmers' current socioeconomic (Q1–Q10) and environmental factors (Q11–Q16) to explore the socioeconomic and farming situation and attitudes and awareness of the ESs related to the Chure landscape and assessed its impact on the households' WTA afforestation.

In the fourth part, the main evaluation of WTA AF, compensation and land for AF (Q17), and the multiple reasons for no WTA AF were collected. We clarified that the compensation and the survey were not associated with any governmental or organizational policy so that the farmers would willingly participate in the program and provided accurate information about compensation and land valuation [21]. The core CVM question to estimate WTA value was "Assume that the government will implement a program to promote AF in upstream farming land. For this, the government will make payments for 5 years. Would you participate in this program? If yes, how much will be the minimum acceptable annual compensation and the maximum acceptable land area that you are willing to change for afforestation?" Participants who answered "No" to the first part of the question were asked to choose the reason from the provided multiple choices.

Table 1. Contents of the final questionnaire survey.

Category of Questionnaires (Q)	Contents
Basic socioeconomic situation (Q1–Q3) Household situation (Q4–Q10)	Gender, Age (group), and Education Level
	Main income source, number of family members, manpower for farming (family members engaged in farming), household's average monthly income, land holding, crop production sufficiency, and irrigational water accessibility
Attitude and awareness of the local environment (Q11–Q16)	Risk level (of farming land), engagement in local resource management, environmental degradation level, importance of forest to environmental degradation, needs of forest resources, and satisfaction level of forest resource accessibility
Willingness to accept afforestation in farmland (Q17)	If yes (willing to accept afforestation) a. The bid values of minimum acceptable compensation (NPR) b. The bid values of maximum acceptable farmland size (Kattha) to implement afforestation
	If no (not willing to accept afforestation) Reasons (multiple choices): i. lack of information; ii. payment options are too low; iii. distrust system (I do not trust that payment will be made smoothly, even if it will be implemented); and iv. no need to change (current land-use practices)

The WTA compensation bid amount options in Nepalese Rupees (NPR; NPR 1 = USD 0.0077 at the time of the survey) were 500, 1000, 2000, 3000, 4000, and 5000. The WTA land options in Kattha, in interval values, were >0–5, >5–10, >10–15, >15–20, >20–25, and >25. The bid value options were based on a pre-questionnaire survey and then finalized after expert consultation. For the range of the land size, we also considered agricultural land holding patterns in Nepal [45] and then consulted with local land management department officers.

2.3. Data Analysis Method

We calculated respondents' WTA level for compensation and land based on the CVM, which is a standard method to estimate the value of both the use and non-use of public and environmental goods and services [26]. The expected average WTA values for AF implementation of Hupsekot upstream farmers were expressed using the following formula, the traditional partition group processing method [20,21]:

$$E(WTA) = \sum_{i=1}^{n} Ai \cdot Pi \tag{1}$$

where Ai denotes the degree of farmers' WTA (n options), Pi denotes the probability of WTA, and n denotes the sample size of farmers.

The decision-making process of the respondents for WTA entailed two stages. After deciding whether farmers were willing to accept AF implementation, they decided on the compensation value and land area for change, which is impacted by each household's socioeconomic and environmental factors. We designed 16 impact factors and employed them as independent variables (Table 1). To clarify its impact on farmers' WTA in the study area, we used the ordinal logistic regression model (OLRM) and analyzed individual respondents' socioeconomic and environmental characteristics. OLRM was particularly used to reflect the different characters of the same variable (of independent variables) and the WTA levels and distinguish between the WTA and its amount or value [33]. This model can further analyze the linear relationship of impact factors to WTA [46]. The OLRM estimated the value of WTA based on how much the dependent variable will change with one unit change in independent variables by calculating the odds ratio. In this model, continuous dependent variables can be narrowed down by setting them into an ordinal scale which reduces subjectivity, provides more clarity in data, and provides a stronger conclusion about demographic attributes [47]. Since this study aims to identify farmers' important characteristics with minimum and maximum compensation value and land to implement AF, the ordered model was appropriate. Hence, this model forecasts the impact of changes in Chure land's socioeconomic and environmental factors to estimate the WTA compensation and land values.

We used SPSS software version 22 for OLRM. Our assumptions for this analytical model were tested and validated. To analyze the linear relationship of assumptions, ordinal variables were treated as covariates and p-values less than 0.1 were considered statistically significant.

2.4. Variables Used in the Statistical Analysis

We edited and coded respondents' socioeconomic and environmental parameters and assigned values according to the following categories for statistical analysis in Table 2. In our study, independent variables, such as age, income sources, number of family members, manpower for farming, monthly income, and land holding were assigned as continuous variables. We calculated the mean value of each age group and then conducted it as a continuous variable. Other independent variables such as education, irrigational water accessibility, risk level, environmental degradation level, importance of forest for environmental degradation, and level of satisfaction were assigned ordinal values. For the needs of forests, we assigned ordinal values based on the number of consumptions of forest resources. Furthermore, we assigned nominal values for the following respondents: gender (male = 1, female = 0), income sources (farming = 1, off-farming = 0), crop production sufficiency (sufficient = 1, not sufficient = 0), and engagement in local resource management (engaged = 1, not engaged = 0). We measured ordinal and nominal variables according to their natural rank or characteristics to analyze the linear logistic relationship with the willingness to accept (WTA) value [21,33,46]. To conduct OLRM for dependent variables, we assigned "no WTA = 0". WTA bid value levels were divided into three ordinal categories. For WTA compensation, we categorized 1 = 500–1000, 2 = 200–3000, and 3 = 4000–5000. Likewise, for WTA land, we categorized 1 $\geq$ 0–5, 2 $\geq$ 5–15, 3 $\geq$ 15. The ordinal size and the range of the categories were divided based on the study objective and distribution values obtained from the output by considering the model accuracy [48].

Table 2. The descriptive statistics of variables (N = 232).

Variables (Symbol)	Measure	Description	Min.	Max.	Mean	Std. D.
Gender	Nominal	0 = Female, 1 = Male	0	1	0.6	0.4
Age	Continuous	Years	21.5	70.5	40.6	11.8
Education level [1] (ED)	Ordinal	1 = Uneducated (no former education), 2 = Primary, 3 = Secondary, 4 = Senior high school [1]	1	4	1.9	0.9
Main income source (IS)	Nominal	0 = Off-farming, 1 = Farming	0	1	0.3	0.4
Number of family members (FM)	Continuous	Persons	2	15	6.21	2.5
Manpower for farming (MF)	Continuous	Persons	0	9	3.2	1.5
Households' average monthly income (MI)	Continuous	Nepalese Rupees (NPR)	10,000	150,000	19,267.2	15,622.0
Land holding (in Kattha) (LH)	Continuous	Kattha (1 Kattha = 0.0126 hectare)	1.5	60.0	12.0	9.2

Table 2. *Cont.*

Variables (Symbol)	Measure	Description	Min.	Max.	Mean	Std. D.
Crop production sufficiency (CPS)	Nominal	0 = Not sufficient, 1 = Sufficient	0	1	0.2	0.4
Irrigational water accessibility (IWA)	Ordinal	1 = Very poor, 2 = Relatively poor, 3 = Fair, 4 = Good	1	4	2.4	1.1
Risk level (RL)	Ordinal	1 = Very low, 2 = Relatively low, 3 = Medium, 4 = Relatively high, 5 = Very high	1	5	2.9	1.3
Engagement in local resource management (ELRM)	Nominal	0 = Not engaged, 1 = Engaged	0	1	0.3	0.4
Environmental degradation level (EDL)	Ordinal	1 = Very low, 2 = Relatively low, 3 = Medium, 4 = Relatively high, 5 = Very high	1	5	3.7	1.1
Importance of forest for environmental degradation (IFED)	Ordinal	1 = Very unimportant, 2 = Relatively unimportant, 3 = Neutral, 4 = Relatively important, 5 = Very important	1	5	3.8	1.2
Needs of forest resources (NS)	Ordinal	1 = Only daily household, 2 = Daily household and income source, 3 = Daily household, income source, and cultural, 4 = Daily household, income source, cultural, and beauty	1	4	2.5	0.7
Satisfaction level of forest resource accessibility (SL)	Ordinal	1 = Very unsatisfied, 2 = Relatively unsatisfied, 3 = Relatively satisfied, 4 = Very satisfied	1	4	2.5	0.8

Note: [1] Senior high school: we did not find any respondents' educational background beyond senior high school.

3. Results

3.1. Farmers' Socioeconomic and Environmental Characteristics

The collected data on respondents' socioeconomic and environmental characteristics are summarized and can be found in Appendix B. We found 65.9% male and 34.1% female. Amongst them, the majority were younger than 45 years old (68.1%). More than half the farmers had either never gone to school (35.3%) or only had primary-level education (37.9%). The highest level of education was senior high school. The majority of livelihoods depended on off-farming income sources (63.4%), and 83.2% managed their monthly life with less than NPR 20,000, indicating very low income. The average population of households was six, where an average of three members were directly involved in farming. Nearly half of the farmers held small lands (less than 10 Kattha) and less than 25% of the farmers could survive from their annual crop production. Only 38.8% of the farmers had better access to irrigation, with the rest depending on monsoon rain or different sources. A total of 65.6% of farmland faces a medium risk of soil erosion. These outcomes prove that the existing social, economic, and farming situation is insufficient to support better livelihood for Hupsekot upstream farmers.

For environmental management, the majority of the people were not engaging in any organization or programs directly or indirectly. A total of 64.2% of the farmers perceived the level of local environmental degradation as serious because they realized that pollution downstream, water scarcity or long droughts, river cutting, and soil erosion had increased. The majority of farmers believed that the forest was important to mitigate environmental degradation. The result of the comparative statistic (Figure 2) shows that, although they had different realization levels of environmental degradation, most of them acknowledged the importance of forests in managing it. A large number of farmers (84.9%) required forest for the combination of daily household needs and direct income sources. However, the majority (54.3%) were unsatisfied with its current accessibility. The comparative result shows that except for those who need forest resources for multiple purposes, the farmers were highly unsatisfied (Figure 3), indicating the high demand for forest for daily livelihood and the low supply.

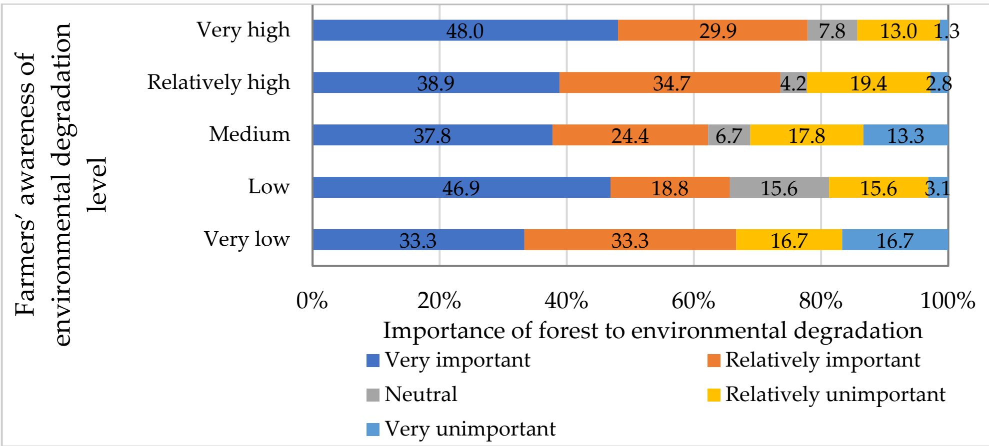

Figure 2. Respondents' awareness of environmental degradation level and the importance of forests in managing degradation (%, N = 232).

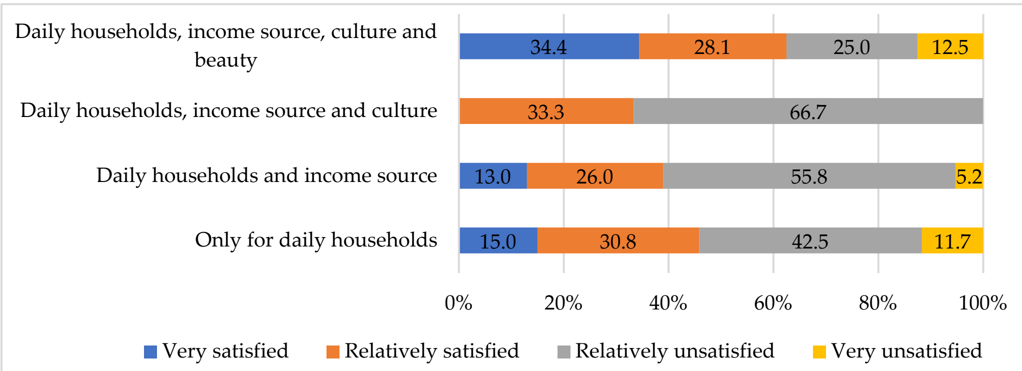

Figure 3. The forest needs and satisfaction level for respondents (%, N = 232).

3.2. Distribution of WTA Value

We obtained absolute and relative frequency distribution of households' WTA and reason for non-acceptability. We set the median value of each interval for the value of a household's WTA land, referring to the statistical standards and to previous related studies [20,21]. Farmers' minimum WTA compensation amount and maximum WTA land value were calculated based on respondents' responses (Tables 3 and 4). The result shows that most households (70.3%) had WTA AF implementation at a compensation of less than NPR 2000. Amongst them, 12% of farmers accepted the minimum compensation of NPR 500/Kattha/year and expressed concern for environmental degradation. Most of the respondents showed WTA NPR 1000 and 2000, showing their concern for minimum forest management cost and forgone loss. The majority of farmers (56.9%) were not willing to change more than 5 Kattha and, accordingly, 10 Kattha of their land into forest.

Table 3. Distribution of households' WTA compensation value to implement AF.

	Compensation (NPR [1]/Year/Kattha)	Number of Respondents	Proportion (%)
WTA = 1	500	28	12.1
	1000	53	22.8
	2000	50	21.6
	3000	14	6.0
	4000	5	2.2
	5000	13	5.6
WTA = 0	0	69	29.7
Total		232	100
Acceptable		163	70.3
Unacceptable		69	29.7

[1] NPR 1 = USD 0.0077 (during the survey).

Table 4. Distribution of households' WTA land value to implement AF.

	Land (in Kattha [1]/Household)	Number of Respondents	Proportion (%)
WTA = 1	>0–5	132	56.9
	>5–10	26	11.2
	>10–15	2	0.9
	>15–20	2	0.9
	>20–25	0	0
	>25	1	0.4
WTA = 0	0	69	29.7
Total		232	100
Acceptable		163	70.3
Unacceptable		69	29.7

[1] 1 Kattha = 0.0126 hectare.

Using the distribution data on WTA obtained during the survey, we calculated the average expected compensation at NPR 1268.67 (USD 9.76)/year/Kattha and 2.7 Kattha of land to implement AF upstream of the Hupsekot rural municipality by using the following equation:

$$WTA(Compensation) = \sum_{i=0}^{n} Ai \cdot Pi \quad = 500 \times \frac{28}{232} + 1000 \times \frac{53}{232} + 2000 \times \frac{50}{232} + 3000 \times \frac{14}{232} + 4000 \times \frac{5}{232} + 5000 \times \frac{13}{232} = \text{NPR } 1268.67/\text{Kattha}/\text{per year}.$$

$$WTAWTA(Land) = \sum_{i=0}^{nn} Ai \cdot Pi = 2.5 \times \frac{132}{232} + 7.5 \times \frac{26}{232} + 12.5 \times \frac{2}{232} + 17.5 \times \frac{2}{232} + 22.5 \times \frac{0}{232} + 27.5 \times \frac{1}{232} = 2.64 \text{ Kattha}/\text{per household}.$$

where *Ai* denotes the standards of the bid option of *WTA* and *Pi* denotes the probability of *WTA*.

Considering land holding and WTA land for AF, we analyzed the number of respondents who showed WTA (Figure 4). A total of 43% of the farmers showed WTA 25%–50% of their total land holding to change for AF, followed by 36% of the farmers agreeing to 10%–25%. Only 21% of the farmers were willing to accept more than 75% of their total land.

Further, sixty-nine farmers replied for unwillingness to accept the AF proposal. Since multiple reasons or options were provided in the responses, the sum of the total percentage exceeded 100 (Figure 5). The results show that the reason behind not enrolling in AF was not so much related to payment options (2.89%). The main reasons were that respondents think that there is no need to change current land-use practices or no need for extra forest cover (46.37%) and the belief that the PES program is not easy to implement (33.33%). Furthermore, some farmers distrusted the government's payment system (23.18%) and the lack of information regarding PES (21.73%).

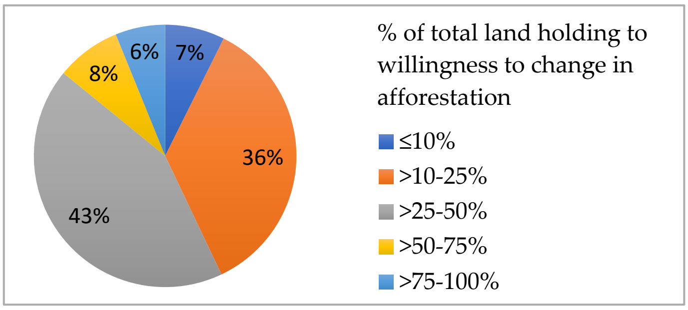

Figure 4. Respondents' WTA land for AF (based on respondents who showed WTA AF; N = 163).

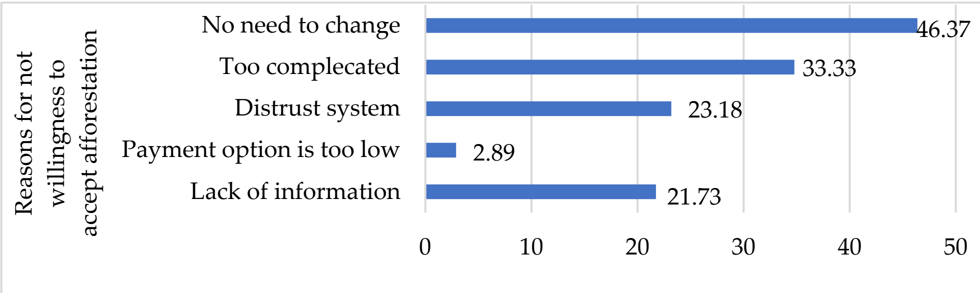

Figure 5. Respondents' reasons for unwillingness to accept AF (N = 69).

3.3. Regression Analysis Results for WTA Impact Factors

We used SPSS (version 27) for OLRM and found the models to be significant ($p \leq 0.001$) for both WTA results (Tables 5 and 6). This shows a significant improvement in fit as compared to the null model, making it a good fit. The Pearson correlation and deviance were not statistically significant, which demonstrated a goodness-of-fit. The results of the descriptive measures, such as Cox and Snell R^2, Nagelkerke R^2, and McFadden R^2, supported the models' ability to fit the data well.

Table 5. Model applicability for WTA compensation.

Test Model Evaluation	−2 Log Likelihood	Chi-Square	df	*p* Value
Model fitting information	(Final) 452.855	141.833	16	0.000
Goodness-of-fit:				
Pearson		612.206	677	0.964
Deviance		452.855	677	1.000
Cox and Snell R^2 = 0.457; Nagelkerke R^2 = 0.496; McFadden R^2 = 0.238.				

Table 6. Model applicability for WTA land.

Test Model Evaluation	−2 Log Likelihood	Chi-Square	df	*p* Value
Model fitting information	(Final) 278.080	182.645	16	0.000
Goodness-of-fit:				
Pearson		677.846	677	0.592
Deviance		278.080	677	1.000
Cox and Snell R^2 = 0.545; Nagelkerke R^2 = 0.632; McFadden R^2 = 0.396.				

The results of OLRM for both WTA compensation (Table 7) and land (Table 8) for AF were related to AF implementation; hence, we described it together to understand the trend and relationship of the impact factors with both WTAs. The ORLM shows that education level (ED) is significantly related to WTA compensation value and land holding (LH) is significantly related to WTA land. Further, crop production sufficiency

(CPS), risk level (RL), engagement in local resource management (ELRM), environmental degradation level (EDL), the importance of forest for environmental degradation (IFED), and the satisfaction level of forest resource accessibility (SL) are significant impact factors for both WTA compensation and land, while gender, age, income source (IS), number of family members (FM), manpower for farming (MF), monthly income (MI), irrigational water accessibility (IWA), and needs of forest resources (NF) do not show statistical significance for both WTA compensation and land.

Table 7. Parameter estimation for WTA compensation value.

Variables	Estimate	Std. Error	Wald	Sig. (*p*)	Exp (β)
[Gender = female]	−0.024	0.290	0.007	0.935	0.977
[Gender = male]	0 [a]	-	-	-	-
Age	0.002	0.014	0.020	0.887	1.002
ED	−0.370 **	0.178	4.339	0.037	0.691 **
[IS = off-farming]	0.143	0.312	0.211	0.646	1.154
[IS = farming]	0 [a]	-	-	-	-
FM	0.056	0.061	0.830	0.362	1.058
MF	−0.026	0.105	0.061	0805	0.974
MI	1.346×10^{-6}	9.263×10^{-6}	0.021	0.885	1.000
LH	0.001	0.015	0.002	0.962	1.001
[CPS = not sufficient]	−2.745 ***	0.381	51.951	0.000	0.064 ***
[CPS = sufficient]	0 [a]	-	-	-	-
IWA	−0.154	0.132	1.365	0.234	0.857
RL	0.451 ***	0.123	13.510	0.000	1.570 ***
[ELRM = not engaged]	−0.826 ***	0.303	7.406	0.007	0.438 ***
[ELRM = engaged]	0 [a]	-	-	-	-
EDL	0.293 **	0.142	4.243	0.039	1.340 **
IFED	0.368 ***	0.129	8.151	0.004	1.444 ***
NF	0.038	0.204	0.035	0.853	1.039
SL	−0.293 *	0.171	2.930	0.087	0.746 *

Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; 0 [a] = reference or baseline category.

Table 8. Parameter estimation for WTA land.

Variables	Estimate	Std. Error	Wald	Sig. (*p*)	Exp (β)
[Gender = female]	−0.475	0.362	1.723	0.189	0.622
[Gender = male]	0 [a]	-	-	-	-
Age	0.009	0.017	0.325	0.568	1.009
ED	−0.162	0.215	0.571	0.450	0.850
[IS = off-farming]	−0.036	0.380	0.009	0.925	0.965
[IS = farming]	0 [a]	-	-	-	-
FM	0.108	0.076	2.024	0.155	1.114
MF	−0.032	0.124	0.065	0.799	0.969
MI	3.190×10^{-6}	1.093×10^{-5}	0.085	0.770	1.000
LH	0.077 ***	0.018	18.830	0.000	1.080 ***
[CPS = not sufficient]	−1.456 ***	0.415	12.290	0.000	0.233 ***
[CPS = sufficient]	0 [a]	-	-	-	-
IWA	0.065	0.158	0.170	0.680	1.067
RL	0.512 ***	0.154	11.067	0.001	1.668 ***
[ELRM = not engaged]	−1.073 ***	0.375	8.177	0.004	0.341 ***
[ELRM = engaged]	0 [a]	-	-	-	-
EDL	0.869 ***	0.186	21.710	0.000	2.383 ***
IFED	0.572 ***	0.158	13.086	0.000	1.771 ***
NF	0.066	0.246	0.071	0.790	1.068
SL	−0.903 ***	0.221	16.767	0.000	0.405 ***

Significance level: *** $p < 0.01$; 0 [a] = reference or baseline category.

Education was highly statistically significant for WTA compensation with a negative coefficient. This indicates that farmers with higher education had 0.691 times lower WTA compensation than less educated farmers. This may be because educated farmers may be more aware of environmental situations and the need for AF. Land holding was highly significant for WTA land and had a positive coefficient; hence, farmers holding larger lands had 1.080 times higher WTA land to change for AF than small farmers. This may be because larger land provides higher food security and the ability to adopt disaster mitigation measures by changing land-use practices.

Insufficient crop production was highly significant and had negative coefficients for both WTA compensation and land. Farmers of less productive lands had 0.064 times lower WTA compensation and 0.233 times lower WTA land for AF than farmers of highly productive lands. This may be because less productive farmers are aware of the impact of environmental degradation on productivity and the importance of forests; however, they are also aware of the food sufficiency provided by maximum land. Risk level had a positive coefficient and was highly significant for both WTA compensation and land. Hence, farmers in high-risk areas have 1.570 times higher WTA compensation and 1.668 times higher WTA land than the farmers in lower-risk areas. This is possibly because they need to invest in higher measures, such as more forest land with different series of management. Farmers not engaging in local resource management were highly significant and had negative coefficients for both WTA compensation and land. This shows that farmers who never engaged in any organization related to local resource management were more likely to accept 0.438 times lower compensation than engaged farmers. Furthermore, non-engaged farmers were 0.341 times less likely to change land size than engaged farmers. This may be because non-engaged farmers are inexperienced about ES valuation or unaware of AF implementation; therefore, they agreed to a lesser compensation value of the land area for change. Environmental degradation level was significant for WTA compensation and highly significant for WTA land, with both having positive coefficients. This shows that farmers who are aware of the criticality of environmental degradation are likely to demand 1.340 times higher compensation and agree to 2.383 times more land for AF than those who do not believe the situation to be serious. The importance of forest was significant, with positive coefficients for both WTA compensation and land. This means that farmers who are aware of the forest's importance in managing environmental degradation are likely to have 1.444 and 1.771 times higher WTA compensation and land, respectively. This indicates that farmers who pay close attention to the environment and ESs are aware of the need for maximum land for forest extension and the monetary valuation for compensation. The satisfaction level of forest accessibility was significant to WTA compensation and highly significant to WTA land with negative coefficients. Hence, more satisfied farmers have 0.746 and 0.405 times lower WTA compensation and land than less satisfied farmers. This demonstrates that satisfaction can have a higher impact on WTA land than compensation value. Furthermore, the satisfied farmers also indicate well-managed forests and an understanding of their importance; however, due to the sufficiency, they do not see the need to extend the forest cover.

4. Discussion

Despite empirically estimating WTA value, the CVM is not beyond bias, as it involves questionnaires, which can have flexible and manipulative questions, as opposed to observing human behavior [49]. This creates a lack of trust regarding the accurate and valid acceptance value of WTA or WTP [50,51]. Furthermore, respondents unfamiliar with monetary values and in hypothetical situations are more likely to place different values on goods as compared to familiar and actual situations [52]. However, the limitation of the CVM can be manifested as systematic errors rather than random errors [21,52].

To estimate farmers' WTA values, we conducted the survey on the premise that the respondents had a complete understanding of ESs and policies [53]. Hence, our questionnaire gave a summary of Chure ESs, the importance of AF and PES, and the objectives of the survey. Since local farmers were not familiar with monetary compensation for ESS and AF implementation, it was inevitable that their WTA valuation differed for compensation and land, and some respondents may have answered without any basic knowledge of Chure.

An expert-based assessment of ESs shows that forests provide the highest number of ES goods and services and support the livelihoods of the local people by improving provisioning services compared to other land-uses and land cover [54,55]. However, to improve the farmland and livelihood of Chure farmers, both government and studies have mainly focused on agroforestry and have given less attention to farming issues, such as the need or possibility of new formation of land-use practices. The result of the farming scenario of this study, such as crop production sufficiency and irrigational water accessibility, relates to previous studies that highlight the insecure land ownership or inability to survive on available land in the Chure landscape [36,37].

The majority of farmland areas lack access to minimum irrigational water accessibility and highly fragile soil, leading to low production for livelihood, high environmental risks, and high dependency on forests for daily livelihood [37,56,57]. Furthermore, we cannot ignore the critical issue of rapidly increasing migration, whereby the cultivated land is becoming barren, especially in mountainous areas [37], and AF can be an option for managing unproductive land. Most of the respondent farmers agreed to participate in AF, and their standard value for the willingness to accept (WTA) land was estimated at 2.64 Kattha per household. This study explored two possibilities: providing farmers with an alternative land-use practice to address these issues and implementing AF under a payment mechanism. The majority are willing to implement AF on half of their total land. However, the availability of land in the study area for tree plantation raises questions about whether it can improve the environment and biodiversity to the extent that larger, expanded forest covers do. The findings indicate that small forest patches within farmland, when managed with careful planning, provide better services and enhance agricultural productivity compared to poorly planned large forests, while also reducing human pressure on nearby forests [58]. The estimated WTA compensation value for implementing AF in farmland was NPR 1268.67 per Kattha per year, which is significantly higher than the compensation accepted by farmers for watershed conservation [59] and provides an opportunity cost [60] or cost–benefit analysis [61] for conserving existing forests.

A comparison of existing studies related to WTA compensation for AF and other ESs has revealed the impact of socioeconomic and environmental factors. We applied OLRM, estimating that WTA is not influenced by households' income, including age, gender, family members, or family members involved in farming and the importance of forests. This supports a traditional CVM hypothesis that WTA levels are not influenced by households' income [62] and other socioeconomic variables [16]. However, previous studies highly emphasized the importance of household income and suggested that the WTA value was directly or indirectly influenced by households' income level for farmers with lower economic development [20,21,31]. Another study stated, "the landowners who considered their land as a long-term investment and paid close attention to the environmental situation are more likely to implement AF or facilitate ESS at all payment levels than others who do not consider long-term investment as important" [63]. By assessing similar trends of impact factors for both WTA values (compensation and land), this study extended the possibility that farmers require payment equivalent to their land-use change because of the forgone production level, riskier or degraded environment, efforts or improvement measures, and long-term investments, such as patrolling and protecting until they achieve a return from the forestation.

While analyzing the important impact factors to estimate WTA values, it is important for policymakers to consider how these factors can be a better target in terms of cost, especially in countries like Nepal or in projects that might have limited budget for PES, maximum land available to extend maximum forest land cover, and a higher need for AF programs. Hence, this study extends the possible relationship between impact factors to both WTA compensation and land to estimate its values by conducting OLRM. Some impact factors, such as crop production sufficiency, engagement in local resource management, and lower satisfaction level of forest accessibility, which are favorable for compensation but not for land-use change, can have more potential for economic compensation to motivate farmers to accept larger land size for AF. Less educated farmers can be more favorable for lower budgets and bigger landowners can be greater suppliers of land to enhance forest cover.

Moreover, policymakers should focus on lower-risk areas as prevention measures and on farmers who think the environmental degradation is not serious and therefore that forest ESs are not so important for environmental balance. Converting them will help avoid increasing natural risk and decreasing livelihood resilience. Rural farmers need maximum awareness and information to change maximum land for sustainable land-use practices. For farmers unwilling to participate in AF even with substantial compensation, it is important to provide information about PES and AF and win their trust, especially if they are not familiar with payment mechanisms for ES and land-use change practices. Further, the PES policy for compensation standards should be flexible to improve with changing scenarios and time periods that increase the forgone loss as time goes by [21], balanced with the socially preferred level [8,21].

The findings provide inputs for the formulation of ecological compensation and agricultural land-use change standards and guide ecological policymaking. This study can be used as a reference for ES evaluation for other similar situations, such as insecure farming with backward economies and fragile ecology where farmers are unfamiliar with compensation for ES conservation.

5. Conclusions

We analyzed farmers' WTA compensation and land as key components for socially preferred levels of AF implementation. We assessed farmers' socioeconomic and environmental impact factors of the Chure landscape in Nepal where the AF program as an alternative land-use practice, and compensation mechanisms have not been introduced yet. We found that the majority of farmers showed WTA AF implementation with an average WTA compensation of NPR 1268.67/Kattha/year and an average WTA land of 2.64 Kattha/household.

We aimed to provide a reasonable explanation for the impact factors. By analyzing the relationship between these impact factors, WTA compensation, and land value, this study developed a framework to understand how farmers' WTA compensation relates to land value. Additionally, it explained how this relationship can be useful for targeting investments in AF by maximizing forest cover. We conducted OLRM to analyze significant impact factors for both WTA compensation and land value. The main findings were:

- The impact factors of crop sufficiency, risk level, engagement in local resource management, level of environmental degradation, importance of forest, and level of satisfaction with forest accessibility were significant to both WTA compensation and land with similar coefficients. Other impact factors, such as education, were significant for WTA compensation, and land holding was significant for WTA land. This shows that there is a high possibility that similar factors have a significant impact on WTA alternative land-use practices. However, the result of the level of satisfaction with forest accessibility clarified that the level of significance of these impact factors may vary within different WTAs.
- This study extended a possible relationship that if farmers are well aware of the environmental situation, there is a high possibility of accepting more land for AF as a disaster mitigation measure. However, they would have to be given a compensation equivalent to the land.

The study's findings provide valuable insights for policymakers to identify potential target factors to implement AF based on environmental protection, improving livelihood resilience, environmental awareness, and maximum forest cover within an economic budget.

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Abbreviations

Abbreviation	Definition
AF	Afforestation
CPS	Crop production sufficiency
CVM	Contingent valuation method
ED	Education level
EDL	Environmental degradation level
ELRM	Engagement in local resource management
ES	Ecosystem
ESS	Ecosystem services
FM	Number of family members
IFED	Importance of the forest for environmental degradation
IS	Main income source
IWA	Irrigational water accessibility
MF	Manpower for farming
LH	Land holding
LS	Satisfaction level of forest resource accessibility
MI	Households' average monthly income
NPR	Nepalese Rupees
NS	Need for forest resources
OLRM	Ordinal linear regression model
RL	Risk level
WTA	Willingness to accept
WTP	Willingness to pay

Appendix A. Additional Figures

Figure A1. River cutting and environmental risk scenario in Hupsekot (pictures are taken from Google Maps).

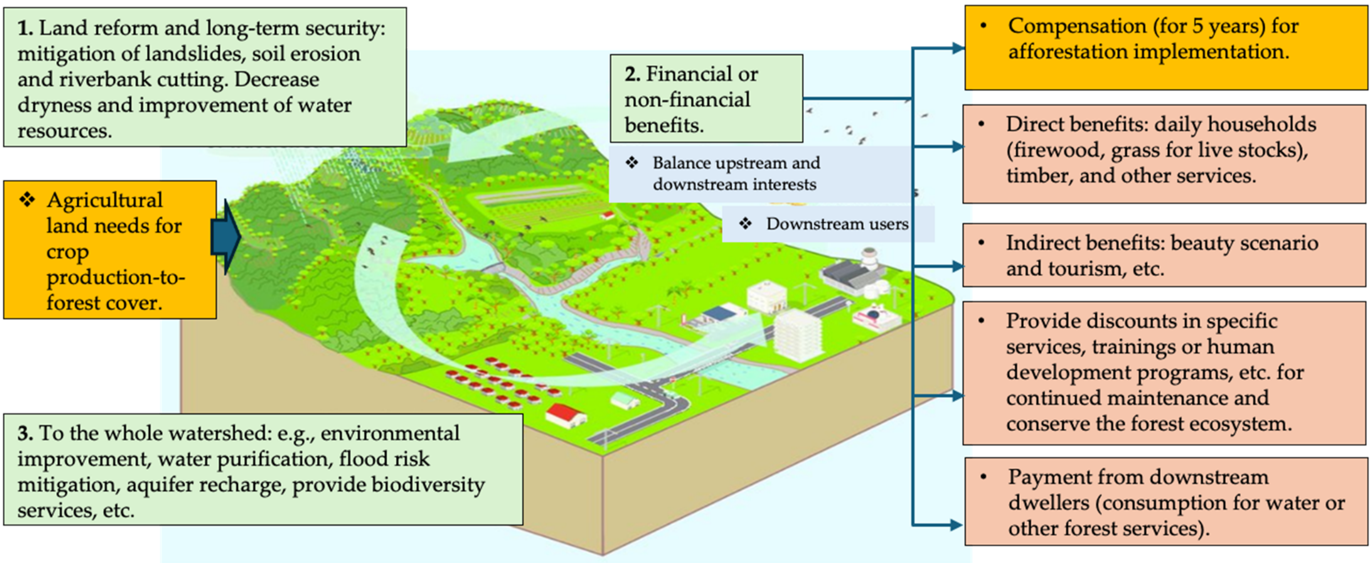

Figure A2. The importance of implementing afforestation as an alternative land-use practice in agricultural areas and its potential benefits for upstream (fragile) landscapes, based on the concept of payments for ecosystem services (PES).

Both figures, Figures A1 and A2, were included in the questionnaire survey to explain the local environmental and farming situation, as well as the need for afforestation (AF) to maximize forest cover, by showing local maps and pictures.

Appendix B. Additional Table

Table A1. Farmers' socioeconomic and environmental characteristics (N = 232).

Variables		Description	Number of Respondents	Proportion (%)
Socioeconomic variables	Gender	Female	79	34.1
		Male	153	65.9
	Age (in years)	18–25	19	8.2
		26–45	139	59.9
		46–65	69	29.7
		66–75	5	2.2
	Education	Uneducated	82	35.3
		Primary	88	37.9
		Secondary	45	19.4
		Senior high school	17	7.3
	Main income source	Farming	85	36.6
		Off-farming	147	63.4
	Number of family members	1–3	26	11.2
		4–6	117	50.4
		≥7	89	38.4
	Manpower for farming	0	1	0.4
		1–2	91	39.3
		3–4	96	41.4
		≥5	44	18.9

Table A1. *Cont.*

Variables		Description	Number of Respondents	Proportion (%)
Socioeconomic variables	Households' average monthly income (Nepalese Rupees, NPR)	10,000	95	41.0
		20,000	98	42.2
		30,000	32	13.8
		50,000	4	1.7
		≥100,000	3	1.3
	Land holding (Kattha)	≤5	63	27.2
		6–10	71	30.6
		11–20	71	30.6
		21–40	25	10.7
		≥41	2	0.9
	Crop production sufficiency	Not sufficient	176	75.9
		Sufficient	56	24.1
	Irrigational water accessibility	Very poor	57	24.6
		Poor	85	36.6
		Fair	31	13.4
		Good	59	25.4
Attitude and awareness of the local environment	Risk level (of farming land)	Very low	66	28.4
		Relatively low	2	0.9
		Medium	50	21.6
		Relatively high	102	44.0
		Very high	12	5.2
	Engagement in local resource management	Not engaged	161	69.4
		Engaged	71	30.6
	Environmental degradation level	Very low	6	2.6
		Relatively low	32	13.8
		Medium	45	19.4
		Relatively high	72	31.0
		Very high	77	33.2
	Importance of forest to environmental degradation	Very unimportant	11	4.7
		Relatively unimportant	38	16.4
		Neutral	17	7.3
		Relatively important	67	28.9
		Very important	99	42.7
	Needs of forest resource	Only for daily household	3	1.3
		Daily household and income source	120	51.7
		Daily household, income source, and cultural	77	33.2
		Daily household, income source, cultural, and beauty	32	13.8
	Satisfaction level of forest resource accessibility	Very unsatisfied	22	9.5
		Relatively unsatisfied	104	44.8
		Relatively satisfied	67	28.9
		Very satisfied	39	16.8

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