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Analyzing Various Factors Affecting Farmers' Willingness to Adopt Soil Erosion Control Measures in the Sebeya Catchment, Rwanda

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Abstract: Soil erosion is a worldwide environmental problem leading to low agricultural productivity and water quality degradation. Improving soil erosion control measures is essential. This study reports the results of a survey of 75 farmers, using structured interviews, field observations, and focus groups to analyze farmers' perceptions concerning current and future efforts to adopt Soil Erosion Control (SEC) measures in the Sebeya catchment located in the Western Province of Rwanda. Various factors influencing farmers' perceptions of soil erosion causes, effects, and willingness to adopt SEC measures were analyzed using descriptive statistics and SPSS (Version 20), including *t*-tests, chi-square tests, and a binary logistic regression model. Chi-square test results indicate that gender, farmer age, land ownership, farmland size, social media access, and credit access were strongly associated ($p < 0.05$) with the adoption of SEC measures, while marital status and education were not. A binary logistic regression model showed that among farmers' socioeconomic characteristics, farming experience (B = 0.749; p = 0.020) and access to socio media (B = 2.107; p = 0.027) were positively correlated, while age (B = −0.642; p = 0.035) and gender (B = −2.034; p = 0.032) were negatively correlated ($p < 0.05$) with the adoption of SEC measures. In order to mitigate high soil erosion rates and increase food production, there is a need for the government to support farmers, and train them. A highly skilled technical team should be mobilized to assist in implementing SEC measures in the Sebeya catchment.

Keywords: Sebeya catchment; soil erosion; soil erosion control; farmers' perceptions; Rwanda

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1. Introduction

The effects of soil erosion are among the most significant environmental problems today, leading to low agricultural productivity and water quality degradation [1–3].

Rainfall is the main natural factor causing soil erosion through many phenomena: Disintegration, detachment, transport, and deposition [4]. Geomorphologic soil erosion is one of the most important processes in soil morphology. Human activities such as deforestation, overgrazing, tillage, improper agricultural practices, and changes in land cover and land use affect water movement on the earth's surface [5]. Topsoil and nutrient losses due to soil erosion lead to a decrease in the soil's water-holding capacity and, ultimately, the reduction of soil productivity. River sediments, mainly constituted by eroded soil materials and accompanying pollutants from agriculture, adversely impact various projects that use the river as a source of water supply.

In developing countries, poor farming techniques and a lack of financial resources for the agricultural systems make farmlands vulnerable to erosion [6]. Strategically, SEC measures are important adaptation measures for farmers to improve their productivity [7,8]. However, the limiting factors to the farmers' adoption of some SEC techniques, such as hillside water reservoirs, terraces, contour bunds, check dams, retaining walls, and sediment basins, are mostly linked to poverty and limited knowledge of agronomic practices [9,10].

In several developed countries, suitable SEC measures have been efficiently implemented, and these strategies helped substantially to reach the soil loss tolerance limit [4]. Soil loss tolerance (or T-value) is a soil loss value used to anticipate that the predicted soil erosion will not cause a significant reduction in soil productivity or excessive river sedimentation [11]. Based on the literature, the soil loss tolerance ranges from 1 to 11.5 tons per hectare per year [12]. Practically, many studies have used 11.5 t ha^{-1} $year^{-1}$ as the maximum acceptable soil loss tolerance value [12].

In Rwanda, 80% of the economy is principally supported by agriculture, whereas the land is being exposed to high rates of soil erosion due to the conversion of land to agriculture [13]. Caused by several influential factors such as heavy rainfall, population pressure, and agricultural expansion on steep lands, Rwanda is highly vulnerable to soil erosion, rated at 250 t ha^{-1} $year^{-1}$ [14–16]. Due to this commitment, the government has implemented plans to control soil erosion and floods in all nine level-1 catchments covering the entire territory of Rwanda.

The Sebeya catchment is highly prone to soil erosion resulting in excessive soil loss from agricultural land and sedimentation of the Sebeya river [15]. The eroded sand materials decrease the hydraulic efficiency of the turbines within the Keya hydropower plant installed on the Sebeya river. The abrasion of turbines leads to a decrease in power production and sometimes imposes the replacement of some of the turbine components, especially during the rainy season [17,18]. At the same time, the high turbidity of the Sebeya river imposes a high cost of coagulants on the Gihira water treatment plant. This problem of soil erosion at the Sebeya catchment outlet has a significant negative impact on the aesthetic and quality of Lake Kivu's water, which harms both recreational and aquatic life on the lake. Therefore, controlling soil erosion is crucial to increasing soil productivity while reducing the downstream Sebeya river and Lake Kivu sedimentation.

SEC measures are required for farmers to cope with and resist the potential risks of soil erosion [7,8]. However, factors affecting farmers' willingness to adopt SEC measures were not studied in the Sebeya catchment. For this research gap, the objective of this study was to examine farmers' perceptions of the actual soil erosion status and strategically assess various factors affecting the adoption and implementation of SEC measures in the Sebeya catchment.

2. Methodology

2.1. Study Area

As shown in Figure 1, the Sebeya catchment area is shared by four country subdivisions: Rubavu, Nyabihu, Rutsiro, and Ngororero Districts. Sebeya is the main river in this catchment, originating from the Rutsiro mountains, and is 48 km long.

The superficial area and the estimated population density of the Sebeya catchment area are 363.1 km^2 and 644 inhab/km^2, respectively, compared to 26,338 km^2 and 415 inhab/km^2 on a country scale [15,19]. This catchment provides suitable conditions for agriculture because it has significant infiltration rates while being rich in minerals, except for clay soils on flat topography. Steep slopes also characterize this catchment, with the altitude and rainfall varying from 1462 m to 2979 m and 1200 mm to 1700 mm, respectively [15]. Based on all these factors, the Sebeya catchment is exposed to high-rated soil erosion [16].

2.2. Determining the Sample Size and Sampling Procedures

The main objective of a research survey is to provide insight into how the findings from a sampled population can be generalized to the population as a whole [20]. The sample size in sampling analysis may be manageable; it must be optimum [21]. If a survey is just for information on the research trends, small sample sizes can be selected, while large sample sizes are required for high-precision studies [22]. The required sample size depends on the margin of error and the significance level of the research [20].

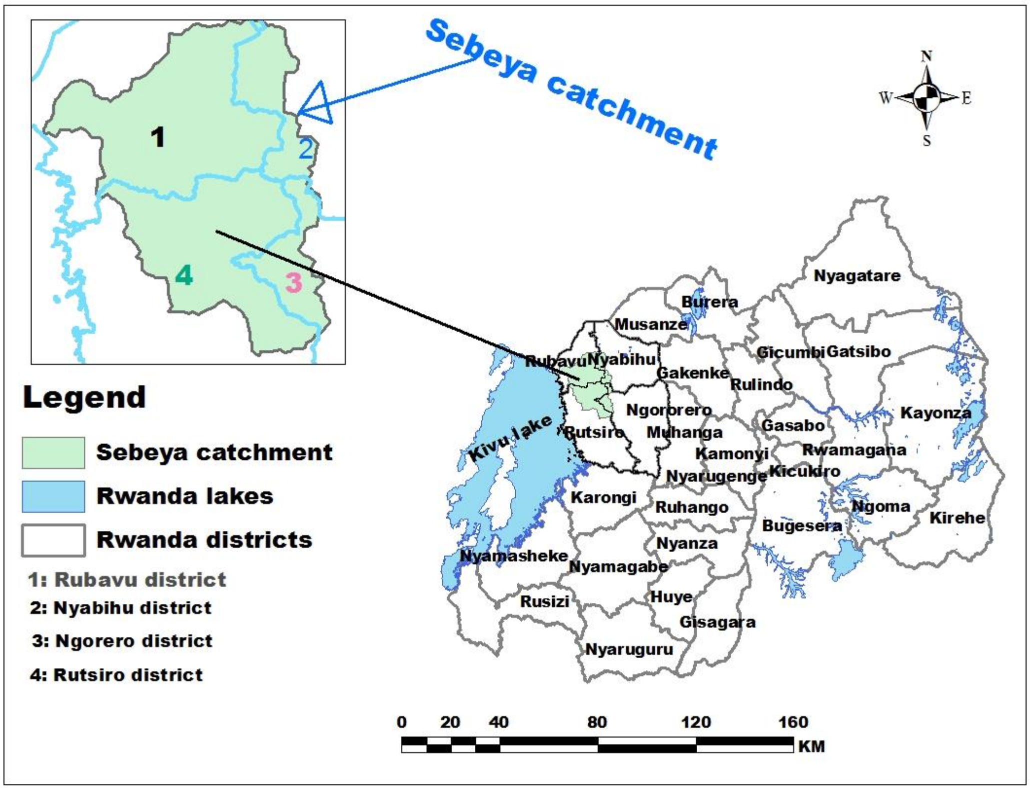


Figure 1. Rwanda map showing the Sebeya catchment.

In this study, a sample of farmers was selected using a systematic random sampling at a 91.6% confidence level, with 0.5 degrees of variability, and a 10% margin of error as a level of precision while using the Cochran formula [20] as shown in the following Equation (1).

$$n = \frac{Z^2 \hat{p}\hat{q}}{e^2} = \frac{(1.73)^2(0.50)(0.50)}{(0.10)^2} = 75 \text{ farmers} \tag{1}$$

In this equation, n stands for the required sample size; $\hat{p}$ is the estimated proportion of an attribute that is present in the population (in this study, $\hat{p}$ is the percentage of farmers who are supposed to adopt the practice, hence: $\hat{p}$ = 50% and $\hat{q} = 1 - \hat{p}$ = 50%); e is the acceptable margin of error; Z is the statistical value representing the confidence level; and α is the value chosen by the researcher to determine the statistical significance of the random sampling. It represents an acceptable probability of a Type I error [23].

In this investigation, study tours were executed to collect primary first-hand data about cultivated crops, topography, soil characteristics, hydrographic network, and the existing SEC measures in the Sebeya catchment.

Interviews of farmers from six identified sectors (Gisenyi, Rugerero, Nyundo, Nyakiriba, Kanama, and Nyabirasi) were conducted in order to attain scientific and practical insights into farmers' perceptions of the causes and effects of soil erosion, as well as their perceptions and actions regarding the adoption and implementation of soil erosion control measures in the Sebeya catchment.

2.3. Data Collection

Multifarious published journal articles and government reports have provided secondary data about erosion rates, causes, effects, and control in the Sebeya catchment. Therefore, the authors used this method to synthesize various researchers' views on this topic. The Digital Elevation Model (DEM) data used to delineate the Sebeya catchment were obtained from CGIS Rwanda (Center of Geographical Information System).

2.4. Data Analysis

Descriptive statistics using SPSS (Version 20) were used along with the *t*-test, the chi-square test, and the binary logistic regression model to describe farmers' socioeconomic characteristics and tie their perceptions of soil erosion and various explanatory variables. As part of this study, the following variables were analyzed: Gender, age, marital status, education, farmland size, land ownership, amount of livestock, experience in agriculture, total income from the farm, main occupation, off-farm activities, access to media, and access to credit. All these variables were chosen based on the literature and the researchers' opinions [24].

This study utilized the following steps to understand farmers' perceptions of adopting SEC measures in the Sebeya catchment (Table 1).

Table 1. Research design.

Case Study	Research Questions	Methods	Results
A sample of 75 farmers in the Sebeya catchment.	What is the actual status of various farmers' socioeconomic characteristics in the Sebeya catchment?	Scoring of various farmers' socioeconomic characteristics.	Actual status on various farmers' socioeconomic characteristics in the Sebeya catchment.
	What are the farmers' perceptions of various causes of soil erosion and its effects?	Assessing farmers' views on various causes and effects of soil erosion on agricultural lands.	A collection of farmers' views on the main causes and effects of soil erosion in the Sebeya catchment and their assessment.
	How do farmers express their needs to improve the existing and implement new soil erosion control measures?	Scoring of various proposed SEC measures.	Farmers' views on the improvement and implementation of the existing and new proposed SEC measures in the Sebeya catchment.
	How do different farmers' socioeconomic characteristics affect the adoption of SEC measures?	Using the binary logistic regression model to analyze the statistical significance of nine socioeconomic factors influencing the adoption of SEC measures.	The level of the statistical significance of the nine factors influencing the adoption of SEC measures in the Sebeya catchment.

In this research, the binary logistic regression model was involved because the dependent variable (adoptability or willingness to adopt the proposed SEC measures) is a binary consisting of two values, 1 and 0, for an adopter and a non-adopter, respectively. The expected value is simply the probability p. Practically, the dependent variable is modeled indirectly as the logistic transformation of p, as shown in Equation (2) [25–27].

$$\text{logit (p)} = \ln\left(\frac{p}{1-p}\right) = \text{B}_0 + \text{B}_1 * \text{X}_1 + \text{B}_2 * \text{X}_2 + \text{B}_3 * \text{X}_3 + \text{B}_4 * \text{X}_4 \quad (2)$$

where Bi represents the coefficients of the logistic regression model and odds = $\frac{p}{1-p}$. In this context of binary logic regression, the language of odds is used more than the language of probability.

3. Results

3.1. Estimating Soil Loss from Sebeya Catchment

Data on soil erosion and its controlling factors can be collected in the field or from simulated conditions in the laboratory. Field measurements provide more realistic data on soil loss because many factors are controlled in laboratory experiments. Three methods are commonly used to estimate or predict soil erosion: Erosion pins, bounded field erosion plots, and empirically based equations to predict soil loss and sediment yields from a catchment. Erosion models often use secondary data available in a geographic information system as an alternative approach because measuring soil erosion is expensive and time-consuming [14].

As a result, this paper presents a classification of soil erosion in the Sebeya catchment area into six categories: Very low risk (0–5 tons/ha/year), low risk (5–10 tons/ha/year), moderate risk (10–25 tons/ha/year), high risk (25–50 tons/ha/year), very high risk (50–100 tons/ha/year), and extremely high risk (>100 tons/ha/year). Approximately 8000 hectares are at high risk, while approximately 6000 ha are at very high risk. In total, approximately 4500 ha of the Sebeya catchment land was found to be highly vulnerable to soil erosion [16]. This study estimated the soil loss from the Sebeya catchment area at 130.724 tons/ha based on the Universal Soil Loss Equation (USLE) combined with GIS applications. In the Sebeya catchment, soil erosion is accelerated by heavy rainfall, insufficient SEC measures, and human activities.

3.2. Farmers' Socioeconomic Characteristics

The results of the SPSS analysis of different farmers' socioeconomic characteristics are shown in Table 2. Statistical comparisons were made based on the percentage of respondents who answered each question similarly.

Table 2. Qualitative results of different farmers' socioeconomic characteristics as analyzed using SPSS in the Sebeya catchment (n = 75).

Attribute	Frequency	Attribute	Frequency
1. Gender		**5. Land ownership**	
Male	43(57.3%)	Farmland inherited	27(36%)
Female	32(42.7%)	Farmland bought	30(40%)
2. Age		Farmland hired	10(13%)
18–25	8(11%)	Not owner but a daily laborer	8(11%)
26–30	13(17%)	**6. Total farmland size**	
31–40	27(36%)	≤0.1 ha	15(20%)
41–55	21(28%)	>0.1 ha	60(80%)
>55	6(8%)	**7. Main occupation**	
3. Marital status		Farmer but not the owner	5(7%)
Married (live together)	59(79%)	Owner but not farm laborer	10(13%)
Single	7(10%)	Owner & daily laborer	60(80%)
Divorced	4(5%)	**8. Access to social media**	
Widowed	5(6%)	Yes	13(17%)
4. Education		No	62(83%)
Illiterate (no formal education)	11(15%)	**9. Access to credit**	
Can read and write	4(5%)	Yes	18(24%)
Primary education	42(55%)	No	57(76%)
Secondary education	15(20%)		
University	4(5%)		

The researchers used Table 3 to collect the quantitative information and the statistical analysis results with a t-test to compare the data.

Table 3. Quantitative results on different farmers' socioeconomic characteristics as analyzed using SPSS in the Sebeya catchment (n = 75).

Parameter	Sample Min	Max	Mean ($\bar{X}$)	Country Mean (μ) [28]	*t*-Test Ho: $\bar{X}$ = μ
Age (years)	18	67	38.40	-	N.A.
Farming experience (years)	1	48	17.95	-	N.A.
Total farmland size for Irish per household (m^2)	75	90,000	2540	165	DD
Total farmland size for maize per household (m^2)	48	41,160	1887	615	DD
Total farmland size for beans per household (m^2)	60	25,290	1814	778	DD
Income from Irish potatoes per household (kg/season)	40	4000	255	127	DD
Income from beans per household (kg/season)	10	30,000	821	67	D.D.
Income from maize per household (kg/season)	10	4000	198	88	D.D.
Number of cows per household	1	6	0.31	0.67	NS
Number of pigs per household	2	9	0.33	0.52	SS
Number of goats per household	1	5	0.60	0.72	SS
Number of poultry per household	2	13	0.69	1.64	NS
Number of rabbits per household	7	15	0.29	0.31	SS

DD: The sample mean and the country means are distinctly different. No *t*-test is needed. **NS:** The sample and country mean are not statistically the same. **S.S.:** The sample mean and the country means are statistically the same.

Based on the interview results in Table 3, this study depicted that the total farmland size per household (m^2) for Irish potatoes, maize, and beans ranged between 75 and 90,000; 48 and 41,160; and 60 and 25,290; with average values of 2540, 1887, and 1814 m^2/H.H, respectively. In addition, farmers in the Sebeya catchment reported that the income per household from Irish potatoes, beans, and maize ranged between 40 and 4000; 10 and 30,000; and 10 and 4000; with average values of 255, 821, and 198 kg/season/H.H., respectively.

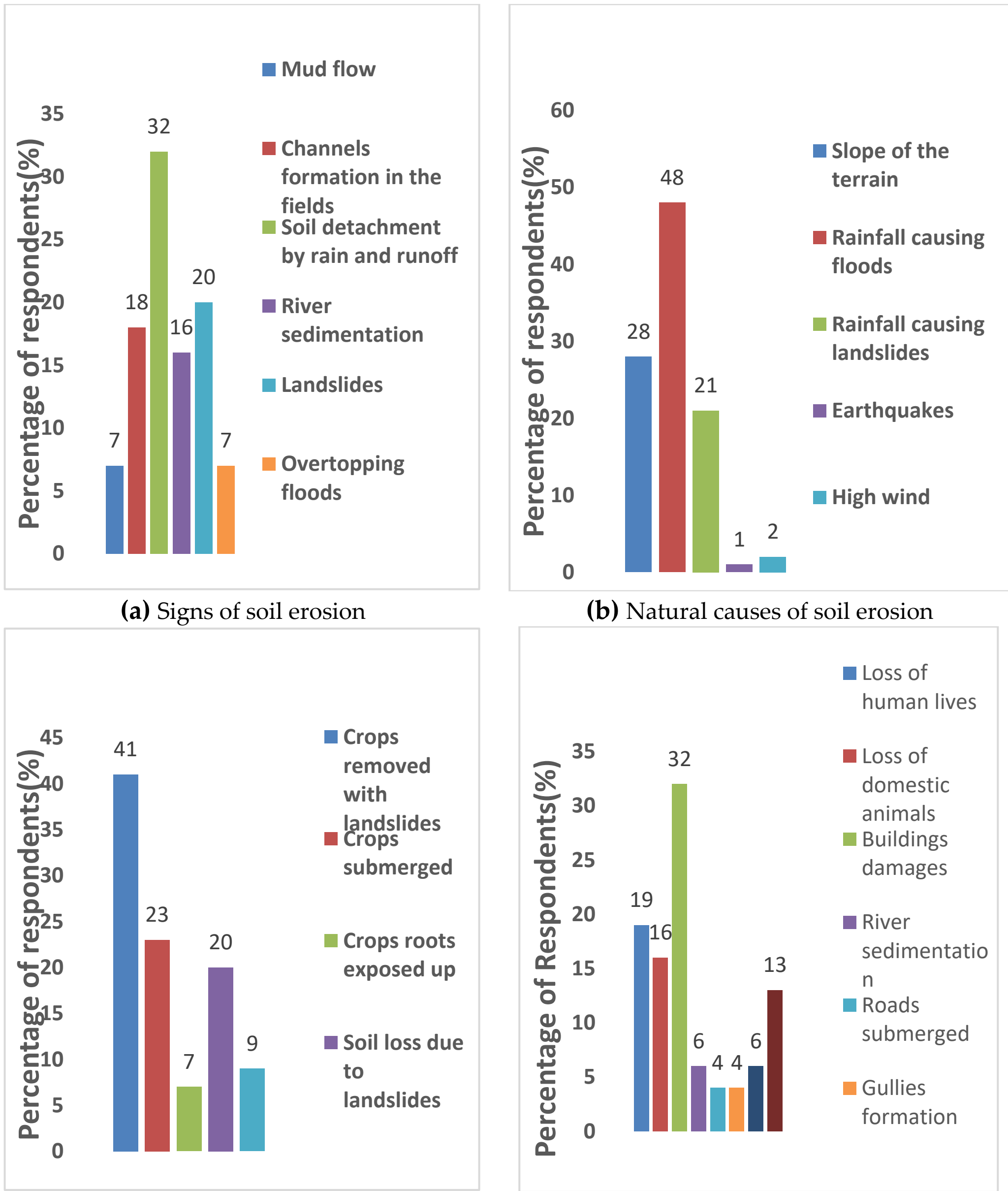
Quantitatively, this research revealed that the number of domestic animals per household varied between 1 and 6 cows, 2 and 9 pigs, 1 and 5 goats, 2 and 13 poultry, and 7 and 15 rabbits, with an average value per household of 0.31 cows, 0.33 pigs, 0.60 goats, 0.69 poultry, and 0.29 rabbits in the Sebeya catchment. In comparison with the mean values estimated per household countrywide [28] in Table 3, a *t*-test was applied to test the significance of the mean of this random sample, as illustrated in [29]. As indicated in Table 3, the sample and the country means were statistically the same for pigs, goats, and rabbits. At the same time, the *t*-test revealed that the two values of the mean were statistically different for cows and poultry.

3.3. Farmers' Perceptions of Causes and Effects of Soil Erosion

In Figure 2, farmers were asked to identify the indicators, major causes, and effects to assess the severity of soil erosion and causes of the agricultural productivity decline in their farmlands.

Various soil erosion signs given in Figure 2a indicate that, in the Sebeya catchment, soil erosion is approximatively known by 80.67% of farmers. Similarly, Biratu and Asmamaw [30] reported that (93.1%) of respondents recognized excessive soil erosion in their farmlands.

In this study, farmers in the Sebeya catchment could recognize four types of soil erosion: Gully erosion (42.6%), rill erosion (20%), stream bank erosion (18.7%), and sheet erosion (18.7%). The results of this research are backed by a recent study [31], which affirms that sheet and rill erosion are the main types of erosion that occur on cultivated hillsides of Rwanda.



(a) Signs of soil erosion **(b)** Natural causes of soil erosion

(c) Onsite effects of soil erosion **(d)** Offsite effects of soil erosion

Figure 2. Assessment of farmers' perceptions of soil erosion in the Sebeya catchment based on indicators, causes, and effects.

According to Figure 2b, heavy rainfall combined with high runoff is the most important natural factor contributing to soil erosion in the Sebeya catchment. This finding is supported by Munyaneza et al. [17], who reported that human activities caused storm runoff and accelerated soil erosion in the Sebeya catchment. Generally, the main causes of soil erosion perceived by farmers in the Sebeya catchment were the slope of the land, deforestation, continuous cultivation of land without fallow, high intensity of rainfall, and absence of appropriate SEC measures. The same causes were reported by Belay [32], and Amenu and Megersa [33], while Pravat et al. [34] confirmed that soil erosion's first and second causes were heavy rainfall and slope steepness, respectively. The lack of land for agriculture and settlements is one of the major reasons for the persistence of deforestation in the Sebeya catchment [35]. Soil and nutrient losses (Figure 2c) constitute the main onsite damages due to soil erosion, adversely impacting soil productivity. Similarly, Biratu and Asmamaw [30] stated that almost all respondents acknowledged the decline in soil fertility due to soil erosion through farmers' interviews.

Figure 2d illustrates soil erosion with considerable offsite damage in the Sebeya catchment. Furthermore, the eroded soil materials and the accompanying pollutants are among the harmful effects of soil erosion in the three hydropower plants, the Gihira water treatment plant, and disturbances to aquatic ecosystems and human recreation in Lake Kivu [18].

3.4. Needs for the Implementation of SEC Measures in the Sebeya Catchment

Soil erosion is one of the most pressing environmental problems worldwide. It is one of the ecological phenomena to which the adage "Prevention is better than cure" is most applicable. Erosion control is any action to prevent soil erosion from detaching soil surface particles while elucidating the necessity of implementing SEC measures [12].

Table 4 lists 35 BMPs practices mostly applied to control soil erosion on agricultural lands as classified into six groups according to their respective purposes. With high percentages of soil loss reduction, if applied on agricultural lands, the 22 SEC measures (written in italic in Table 4) were found suitable and proposed to be implemented in the Sebeya catchment.

Table 4. Various SEC measures most applied on agricultural lands.

S.N.	Purposes	Typical SEC Measures
1	BMPs for erosion control on farmlands	*Terraces*, *contour bunds*, no-tillage, cover crops, *mulching*, *anti-erosive ditches*, strip cropping, crop rotation, agroforestry, *stabilizing grasses on farm bunds* (vetiver grass, reed, cetaria, tripsacum, paspalum).
2	BMPs for slope stabilization	Stabilizing trees (*grevelia*, *bamboo*), stabilizing grasses (*vetiver grass*, *reed*, *cetaria*, *tripsacum*, *paspalum*), retaining walls (*use of gabions* or stones).
3	BMPs for river banks stabilization	Stabilizing trees (grevelia, bamboo), *stabilizing grasses* (vetiver grass, reed, cetaria, tripsacum, paspalum), *stone revetment*, *use of riprap*, retaining wall (made of *gabions*); *use of sandbags*.
4	BMPs for sediments control	*Sand traps*, *sediment basins*, constructed wetlands, strip cropping along the river buffer zones; siltation ponds at the end of storm sewers; grassed waterways, and protective sediment barriers.
5	BMPs to prevent large velocities of runoff	*Check dams*, *grassed waterways*, *stone blocks in a channel*, stilling basins, storm sewer drains, roadside channels, ditches, and hillside water ponds.
6	BMPs to prevent significant volume flow rates of runoff	*Hillside water ponds*, *roof runoff cisterns*.

In this investigation, the interview results revealed that the level of implementation of the 22 proposed SEC measures had reached 4.57%. In contrast, 95.43% effort is required for better controlling soil erosion to the acceptable soil loss rates in the Sebeya catchment. Furthermore, the Integrated Water Resources Management department in Rwanda (IWRM) [35] reported that the rehabilitation of 1373 ha in the Sebeya catchment was successful by applying various SEC measures, including tree plantation, agroforestry, and terraces. Therefore, the improvement of SEC measures is strongly needed in the Sebeya catchment. Among different soft BMPs (Table 4), trees and protective grasses should be planted along the river banks, and buffer zones should be established. The no-tillage method, cover crops, crop rotation, mulching, agroforestry, and stabilizing grasses on farm bunds are the soft BMPs that farmers can easily implement on their farmlands. Soft BMPs are those agronomic measures easily implemented at a low cost. At the same time, terraces (which are still few) and anti-erosive ditches constitute the main hard BMPs in the Sebeya catchment [36]. Similarly, Onu and Mohammed [37] reported that farmers needed to systematically improve all the existing SEC measures in Kogi state (Nigeria).

Technologically, bench terraces are earth embankments constructed to transform long slopes into a series of shorter slopes to intercept the surface runoff. Their implementation is mainly needed to control soil erosion on agricultural lands with slopes ranging from 16% to 60%, while progressive terraces and contour bunds are suitable on slopes less than 16% [36]. Based on slope ranges, various SEC measures were initially proposed in the Sebeya catchment by the Ministry of Environment [16]. Table 5 shows how various proposed SEC measures can be efficiently implemented in the Sebeya catchment within slope ranges.

Table 5. Proposed combinations of SEC measures in the Sebeya catchment.

Land Slope	Soil Depth (>1 m)	(0.5–1) m	(<0.5 m)
(0–6%)	AG+CC+CT+DC+M+SG	AG+CC+CT+DC+M+SG	AG+CC+CT+DC+M+SG
(6–16%)	CC+CT+DC+M+PT+SG Or CB+CC+CT+DC+M+SG	CC+CT+DC+M+PT+SG Or CB+CC+CT+DC+M+SG	M+PT or CB+DC+M+SG Or CB+CC+CT+DC+M+SG
(16–40%)	BT+CC+CT+DC+M+SG	BT+CC+CT+DC+M+SG	CC+CT+DC+M+PT+SG or CB+CC+CT+DC+M+SG
(40–60%)	BT+CC+CT+DC+M+SG	BT+CC+CT+DC+M+SG	A.F.
(>60%)	A.F.	A.F.	A.F.

A.F.: Afforestation; **AG:** Agroforestry; **B.T.**: Bench terraces; **C.B.**: Contour bunds; **CC:** Crop cover; **CT:** Contour tillage; **DC**: Drainage channels; **M**: Mulching; **P.T.**: Progressive terraces; **S.G.**: Stabilizing grasses on farm bunds.

4. Discussion

4.1. Actual Status of Soil Erosion and its Control in the Sebeya Catchment

In order to clarify the severity of soil erosion in the Sebeya catchment, this study classified this region as a very high-risk zone of soil erosion with an annual average soil loss of 130.724 tons/ha/year due to insufficient SEC measures, heavy rainfall, and human activities accelerating soil erosion. Among the greatest worldwide environmental concerns is soil erosion because it not only causes soil nutrient deprivation and land degradation but also leads to many notable offsite environmental problems such as flooding, water siltation, and pollution [4]. This research assessed various SEC measures (Table 4) and recommended their implementation in the Sebeya catchment. However, some SEC techniques, such as terraces, contour bunds, and drainage channels, are costly to build [4–10].

4.2. Adoptability of SEC Measures in the Sebeya Catchment

The chi-square test is a statistical measure used in sampling analysis to assess the relationship between two attributes (variables) [38]. It is symbolized as χ^2. In this study, the significance of the chi-square value [χ^2 (calculated)] was determined by using the suitable degree of freedom [df = (r − 1)(c − 1)] and the degree of significance ($\alpha = 0.05$) in comparison with the chi-square value from a table [χ^2 (critical)]. Table 6 shows the chi-square test results to find relationships between variables (adoption factors) and the four selected SEC measures (terraces, mulching, anti-erosive ditches, stabilizing grasses on the farm bunds) in the Sebeya catchment.

Table 6. Significance of variables (adoption factors) for the four selected SEC measures.

S.N.	Variables (Adoption Factors)	df (r − 1)(c − 1)	χ^2 (Calculated)	χ^2 (Critical)	*p*-Value	χ^2 test (Ho) *
1	Age of a farmer (yr)	12	26.762	21.026	0.0084	S
2	Gender of a farmer	3	13.480	7.815	0.0037	S
3	Marital status	9	1.170	16.919	0.9989	NS
4	Education	12	0.310	21.026	0.9999	NS
5	Farmland size (ha)	3	8.350	7.815	0.0393	S
6	Main occupation	6	13.330	12.592	0.0380	S
7	Access to media	3	8.580	7.815	0.0353	S
8	Access to credit	3	11.870	7.815	0.0078	S

* **Ho:** There is no relationship between the selected independent variable (adoption factor) and the dependent variable (the adoptability of the four proposed SEC measures: Terraces, mulching, anti-erosive ditches, and stabilizing grasses on the farm bunds). **S** = the adoption factor is statistically significant for the proposed SEC measures. **N.S.** = the adoption factor is statistically not significant for the proposed SEC measures. **r =** number of rows. **c** = number of columns.

This study also uses the Binary Logistic Regression Model [26,39] to investigate if there is a statistical significance between explanatory variables (independent variables) and the adoption of SEC measures in the Sebeya catchment. The nine variables commonly associated with SEC adoption are listed in Table 7 [24].

Table 7. Compiled results from the binary logistic regression model (*).

Parameter	B	S.E.	Wald	df	Sig.	Exp (B)
Gender	−2.034	0.949	4.594	1	0.032	0.131
Age	−0.642	0.319	2.231	1	0.035	1.719
Marital status	−0.220	0.488	0.203	1	0.652	0.803
Education	−0.507	0.409	1.532	1	0.216	0.602
Total farmland size	−2.225	1.222	3.318	1	0.069	0.108
Main occupation	−0.335	0.852	0.155	1	0.694	0.715
Farmers experience	0.749	0.321	5.440	1	0.020	2.115
Access to social media	2.107	0.954	4.880	1	0.027	8.223
Access to credit	−0.521	0.841	0.384	1	0.536	0.594
Constant	3.420	4.823	0.503	1	0.478	30.572

* While assessing the effect of the nine explanatory variables (adoption factors) on the adaptability of the four selected SEC measures (terraces, mulching, anti-erosive ditches, and stabilizing grasses on the farm bunds), the following notations and meanings were used [26,39]: **B:** Regression coefficient in the binary logistic regression model. **S.E:** Standard error. **Exp (B):** Odds ratio. **Sig.:** *p*-values (in the column of Sig.). **Wald:** A Wald chi-square test was used to determine whether the coefficients within the model are statistically significant. **df:** Degree of freedom (for the Wald chi-square test).

Many studies have shown that various socioeconomic characteristics affect farmers' adoption behavior of SEC measures [24–33]. In analyzing the impacts of the nine independent variables on the dependent variable (adoption of SEC measures in the Sebeya catchment), the following summary presents the results and interpretation using the chi-square test and the Binary Logistic Regression Model.

Gender of a farmer

Based on the socioeconomic characteristics of the respondents (Table 2), 57% were male, and 43% were female. Many researchers have reported large numbers of males in farmers' interviews (70%) and (78%), whereas women respondents constituted 30% and 22%, respectively, for Senkoro [40] and Pravat et al. [34]. The chi-square test (Table 6) also indicates that the gender of the respondents is associated with their participation in adopting SEC measures at (χ^2 = 13.480; df = 3 and p = 0.0037). However, this finding differs considerably from that of Biratu and Asmamaw [30]. They stated that the chi-square test did not indicate an association between respondents' gender and the extent to which they participated in SEC activities.

The gender of respondents is negatively correlated with the adoption of SEC measures and is statistically significant at the 0.05 level (B = −2.031; *p*-value = 0.032), which is also confirmed by the Wald statistics (4.591). These results reflect that males and females are likely to be engaged in implementing and maintaining SEC measures. However, male farmers may have better perceptions of soil erosion because they have more access to information-sharing events at farmer conferences than female farmers [41].

Age of a farmer

Some published findings have revealed that the age of a farmer is one factor influencing the farmers' adoption of SEC measures [30,41].

In this study (Table 2), respondents were categorized into five age ranges as follows: 18–25 (11%), 26–30 (17%), 31–40 (36%), 41–55 (28%), and above 55 (8%). This study recorded a very small percentage of farmers aged between 18 and 25 (11.2%) because many young people are still at school and are not interested in farming once they have completed their secondary education. Most respondents were in the age ranges 31–40 and 41–55, indicating that the involved farmers were still in their economically active age for better advancements in their farming activities. They may buy or hire new hectares of farmlands and pay much attention to SEC measures. Moreover, the farmers in these age ranges are more engaged in fulfilling their family needs, such as food security and school fees for their children. They have more family responsibilities than the young and old farmers.

The chi-square test (Table 6) indicated that the age of farmers and adoption of the SEC measures have a significant association (χ^2 = 26.762, df = 12; p = 0.0084). Similarly, Alemu [42] confirmed that the age of farmers significantly influenced their knowledge of the proposed SEC measures (χ^2 = 9.686, p = 0.046).

Among the socioeconomic characteristics, the age of the respondents correlated negatively with the adoption of SEC measures. It was statistically significant at the 0.05 level (B = −0.642 and p-value = 0.035), and the Wald statistics (4.050) also showed its significant relationship. This finding is in line with Asfaw and Neka [39] and Belachew et al. [43], who confirmed that age is relevant in adopting SEC measures with B = −0.067, p-value = 0.045, and Wald statistics of 4.016. The negative sign indicates that as the age of farmers increases, the probability of participating in SEC practices decreases. Old farmers do not have enough energy to implement SEC measures in their farmlands. The younger the farmer, the more he or she tends to adopt SEC measures. Young farmers are usually more educated, physically apt, and highly adaptive to innovations concerning SEC technologies. Throughout the literature, Nadhomi et al. [44] reported that the maximum age to adopt SEC practices would be approximately 51 years. In this study, the average age of the respondents was 38 years, an age below the calculated age limit for the adoption potential of SEC measures. This age (38 years) suggests that farmers in the Sebeya catchment would tend to adopt new SEC measures.

Marital status of the respondents

Among the farmers' socioeconomic characteristics (Table 2), marital status was categorized into four groups, married (79%), single (10%), divorced (5%), and widowed (6%). Similarly, Alemu [42] reported a comparatively high percentage (94.6%) of married respondents in a farmers' interview.

However, the chi-square test indicates that there is no significant relationship between the marital status of farmers and their perceptions of adopting SEC measures in the Sebeya catchment (χ^2 = 1.170, df = 9; p =0.9989).

In this study, the binary logistic analysis depicted that the marital status of the respondents correlated negatively with the adoption of SEC measures and was statistically insignificant at the 0.05 level (B = −0.220, p-value = 0.652), where the Wald statistics (0.203) also revealed the same insignificance.

Education level of the farmers

In order to analyze the impact of the farmers' education level on the willingness to adopt SEC measures, respondents were grouped into five categories as shown in Table 2: Illiterate (who cannot read and write), who can read and write, primary, secondary, and university education with 15%, 5%, 55%, 20%, and 5%, respectively. However, the chi-square test does not show a significant relationship between farmers' education level and their participation in SEC activities (χ^2 = 0.310, df = 12, p = 0.9999). Similar studies [30] also reported a chi-square test result that does not show a significant relationship between farmers' education and the level of participation in SEC activities (χ^2 = 3.155, p = 0.206). The educational level of respondents correlated negatively with the adoption of SEC measures at the 0.05 level (B = −0.1507; p-value = 0.216) but statistically insignificant. The Wald statistics (1.532) also revealed its insignificant association with adopting SEC measures. Similarly, Betela and Wolka [45] reported that education status was negatively correlated at an insignificant level.

On the contrary, our result does not corroborate the findings of recent studies, which documented the positive and significant effect of education in fostering the adoption of SEC measures [39,43,46]. Education determines farmers' management ability and awareness of all the available and newly proposed SEC measures. An illiterate farmer would likely be less motivated to try out new technologies for a better livelihood since he or she will not have the opportunity to obtain, understand, or use more information from social media, such as radio and television.

Farmland size

Table 2 shows that the majority of farmers (80%) have large farm sizes (>0.1 ha) compared to the other portion of farmers (20%) who have small farmland sizes (≤0.1 ha). A larger farmland size could push farmers to worry about soil erosion and its effects. Thus, it could positively influence their perceptions and adoption of SEC measures. Moreover, the chi-square test results showed a statistically significant relationship between farmland size and the adoption of SEC measures (χ^2 = 8.350, df = 3; p = 0.0393). Similar studies in Ethiopia found that farmland size positively affected farmers' perceptions and investment in SEC measures [43,47–49]. Furthermore, farmland size was found to exert a positive and significant effect on adopting SEC measures in Uganda [42,50].

Moreover, the binary logistic regression analysis revealed that the cultivated farmland size has a negative and insignificant impact on farmers' adoption of SEC measures (B = −2.225, p-value = 0.69). Throughout the literature [39], the size of farmlands had a negative and insignificant impact on farmers' adoption of SEC measures (B = −0.325, p-value = 0.849). The negative sign indicates that as the farmland size increases, the probability of adopting the SEC measures decreases [39,51]. Generally, large farmlands belong to old farmers who are not physically apt to execute the excessive labor required to implement SEC measures.

Main occupations in the farming system

In this study, 40% of farmers are engaged in farming for the agricultural business, 37.33 % for lack of other employment opportunities, and 22.67% for food security concerns. Table 2 shows three main farming jobs recognized among the interviewed farmers. They were grouped into three classes: A class of farmers who are not owners (7%), a class of farmers who are owners but not farm laborers (13%), and a class of farmers who are owners and daily laborers (80%). At the same time, the chi-square test indicates that the main occupation and the adoption of SEC measures have a significant association (χ^2 = 13.330, df = 6, p = 0.0380).

In this study, farmers in the owner and daily laborer class (80%) should be more motivated to participate fully in protecting their farms against soil erosion while reflecting the positive effects of adopting SEC measures. In summary, farmers who earn a higher income from agriculture tend to have a better perception of soil erosion as this influences their field practices to be more appropriate. Still, the main occupation in the present study was negatively and insignificantly correlated with the adoption of SEC measures with B = −335, p-value = 0.694, and the Wald statistics of 0.155.

Farming experience of respondents

Farmers' experience is another important factor to consider when improving farming practices and technologies. Our study revealed that the farming experience of respondents was positively correlated with the adoption of SEC measures in the study area and statistically significant at the 0.05 level (B = 0.749, p-value = 0.020). This assertion of significance was confirmed by the Wald statistics (5.440). More experienced farmers better understand the importance of improving SEC measures than less experienced farmers [52]. Similarly, Fekadu et al. [53] reported that farmers with more farming experience were more likely to participate in SEC initiatives.

Access to social media

In this study (Table 2), 17% of farmers have access to social media, against 83% with no access. Still, the chi-square test showed a significant relationship between access to social media and the farmers' adoption of SEC measures (χ^2 = 8.580, df = 3, p = 0.0353). This survey indicates that a reasonable proportion of farmers can use social media and obtain sufficient information on implementing SEC technologies. In a similar study, Betela and Wolka [45] reported the same result. Access to social media was associated positively and significantly with the adoption of SEC measures with B = 2.107, p-value = 0.027, and the Wald statistics of 4.880.

Farmers' access to credit

Practically, the accessibility of farmers to credit should indicate a greater likelihood of adopting SEC technologies than those without access. Credit availability may encourage farmers to invest more in yield-enhancing activities, such as adopting and implementing SEC measures in their farmlands. Throughout the literature, Wordofa et al. [52] reported access to credit of up to 66%, while 34% of farmers had no access to credit. In this study, only 24 % of farmers reported having obtained credit, while a large portion of the respondents (76%) needed it (Table 2). Furthermore, the chi-square test revealed that adopting SEC measures is significantly influenced by access to credit facilities (χ^2 = 11.870, df = 3, p = 0.0078).

However, access to credit correlated insignificantly and negatively with the adoption of SEC measures (B = −0.521, p-value = 0.536), as confirmed by the Wald statistics (0.384). Similarly, Karidjo et al. [54] reported that despite its significance at ($p < 0.001$), the access to credit variable was negatively correlated with the adoption of SEC measures. These results suggested that farmers who had access to credit from financial institutions were less likely to invest in adopting SEC technology.

To this end, the research question was: "Are there significant factors affecting farmers' willingness to adopt SEC measures in the Sebeya catchment"? The answer to this question necessitated using the chi-square test and the binary logistic regression model. Using the chi-square test on eight explanatory variables, gender, age of a farmer, land ownership, farmland size, access to social media, and access to credit were the remarkable influential factors strongly associated with SEC measures. At the same time, marital status and education did not. For deep analysis, some farmers' socioeconomic characteristics showed significant correlation while using the binary logistic regression model. In this study, farming experience and access to social media were positively correlated, while age and gender were negatively correlated with the adoption of SEC measures. However, other socioeconomic characteristics such as marital status, education level, farmland size, and access to credit revealed insignificance in adopting SEC measures.

4.3. SWOT Analysis

Table 8 exhibits the SWOT analysis of the performance and adoption of SEC measures in the Sebeya catchment.

Table 8. SWOT analysis of the performance and adoption of SEC measures in the Sebeya catchment.

Strength	**Weaknesses**
Reduction of topsoil and nutrient losses, soil compaction, and runoff.	Insufficient data for adequate planning.
Increase of organic matter while keeping high the soil depth and soil infiltration.	Lack of technical training in planning and implementing SEC measures.
Reduction of soil and water pollution with direct implications on biodiversity preservation.	Lack of incentives for sustainable implementation of SEC measures.
The intervention of the government and NGOs in promoting the BMPs of soil erosion control.	The control of soil erosion is not perfect: persistence of soil erosion (indicators and its effects).
Opportunities	**Threats**
Improvement and implementation of new SEC measures.	Climate change impacting crop yield expectations.
Large-scale adoption.	Excessive rainfall.
Increase in environmental awareness and support.	Financial restrictions.
Significant improvement in communication through social media.	Some technologies, bench terraces, check dams, hillside water tanks, retaining walls, and sediment basins, require high capital to invest in SEC measures. They are not affordable by an individual farmer.

4.4. Future Work

Farmers are the most direct perceivers of the development of soil erosion processes in their farmlands [55]. Therefore, many authors [56–59] have found that analyzing farmers' perceptions of soil erosion causes, effects, and control can provide quick and practical information for sustainable farmlands management [56,57].

The performance of the 22 SEC measures (written in italic in Table 4) was assessed, and SEC measures were proposed for implementation while including farmers' perceptions. The emphasis was on the adoptability of structural SEC measures and the afforestation of hillsides.

Relatively little work has systematically and simultaneously examined all three aspects (planning, adoption, and implementation) of SEC measures in the Sebeya catchment. In order to address this research gap, the current research presented an explorative investigation of various causes and effects of soil erosion, adoption, and implementation of SEC measures in the Sebeya catchment from the farmers' perspectives. In addition, further studies were proposed to assess various factors affecting farmers' willingness to participate in the planning process, implementation, and maintenance of SEC measures in the Sebeya catchment.

5. Conclusions and Recommendations

The main consequences of soil erosion in the Sebeya catchment are the reduction of agricultural productivity and water quality pollution. Therefore, its control is essential. This research was initiated to assess farmers' perceptions of soil erosion causes, effects, and control in the Sebeya catchment. It used a detailed survey of 75 farmers with structured interviews, field observation, and focus groups.

Various factors affecting farmers' adoption of SEC measures were assessed using SPSS (Version 20), the *t*-test, the chi-square test, and the binary logistic regression model. The chi-square test indicated that gender, the age of a farmer, land ownership, farmland size, access to social media, and access to credit were associated ($p < 0.05$) with SEC measures, while marital status and education were not. Moreover, the binary logistic regression model revealed that farming experience and social media access positively correlated significantly. In contrast, age and gender were negatively correlated at a 0.05 degree of significance with adopting SEC measures. On the other hand, marital status, education status, farmland size, and access to credit negatively influenced the adoption insignificantly.

In order to mitigate the high-rated soil erosion in the Sebeya catchment, this study suggests combining more than three soil erosion control measures on the same farmland. Moreover, the government should mobilize a skilled technical team to assist in implementing SEC measures within the Sebeya catchment.

To this end, this research recommends further studies to assess various factors affecting farmers' willingness to participate freely in the planning process, implementation, and maintenance of SEC measures in the Sebeya catchment.

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References

1. Simeneh, D.; Getachew, F. Evaluation of land use types and physical soil and water conservation structures in Wyebla watershed in Northern Ethiopia. *Int. J. Environ. Prot.* **2015**, *6*, 90–96.
2. Tegegne, M.; Biniam, S. Estimating Soil Erosion Risk and Evaluating Erosion Control Measures for Soil Conservation Planning at Koga Watershed, Highlands of Ethiopia. *Solid Earth Dis.* **2016**, *8*, 1–23.
3. Chen, G.; Zhang, Z.; Guo, Q.; Wang, X.; Wen, Q. Quantitative Assessment of Soil Erosion Based on CSLE and the 2010 National Soil Erosion Survey at Regional Scale in Yunnan Province of China. *Sustainability* **2019**, *11*, 3252. [CrossRef]
4. Issaka, S.; Ashraf, M.A. Impact of soil erosion and degradation on water. *Geol. Ecol. Landsc.* **2017**, *1*, 1–11. [CrossRef]
5. Borrelli, P.; Diodato, N.; Panago, P. Rainfall erosivity in Italy: A national scale spatio temporal Assessment. *Int. J. Digit. Earth* **2016**, *9*, 835–850. [CrossRef]
6. Antenah, G. *Farmers' Awareness about Land Degradation and Their Attitiudes toward Land Management: A Case of Sidama Zone, Aleta Wondo Wereda, Southern Ethiopia*; Addis Ababa University: Addis Ababa, Ethiopia, 2010.
7. Falcao, K.D.; Panachuki, E.O.; Monteiro, F.D.; Menezes, R.D.; Rodrigues, D.B.; Sone, J.S.; Oliveira, P.T. Surface runoff and soil erosion. *Surf. Runoff Soil Eros. A Nat. Regen. Area Braz. Cerrado* **2020**, *8*, 124–130.
8. Huang, X.L. The effects of farmers' adoption behavior of soil and water conservation measures on agricultural output. *Int. J. Clim. Change Strateg. Manag.* **2020**, *12*, 599–615. [CrossRef]
9. Bizoza, A.R.; De Graff, J. Financial cost-benefit analysis of bench terraces in Rwanda. *Land Degrad. Dev.* **2012**, *23*, 103–115. [CrossRef]
10. Debebbe, W.; Melaku, K.M. Farmers' perceptions' and participation on mechanical soil and water conservation techniques in Kembata Tembaro Zone: The Case of Kachabirra Woreda, Ethiopia. *Int. J. Adv. Struct. Geotech. Eng.* **2013**, *2*, 118–131.
11. Liu, X.B.; Zhang, X.; Wang, X.; Sui, Y.Y.; Zhang, S.L.; Herbert, S.J.; Ding, G. Soil degradation: A problem threatening the sustainable development of agriculture in Northeast China. *Plant Soil Environ.* **2010**, *56*, 87–97. [CrossRef]
12. Bagarella, G.; Lazzarin, R.; Noro, M. On the activation strategy of the chiller in water-loop self-contained refrigeration system: An experimental analysis. *Int. J. Refrig.* **2015**, *57*, 94–102. [CrossRef]
13. Munyaneza, O.; Majoro, F.; Hagenimana, E.; Usabyisa, W. Impact Assessment of Hillside Rainwater Harvesting Ponds on Agriculture Income: Case Study of Ntarama Sector in Rwanda. *J. Water Resour. Prot.* **2016**, *8*, 844–854. [CrossRef]
14. Karamage, F.; Zhang, C.; Ndayisaba, F.; Shao, H.; Kayiranga, A.; Fang, X.; Nahayo, L.; Nyesheja, M.E.; Tian, G. Extent of Cropland and Related Soil Erosion Risk in Rwanda. *Sustainability* **2016**, *7*, 609. [CrossRef]
15. IWRM. *Sebeya Catchment Plan 2018–2024*; Water for Growth Rwanda: Kigali, Rwanda, 2018.
16. MoE. *Mapping of Erosion in Rwanda and Guidelines for Erosion Control*; Ministry of Environment: Kigali, Rwanda, 2018.
17. Munyaneza, O.; Majoro, F.; Mutake, S.; Hagenimana, E. Performance Evaluation of Sediment Basins: Case Study of Keya Hydropower Plant in Rwanda. *J. Water Resour. Prot.* **2014**, *7*, 1387–1398. [CrossRef]
18. Thapa, B.S.; Dahlhaug, O.G.; Thapa, B. Sediment erosion in hydro turbines and its effect on the flow around guide vanes of Francis Turbines. *Renew. Sustain. Energy Rev.* **2017**, *49*, 1100–1113. [CrossRef]
19. NISR. *Demographic and Health Survey*; National Institute of Statistics in Rwanda: Kigali, Rwanda, 2014.
20. Taherdoost, H. Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. *Int. J. Acad. Res. Manag.* **2016**, *5*, 18–27. [CrossRef]
21. Faber, J.; Fonseca, L.M. How a Sample Size Influences Research Outcomes. *Dent. Press J. Orthod.* **2014**, *19*, 27–29. [CrossRef] [PubMed]
22. Kumar, R. *Research Methodology: A Step-by-Step Guide for Beginners*; SAGE publication Ltd.: New Dehli, India, 2011.
23. Kim, J.H. How to Choose the Level of Significance: A Pedagogical Note. *Minich Pers. RePEc Arch.* **2015**, 1–13. [CrossRef]
24. Tesfahunegn, G.B.; Ayuk, E.T.; Adiku, S.G. Farmers' perception on soil erosion in Ghana: Implication for developing sustainable soil management strategy. *PLoS ONE* **2021**, *16*, e0242444. [CrossRef] [PubMed]
25. Kleinbaum, D.G.; Klein, M. *Logistic Regression: A Self-Learning Text*, 3rd ed.; Springer: Atlanta, GA, USA, 2010.
26. Park, H.A. An Introduction to Logistics Regression: From Basic Concepts to Interpretation with Particular Attention to Nursing Domain. *J. Korean Acad. Nurs.* **2013**, *43*, 154–164. [CrossRef]
27. Sakinc, I.; Ugurlu, E. Logistic Regression Analysis to Examine Factors Affecting Gender Diversity on the Boardroom: ISE Case. *Int. J. Bus. Soc. Sci.* **2013**, *4*, 57–61.
28. NISR. *Agricultural Household Survey*; National Institute of Statistics in Rwanda: Kigali, Rwanda, 2021.
29. Stockemer, D. *Quantitative Methods for Social Sciences: A Practical Introduction with Examples in SPSS and Data*; Springer: Ottawa, ON, Canada, 2019.
30. Biratu, A.A.; Asmamaw, D.K. Farmers' perception of soil erosion and participation in soil and water conservation activities in the Gusha Temela watershed, Arsi, Ethiopia. *Int. J. River Basin Manag.* **2016**, *4*, 329–336. [CrossRef]
31. Misebo, A.M. The role of agronomic practices on soil and water conservation in Ethiopia: Implication for climate change adaptation: A review. *J. Agric. Sci.* **2018**, *10*, 227–237. [CrossRef]
32. Belay, T.T. Perception of Farmers on Soil Erosion and Conservation Practices in Dejen District, Ethiopia. *Int. J. Environ. Prot. Policy* **2020**, *2*, 224–229. [CrossRef]
33. Amenu, L.; Megersa, T. Factors Influencing Soil Erosion Management Practices in Ejersa Lafo District, West Showa Zone, Oromia, Regional State, Ethiopia. *J. Appl. Sci. Environ. Manag.* **2021**, *5*, 79–85.

34. Pravat, K.S.; Gourie, S.B.; Ramkrishna, M. Farmers' perceptions of soil erosion and management strategies in South Bengal in India. *Eur. J. Geogr.* **2015**, *6*, 85–100.
35. IWRM. *Catchment Plan Sebeya 2017–2023*; Water for Growth: Kigali, Rwanda, 2017.
36. IWRM. *Feasibility Study and Detail Design of the Early Implementation Project on Sebeya Catchment*; Ministry of Foreign Affairs, Embassy of the Kingdom of the Netherland: Kigali, Rwanda, 2016.
37. Onu, F.M.; Mohammed, A. Competency improvement needs of farmers in soil erosion prevention and control for enhancing crop production: Case study of Kogi State, Nigeria. *Agric. Sci.* **2014**, *5*, 958–963. [CrossRef]
38. Turhan, N.S. Karl Pearson's chi-square tests. *Educ. Res. Rev.* **2020**, *15*, 575–580.
39. Asfaw, D.; Neka, M. Factors affecting adoption of soil and water conservation practices: The case of Wereillu Woreda (District), South Wollo Zone, Amhara Region, Ethiopia. *Int. Soil Water Conserv. Res.* **2017**, *5*, 273–279. [CrossRef]
40. Senkoro, A.J. *Impact of Soil Erosion Control Practices on Household Food Security and Income: A Case of East Usambara Highlands, Tanzania*; Sokoine University of Agriculture: Morogoro, Tanzania, 2010.
41. Nigussie, Z.; Tsunekawa, A.; Haregeweyn, N.; Adgo, E.; Nohmi, M.; Tsubo, M. Farmers' perception about soil erosion in Ethiopia. *Land Degrad. Dev.* **2017**, *28*, 401–411. [CrossRef]
42. Alemu, M.D. Farmers' Perception of Soil Erosion and Adoption of Soil Conservation Technologies at Geshy Sub-Catchment, Gojeb River Catchment, Ethiopia. *Agric. Sci.* **2019**, *10*, 46–65. [CrossRef]
43. Belachew, A.; Mekuria, W.; Nachimuthu, K. Factors influencing adoption of soil and water conservation practices in the northwest Ethiopian highlands. *Int. Soil Water Conserv. Res.* **2020**, *8*, 80–89. [CrossRef]
44. Nadhomi, D.L.; Tenywa, J.S.; Musali, P.; Nakileza, B.R. Farmers' Perception of Erosion Risk and Its Implication on the Adoption of Soil and Water Conservation Practices. *Int. J. Adv. Agric. Sci. Technol.* **2013**, *2*, 28–44.
45. Betela, B.; Wolka, K. Evaluating soil erosion and factors determining farmers' adoption and management of physical soil and water conservation measures in Bachire watershed, southwest Ethiopia. *Environ. Chall.* **2021**, *5*, 100348. [CrossRef]
46. Mango, N.; Makate, C.; Tamene, L.; Mponela, P.; Ndengu, G. Awareness and adoption of land, soil and water conservation practices in the Chinyanja Triangle, Southern Africa. *Int. Soil Water Conserv. Res.* **2017**, *5*, 122–129. [CrossRef]
47. Teshome, A.; de Graaff, J.; Kassie, M. Household-Level determinants of soil and water conservation adoption phases: Evidence from North-Western Ethiopian highlands. *Environ. Manag.* **2016**, *57*, 620–636. [CrossRef]
48. Moges, D.M.; Taye, A.A. Determinants of farmers' perception to invest in soil and water conservation technologies in the North-Western Highlands of Ethiopia. *Int. Soil Water Conserv. Res.* **2017**, *5*, 56–61. [CrossRef]
49. Sileshi, M.; Kadigi, R.; Mutabazi, K.; Sieber, S. Determinants for adoption of physical soil and water conservation measures by smallholder farmers in Ethiopia. *Int. Soil Water Conserv. Res.* **2019**, *7*, 354–361. [CrossRef]
50. Mugonola, B.; Deckers, J.; Poesen, J.; Isabirye, M.; Mathijs, E. Adoption of soil and water conservation technologies in the Rwizi catchment of south western Uganda. *Int. J. Agric. Sustain.* **2013**, *11*, 264–281. [CrossRef]
51. Alufah, S.; Shisanya, C.A.; Obando, J.A. Analysis of Factors Influencing Adoption of Soil and Water Conservation Technologies in Ngaciuma Sub-Catchment, Kenya. *Afr. J. Basic Appl. Sci.* **2012**, *4*, 172–185.
52. Wordofa, G.M.; Okoyo, E.N.; Erkalo, E. Factors influencing adoption of improved structural soil and water conservation measures in Eastern Ethiopia. *Environ. Syst. Res.* **2020**, *9*, 2–11. [CrossRef]
53. Fekadu, B.; Yenealem, K.; Jema, H.; Belaineh, L. Impact of integrated soil and water conservation program on crop production and income in West Harerghe Zone, Ethiopia. *Int. J. Environ. Monit. Anal.* **2013**, *1*, 11–120.
54. Karidjo, B.Y.; Wang, Z.; Boubacar, Y.; Wei, C. Factors Influencing Farmers' Adoption of Soil and Water Control Technology (SWCT) in Keita Valley, a Semi-Arid Area of Niger. *Sustainability* **2018**, *2*, 288. [CrossRef]
55. Guo, X.; Zhou, L.; Chen, Y.; Zhao, M.; Wang, R. Perception and adaption of ecological environment change for farmers in the typical desertification area: A case of hangjin banner in the Inner Mongolia autonomous region. *J. Arid. Land Resour. Environ.* **2017**, *31*, 64–69.
56. Aniah, P.; Wedamb, E.; Pukunyiemc, M.; Yinimid, G. Erosion and livelihood change in North East Ghana. *Int. J. Sci. Basic Appl. Res.* **2013**, *7*, 28–35.
57. Peprah, J.A.; Afoakwah, C.; Isaac, K. *Crop Yield Volatility among Smallholder Farmers in Ghana*; UNU-INRA: Accra, Ghana, 2016.
58. Tesfahunegn, G.B.; Tamene, L.; Vlek, P.L. Evaluation of soil quality identified by local farmers in Mai-Negus, Northern Ethiopia. *Geoderma* **2011**, *163*, 209–218. [CrossRef]
59. Kusimi, J.M.; Yiran, G.A. Application of local knowledge in land degradation assessment in the Bawku East Municipality. *Ghana J. Geogr.* **2011**, *3*, 88–125.