

The Impact of Adopting Sustainable Farming Practices on Increasing Crop Yields in Rwanda. Ngororero District Case (2020-2025)

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ABSTRACT

OBJECTIVE: To investigate the impact of adopting sustainable farming practices on increasing crop yields in Rwanda. Ngororero District Case (2020–2025).

METHODOLOGY: This descriptive study was carried out in Ngororero District. Both qualitative and quantitative methods were used in the investigation. 329 smallholder farming /Members of cooperatives were sampled by only 290 respondents' responses were taken for analysis. Primary data were collected through structured questionnaires and interview. Quantitative data was analyzed using descriptive statistics with the aid of SPSS software, while qualitative data was subjected to thematic content analysis.

RESULTS: The findings demonstrated that 100% farmers agreed that they adopted terrace farming practices, 94.9% adopted agroforestry practices and 92.3% adopted climate-Smart Agriculture practices to enhance crop yields in Ngororero district. Furthermore, the findings revealed the levels of farmers' adoption of sustainable farming practices was high by 62.4% of the farmers' responses and level of crop yields is indicated by the Crop yield per area (measured in tons per hectare), increased harvest weight, value of crop production per household, Benefit-Cost Ratio of production and High-Yield Seed Varieties as well as Input efficiency specifically Water Use Efficiency and Fertilizer Use Efficiency. Moreover, the study found out that 83.7% of variation in crop yield enhancement in Ngororero District is explained by sustainable farming practices adoption.

CONCLUSIONS AND RECOMMENDATIONS: Conclusively, The development of mixed farming (crops and livestock) has improved nutrient cycling, with farmers employing manure to improve soil quality and yields. The study findings recommend that policy makers and stakeholders prioritise support for SFP adoption through comprehensive agricultural policies, capacity-building initiatives, and investment in agricultural research and development to contribute to achieving the sustainable development goals, particularly goal related to zero hunger and goal 12 related to the responsible consumption and production.

KEYWORDS: *Agricultural, Agricultural productivity, Crop yield enhancement, Farmers & Sustainable farming practices*

I. INTRODUCTION

1.1. Background and problem statement

The necessity of embracing sustainable farming practices extends globally, despite their limited adoption rates (Chao et al., 2024 and Benitez-Altuna *et al.*, 2024). By 2030, eradicating hunger and achieving global food security is the second goal of the United Nations Sustainable Development Goals (Kumar and Pant, 2023). However, the planet's swiftly changing climate, marked by more severe and unpredictable weather patterns, poses a significant threat to crop yields (Singh *et al.*, 2023 and Kassa and Abdi, 2022). Currently, the agricultural industry in Africa is confronted with issues related to climate change, resource depletion, and the need to reduce its environmental footprint (Sinore and Wang, 2024). Rwanda agriculture has seen growth in the recent past, the 2020 Government of Rwanda (GoR) leadership retreat asserted that "Agriculture is not fulfilling its potential for increasing GDP and reducing the trade deficit (Niyongabo, 2024). In Ngororero district, agriculture remains the economic mainstay, with over 85% of households depending on crop production and livestock rearing for their livelihoods (MINAGRI, 2018). The district benefits from a favorable tropical highland climate with bimodal rainfall patterns that support two growing seasons annually, making it suitable for cultivating crops including beans, maize, cassava, Irish potatoes, and

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bananas (Mukuralinda et al., 2016). Ngororero District's ongoing low agricultural productivity can be linked to a number of issues, including climate variability (Nkurunziza et al., 2021) and intensive cultivation without proper soil conservation measures, which have caused severe soil erosion and nutrient depletion (Karamage et al., 2016). Reduced crop yields and deteriorating soil fertility have also been caused by monocropping systems, excessive reliance on inorganic fertilizers, restricted use of organic manure, and a lack of understanding of contemporary agricultural practices (Birasa et al., 2021). In response, the district administration and development partners such as the World Agroforestry Centre have implemented programs promoting radical terracing, agroforestry systems, farmer field schools, and organic farming practices (Ndoli *et al.*, 2018; Bucagu *et al.*, 2013). Despite these efforts, systematic documentation of adoption rates and impacts on household-level crop yields remains limited, necessitating comprehensive assessment to guide future interventions. This is because it is unclear which combinations of sustainable practices result in the biggest increases in crop yields, what factors influence farmers' adoption decisions, and what obstacles stand in the way of a wider adoption of these advantageous practices. Through a methodical evaluation of the connection between crop productivity results and sustainable farming methods, this study will produce the data required to guide policy interventions, bolster agricultural extension initiatives, maximize resource allocation, and ultimately contribute to improved food security and sustainable agricultural development in Ngororero District and similar contexts across Rwanda. Based on the problems described in the background, the researcher found out a problem which can be identified: (i) What are diverse types of sustainable farming practices adopted by smallholder farmers in Ngororero District?, (ii) What is the level of crop yield among smallholder farmers before and after the adoption of sustainable farming practices in Ngororero District? And (iii) Is there any relationship between sustainable farming practices and crop yield enhancement among smallholder farmers in Ngororero District?

II. LITERATURE REVIEW

2.1. Theoretical review

The main theory underlying this study are The Technology Acceptance Model (TAM) and The theory of planned behavior. The Technology Acceptance Model (TAM) was developed by Fred Davis in 1986 and formally published in 1989. The implication of ATM theory for this study is that the TAM can predict farmer adoption and non adoption to modern agricultural approaches. The Technology Acceptance Model (TAM) is used to explain the impact of sustainable farming practices on crop yield by focusing on the psychological, attitudinal, and cognitive factors that influence a farmer's decision to adopt these methods. While the agronomic impact of sustainable farming (like soil health or water retention) directly affects yield, the TAM explains the human side: why and how a farmer adopts these methods, which in turn determines the long-term, sustained increase in yield. The Theory of Planned Behavior (TPB) was developed by Icek Ajzen in 1991 as an extension of the Theory of Reasoned Action (Ajzen, 1991). The theory helps explain the adoption behavior of farmers regarding sustainable practices. Understanding whether farmers in Ngororero District adopt sustainable farming techniques requires examining not just their knowledge of these practices, but their attitudes toward them, their perceptions of social expectations, and their confidence in their ability to implement such practices successfully (Wauters *et al.*, 2010). By applying the Theory of Planned Behavior, this research can systematically analyze the factors influencing farmers' adoption of sustainable practices in Ngororero District, thereby providing a comprehensive understanding of how these practices impact yield enhancement and identifying pathways for more effective promotion of sustainable agriculture in the region.

2.2. Conceptual framework

Under this section the researcher explains the connection between independent and dependent variables with the intervening one which might upset them. According to Kaplan (2002), conceptual framework is a researcher's own position on the problem that gives direction to the study. An independent variable is that factor which affects or regulates a dependent variable (Jabareen, 2008) while dependent variable is a variable reliant on another variable such as independent variable (Mugenda and Mugenda, 2012).

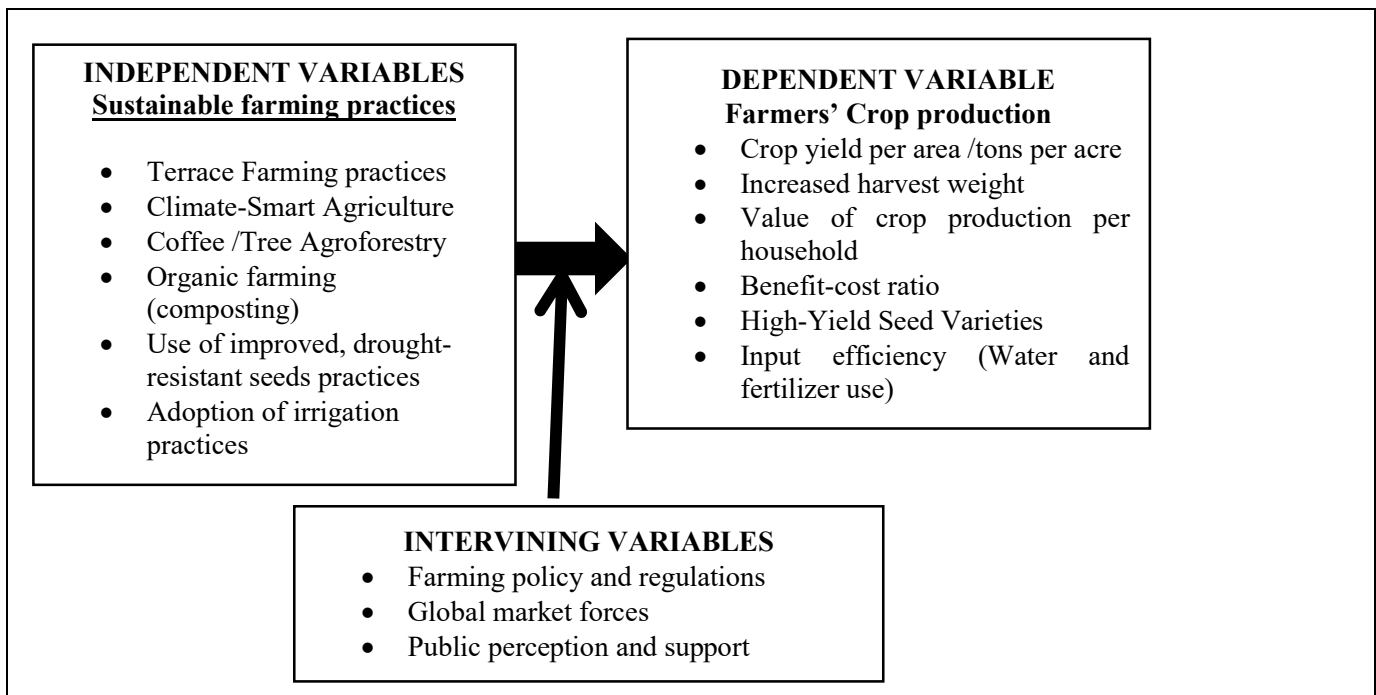


Figure 1.1. Conceptual framework adopted for this stud. **Source :** Researcher' own design (2026)

The study's two key variables are the independent variable and the dependent variable, as seen in figure 1.1. The dependent variables are the result of the independent factors, whereas the researcher controls or manipulates the independent variables to see their impact. Terrace farming, climate-smart agriculture, coffee and tree agroforestry, organic farming (composting), the use of improved, drought-resistant seeds, and the adoption of irrigation techniques are examples of sustainable farming practices that are the study's independent variable. The dependent variable, yield enhancement, can be represented by yield per unit area, total production volume, food provision capacity, yield stability and consistency, and increased crop biomass. The relationship between the independent variables and dependent variables is supported by intervening variables comprising farming policy and regulation, global market forces and public perception and support.

2.3.Emprical review

Numerous studies have tried to evaluate the effect of adopting sustainable agricultural practices on increasing crop yield. For example, Matsuura and Okamoto conducted a cross-survey study in Japan to evaluate the impact of sustainable farming practices on rice production. They used an instrumental variable estimation technique with a sample of 530 small holder farmers (Matsuura and Okamoto, 2018). The results showed that sustainable farming practices in Japan have a complex impact on productivity, often showing initial, minor yield reductions in some areas, like rice farming, but leading to long-term benefits like better soil fertility and resource management. A study on the impact of water-saving irrigation techniques on crop production levels in South Africa was carried out by Steffen et al. (2015). Seventy cooperatives were included in the longitudinal research design. Surveys and cooperative production reports from 2011 to 2015 were used to gather data. While both qualitative and quantitative analysis were employed for data analysis, SPSS was utilized for data display. The results showed that farmers may increase water-use efficiency by 50% by employing water-saving irrigation systems, which would improve crop yields during dry spells. Matiya (2014) conducted a study on the effect of Sustainable agricultural practices improve food security by increasing crop yields and diversity in Uganda. The study revealed that Sustainable agricultural practices improve food security by increasing crop yields and diversity, enhancing soil health, and promoting more efficient use of resources, sustainable methods helped local communities in Kasese District to access a steady supply of fresh food. Similarly, precision agriculture in Iowa and regenerative agriculture in the district contributed to more stable food production by optimizing resource use and making farming systems more resilient to climate variability.

2.4. Research gap identification

Despite the extensive global literature on sustainable agriculture and its potential for enhancing crop productivity, significant knowledge gaps remain regarding the specific impacts of sustainable farming practices on crop yields in the Rwandan context, particularly at the district level. While theoretical frameworks such as diffusion of innovation theory and technology acceptance models have been widely applied to understand agricultural innovation adoption globally, their application to

Rwanda's unique agricultural landscape characterized by high population density, hilly terrain, mandatory land consolidation policies, and cooperative-based extension systems remains limited. The literature predominantly focuses on national-level assessments or selected regions, leaving substantial gaps in understanding district-specific variations in adoption patterns and yield impacts. This study addresses these gaps by providing contextualized, empirical evidence on the impacts of sustainable farming practices on crop yield enhancement in Ngororero District, employing rigorous methodologies to establish causal relationships while examining both the determinants of adoption and the heterogeneous effects across different farmer characteristics and practice types.

III.METHODS AND MATERIALS

3.1. Description of study area

This study has been conducted in Ngororero District, Western Province of Rwanda, with specific focus on five sectors including Muhororo, Hindiro, Ndaro, Kageyo and Bwira sectors, located in Rwanda's Western Province, is characterized by its hilly terrain, fertile soils, and a predominantly rural population totaling 367,955 people, located in 13 sectors, residing on 679 km², with population density of 551 km². The district's topography, with its steep slopes and high elevation, makes it highly susceptible to landslides, particularly during the rainy season. This susceptibility has been exacerbated by factors such as deforestation, poor land-use practices, and increased rainfall due to climate change. The primary livelihood activities in the district include subsistence farming, small-scale trade, and animal husbandry. The fertile soils support the cultivation of various crops such as maize, beans, and potatoes, which are staple foods for the local population. The farming sector is at high risk due to the changing climate reducing the total yield production; which necessitate the need for adopting sustainable agriculture practices (Fashaho *et al.*, 2024). By focusing on these areas, the study aims to provide a deeper understanding of the impact of adopting sustainable agriculture practice on crop yield enhancement in this area.

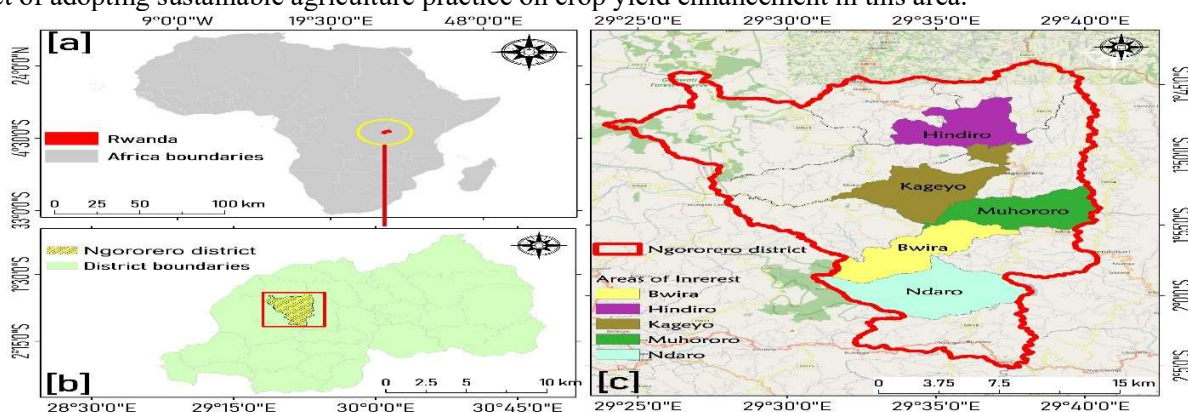


Figure 3.2: Map of study area in Ngororero District)

3.2. Research approaches and design

According to Kumar (2017), a research design provides a predetermined plan that guides how a study is conducted, ensuring that the answers to research questions are accurate, unbiased, reliable, and cost-effective. In line with this understanding, the present study titled the impact of sustainable farming practices adoption on crop yield enhancement in Rwanda's Ngororero District adopted a descriptive survey design because the data collected was mainly concerned with the respondents' opinions and attitudes while practicing agricultural activities on their farms while in the process adopting modern farming technologies as small scale farmers, or either as extension officers and research scientists facilitating the modern technology adoption process. Descriptive survey highlights an accurate quantitative or numeric description and depiction of the respondents', opinion, beliefs and abilities (Creswell & Creswell, 2023). The purpose of descriptive research is to determine and report the way things are happening thus helping in establishing the current status of the population under study (Fetters, 2020). Descriptive survey is used in preliminary studies to enable researchers gather information and interpret data for clarification. This design was chosen because it ensured reliability of the data collected for interpretation (Cohen & Morrison, 2021).

3.3. Study population , sample size and sampling techniques

The target population of this study consists of 1868 farmers in three agricultural cooperatives (COTRAGAGI (Cooperative for Tea Growers), Ngororero Abahuzamugambi Women Cooperative (NAWC) and Kopiguka Cooperative is a coffee-producing cooperative) operating in five selected sectors in Ngororero District. A sample of 329 farmers was computed by applying the Yamane's simplified formula (Yamane, 1992) as follows:

$$n = \frac{N}{1+(a^2)N} \quad \text{Where; } n = \text{sample size} \quad N = \text{total population} \quad a = \text{error of 5\% or 0.05}$$

$$n = \frac{1868}{1+(0.05^2)1868} \text{ or } n = \frac{1868}{1+4.67} \text{ or } n = \frac{1868}{5.67} = 329.45 \cong 329 \text{ Cooperative members}$$

3.4. Sample collection

The study employed a combination of stratified random sampling and purposive sampling techniques to ensure comprehensive data collection from diverse stakeholders in the agricultural sector. Stratified random sampling was used to select 329 smallholder farmers. Purposive sampling was applied for selecting 15 key informants including 5 local leaders (1 per sector), 5 agriculture extension officers (1 per sector) and 5 agronomists (1 per sector). This purposive approach allowed for the deliberate selection of information-rich cases who can provide in-depth insights into agricultural practices, extension services, policy implementation, and farmer organization dynamics.

3.5.Types of data and research tools

Both primary and secondary sources of data was used in this study, and they were gathered using a variety of methods to guarantee a thorough comprehension of the research topic. Primary data was collected using survey questionnaire, key informant interviews and field observations. Secondary data sources are like libraries or other sources that have data collected in other researchers' works. Therefore, the researcher gained these data through consulting different electronic resources and books from libraries.

3.6. Data analysis and processing

In the quantitative section, the processing of the collected data was done through coding, editing, and tabulation. In descriptive statistics, mean and standard deviation was tabulated. For inferential statistics, Pearson correlation and regression analysis was employed. Pearson correlation determined the relationship between variables. Regression analysis was examined whether there is a significant relationship between the variables, helping to determine predictors of crop yield enhancement in Ngororero district.

iv.RESULT PRESENTATION AND DISCUSSION

The present study applied quantitative analysis employing statistical analysis using IBM SPSS statistics version to evaluate data. Quantitative data collected using questionnaires were analyzed using SPSS using descriptive statistics, the researcher used frequencies and percentages to interpret the findings.

4.1. Results presentation

4.1.1. Types of sustainable farming practices in Ngororero District

The first study objective sought to find out the Types of sustainable farming practices in Ngororero District

Table 4.1. Types of sustainable farming practices in Ngororero District

Types of sustainable farming practices in Ngororero District	Agreement (SA & A)		Disagreement (D & SD)		Mean	Std
	F	%	F	%		
Terrace farming is adopted by the farmers to enhance resilience, improve soil health, and combat erosion in hilly terrain.	290	100	0	0.0	4.99	0.834
Farmers in Ngororero District adopted Climate-Smart Agriculture as SFP	268	92.3	12	4.1	4.67	0.671
Coffee Agroforestry is adopted by the farmers to stabilize soil and improve biodiversity.	281	94.9	9	2.1	4.89	0.706
Organic farming (composting) is adopted to enhance resilience, improve soil health, and combat erosion in hilly terrain	271	93.4	19	6.4	4.01	0.809
Use of improved, drought-resistant seeds is adopted by the farmers in Ngororero District	261	90.0	29	10.0	4.68	0.467
Adoption of irrigation systems, such as solar-powered or manual pumps to ensure year-round cultivation and reduce reliance on rain-fed agriculture.	243	87.3	47	12.7	4.09	0.613
Overall mean value (μ)					4.555	0.6833

The results from Table 4.1 show that the overall mean of agreement is high ($\mu = 4.555$, High mean), and the overall standard deviation is (STD = 0.6833, low standard deviation). This High mean indicates that the respondents tend to strongly agree with the statements related to the types of sustainable farming practices adopted by the farmers in Ngororero District. The low standard deviation shown above, in Table 4.2, indicates that the results are more representative of the population and that there is less variability in the measured variable. Considering these points together, the farmers in Ngororero District, adopt several sustainable Farming practices to enhance agricultural productivity, to enhance resilience, improve soil health, and combat erosion in hilly terrain. Home gardens and incorporating tree species into agricultural areas (such as intercropping with coffee or beans) to improve soil fertility, give shade, and fix nitrogen. Terrace farming, agroforestry, organic farming (composting), and the adoption of enhanced, drought-resistant seeds are the main techniques. Particularly in regions like Kageyo, Kavumu, and Muhanda, farmers implement improved bean seeds, liming, and liquid organic fertilizers to improve soil acidity and fertility, as well as post-harvest management (using hermetic bags and sheeting to reduce crop loss) to manage steep terrain. They also construct terraces to prevent soil erosion and improve water management. These programs, which are frequently supported by the Rwanda Climate Change and Development Network, are essential for boosting food security while addressing environmental challenges.

4.1.2. Level of crop yield among smallholder farmers before and after the adoption of sustainable farming practices in Ngororero District

In the table 4.2 above the researcher set out to find out the indicators of crop yield among smallholder farmers brought about by sustainable farming practices in Ngororero District. The results were analyzed used mean and standard deviations so as to drawing conclusions from the survey. The results are discussed as follows:

Table 4.2 .Level of crop yield among smallholder farmers in Ngororero District

Level of crop yield among smallholder farmers in Ngororero District	Agreement (SA & A)		Disagreement (D & SD)		Mean	Std
	F	%	F	%		
Crop yield per area (measured in tons per hectare is a primary indicator of the effectiveness of sustainable farming practices	287	98.9	4	1.1	4.81	0.690
Increased harvest weight in Ngororero District serves as a direct, quantifiable indicator of higher crop yields.	290	100	0	0.0	4.98	0.201
The value of crop production per household indicates level of crop yields by translating physical harvest quantities into monetary terms	261	90.0	29	10.0	4.48	0.919
The Benefit-Cost Ratio (BCR) indicates the level of crop yields by measuring the economic efficiency of production.	271	93.4	19	6.4	4.71	0.469
High-Yield Seed Varieties serve as a key indicator of elevated crop yields by dramatically increasing the productivity per hectare.	281	96.9	18	5.1	4.55	0.467
Input efficiency serves as a primary indicator of crop yield levels by measuring how effectively a plant converts applied resources into biomass or grain.	225	77.6	65	22.4	4.00	1.011
Overall mean (μ)					4.588	0.626

F: Frequency, %: Percentage SA: Strongly agree A: Agree D: Disagree and SD:

The results from Table 4.2 show that the overall mean of agreement is high ($\mu = 4.588$, high mean) and the overall standard deviation is 0.62613. This high mean suggests that the respondents tend to agree with the statements. This implies that respondents knew well the indicators of the level of crop yields in Ngororero District. The low standard deviation indicates

that the results are more representative of the population, with less variability in the measured variables. So, basing on quantitative data, the farmers in Ngororero District, the level of crop yields is indicated by the Crop yield per area.

Table 4.3: Level of sustainable farming practices adoption by farmers

Level of sustainable farming practices adoption by farmers	Frequency	Percentage
High adopted	181	62.4
Medium adopted	90	31.0
Low adopted	19	6.6
Total	290	100.0

Source: Primary data (2026)

The findings in table 4.3 showed that 62.4% of the farmers recorded high adaptation, 31.0% farmers recorded medium adoption, and only 6. % of the farmers had low adoption of sustainable farming practices adoption by farmers. The interview result revealed that sustainable farming practices adoption in the Ngororero district is driven by urgent climate-smart initiatives, land husbandry programs, and agro-processing goals, but faces challenges from mountainous terrain and high poverty rates. The district is experiencing a transition towards improved seed varieties, terrace farming, and soil management, with a high proportion of agricultural land covered by erosion control measures (68.5% as of EICV5 reporting, with 15.9% under land consolidation) (Ngororero District report, 2025). The overall trend shows a shift towards more sustainable, climate-resilient practices through training and cooperative movements (such as the Nkunganire program), significantly increasing yields in areas where sustainable techniques are applied.

4.1.3. Relationship between the adoption of sustainable farming practices and crop yield enhancement among smallholder farmers in in Ngororero District

Under this section the researcher explains the connection between independent and dependent variables with the intervening one which might upset them.

Table 4.4. Correlation between the adoption of sustainable farming practices and crop yield enhancement among smallholder farmers in in Ngororero District

		Sustainable Framing practices	Crop Yield enhancement
Sustainable Framing practices	Correlation	1	0.837**
	Coefficient		
	Sig. (2-tailed)	.	0.000
	N	290	290
Crop Yield enhancement	Correlation	0.837**	1.
	Coefficient		
	Sig. (2-tailed)	0.000	.
	N	290	290

****.** Correlation is significant at the 0.01 level (2-tailed), N: Sample Size Sig.: Significance and r: Correlation coefficient

Source: Primary data (2026)

Correlational coefficient was computed to show whether there is significant impact of of sustainable farming practices adoption on crop yield enhancement in Ngororero District. A high positive value ($r = 0.837$, $p < 0.01$) was obtained to mean that 83.7% of variation in crop yield enhancement in Ngororero District is explained by sustainable farming practices adoption. The researcher went ahead to depict the impact of sustainable farming practices adoption on crop yield enhancement in Rwanda's Ngororero District. Regression analysis was used and the results are depicted in Table 4.5.

Table 4.5. The impact of sustainable farming practices adoption on crop yield enhancement in Rwanda's Ngororero District

Model	R	R- Square	Adjusted R Square	β	p-value
1	.807	.651	.637	.282	.000

• Predictor: Sustainable farming practices β : Beta

- Criterion: Crop yield enhancement

Source: Primary data (2026)

Findings in the Table 4.5 shows a significant contribution of the sustainable farming practices on crop yield enhancement ($\beta = .282, p = .000 < .05$). To clarify this, the results mean that a one- unit increment in sustainable farming practices will result in .282 units of increase in crop yield. This allows the researcher to confirm that the major objective of the study was achieved and confirm that sustainable farming practices adoption significantly affect the crop yield enhancement in Rwanda's Ngororero District.

Table 4.6: ANOVA for the impact of sustainable farming practices adoption on crop yield enhancement in Ngororero District

ANOVA^a

Modal		Sum of squares	df	Mean		
1	Regression	209.502	1	167.239	30.185	.000 ^b
	Residual	286.333	289	15.650		
	Total	495.835	290			

a. **Dependent variable:** Crop yield enhancement df: Degree of freedom

b. **Predictor (Constant):** Sustainable farming practices

An ANOVA was conducted at 5% level of significance. A comparison of F-calculated and F-critical is shown in the Table 4.6. From the findings, F-calculated is 30.185 and F (1, 75) is 3.968. Since the value of F Calculated is greater than F Critical, this indicates the overall regression was significant for the study. The p value $p = 0.00$ is less than 0.05 an indication that the Soil erosion control, organic soil fertility management, climate-Smart crop selection and Agroforest significantly increase crop yields (Crop yield per area, increased harvest weight, value of crop production per household, Benefit-Cost Ratio and High-Yield Seed Varieties as well as input efficiency serves).

Table 4.7. Coefficients for sustainable farming practices and enhanced crop yield in Ngororero District

Variables		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.764	1.36		-19.861	.000
	Sustainable farming practices	1.543	.029	0.985	50.525	.000

Source: Own survey (2026) $P < 0.05$ T: Test and Std: Standard error

***Dependent variable: crop yield enhancement

The results in Table 4.7 indicate that there is a positive and significant influence of sustainable farming practices on crop yield enhancement in Ngororero District. Meaning that as the independent variable increases (sustainable farming practices), the dependent variable (Crop yield enhancement) tends to increase by 1.543 units while holding constant other variables, like farming policy and regulation, global market forces and public perception and support. Finally, the regression results revealed that SFP (Sustainable Farming Practices) has a significant positive effect on crop yield enhancement as indicated by $\beta_3 = 0.985, t = 50.525, p = 0.000 < 0.05$. The implication is that an increase of one- unit in SFP will increase the crop yield enhancement by 0.837.

4.2. Discussion of findings

First and foremost, the results showed that all respondents (100%) agreed that farmers in Ngororero District use terraced farming to improve soil health, increase resilience, and prevent erosion in hilly areas. Nonetheless, Climate-Smart Agriculture was adopted as SFP by 92.3% of farmers. Additionally, 94.9% of respondents said that coffee agroforestry is used by farmers to stabilize soil and enhance biodiversity. The current finding was in line with the interview results that the farmers. The interview results revealed that the important sustainable farming techniques used consist of: In order to increase soil structure and crop resistance, especially in areas like Kageyo, Kavumu, and Muhanda, improved, climate-resilient bean seeds, limes, and liquid organic fertilizers are introduced as part of soil erosion control and climate-smart agriculture". The findings are also in line with the studies conducted in similar settings in Ethiopia by Mekelle (2024). He found out that in agroforestry systems, growing both cash crops and medicinal plants significantly raises rural crop yields. Eriksen et al. (2025) and Quinion et al., (2024) found almost similar results that by generating tree products like timber, firewood, food and construction

materials, agroforestry also enhances the socioeconomic status of the farmers through the income generation (Eriksen et al. 2025) and contributes to the environmental protection and conservation (reduces soil erosion, increases soil moisture and fertility, and maintains microclimate equilibrium) (Quinion et al, 2024) and enhanced the overall agricultural yields and productivity (Mutyasira, et al, 2018).

Second, the Field results in Table 4.3, the levels of farmers' adoption of sustainable farming practices was high by 62.4% of the farmers' responses, medium adoption by 31.0% farmers' recorded and low adoption as highlighted by 6. % of the farmers' perception. The results obtained using interview guide indicated that sustainable farming practices adoption in the Ngororero district is driven by urgent climate-smart initiatives, land husbandry programs, and agro-processing goals, but faces challenges from mountainous terrain and high poverty rates. The interview results revealed that sustainable land management techniques, such as the use of lime and organic fertilizer, improve soil nutrient retention and water-holding capacity, resulting in significant yield improvements. This was supported by Musoni's view that in the Western Province, smallholder farmers in Ngororero District are increasing their adoption of sustainable farming practices such as agroforestry, soil erosion control, and organic fertilizer use which correlates with enhanced crop yields and improved soil health (Musoni, 2025).

Third and last, The Correlational coefficient was computed to show whether there is significant impact of sustainable farming practices adoption on crop yield enhancement in Ngororero District. A high positive value ($r = .837$, $p < 0.01$) was obtained to mean that 83.7% of variation in crop yield enhancement in Ngororero District is explained by sustainable farming practices adoption. The finding was greater as compared with the former studies that were done in India (54%) (Saqib and Saqib, 2023). Malaysia (47%) (Verdoodt and Van Ranst, 2023) and Indonesia (64.7%) (Vermunt, 2020). In another way, this finding was lower as compared with former studies that were conducted in India (90%), South Africa (88.8%) and Egypt (91.3%). The discrepancy might be due to various reasons like sociodemographic differences, government policies, farmers' behavior, accessibility to credits, climatic conditions and equipment's (Wagner, 2020) and Wolka (2023). Similar result highlighted by Scoones (2020) smallholders farmers growing agroforestry trees in their farm as SFP. Serrat (2021) found out that sustainable Farming practices contributing different product for well-being of local community in quantitative and qualitative of agriculture production, generating income and biodiversity conservation and improving ecosystem services. Simutowe et al (2024) revealed that sustainable farming practices increasing food production and crop productivity.

V.CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study concluded that the techniques like terrace farming, organic soil fertility management, climate-smart crop selection, and agroforest were especially successful in raising crop biomass, harvest weight, nutrient uptake and utilization, crop index levels, and improved seed varieties. However, the study also discovered that the use of lime and organic fertilizers to improve productivity and mitigate acidic soil, as well as the adoption of sustainable farming practices, account for 83.7% of the variation in crop yield enhancement in Ngororero District. Manure is used by farmers to enhance soil quality and yields, and the growth of mixed farming (crops and livestock) has enhanced nutrient cycling. Increasing the production of priority crops including Irish potatoes, beans, and maize is the main goal of Ngororero. In order to close this gap, future research should examine whether the advantages of SFP adoption such as higher yield and income outweigh the drawbacks in the other Rwandan regions.

5.2. Recommendations

Based on the results and the conclusion of this study, the researcher would suggest that :Farmer Cooperatives through empower local cooperatives to manage post-harvest activities and connect to larger markets, reducing reliance on middlemen, this is possible by increase the frequency of training and field visits by agronomists to help farmers understand the practical, long-term benefits of sustainable techniques over traditional methods and The study recommends that policy makers and stakeholders prioritise support for SFP adoption through comprehensive agricultural policies, capacity-building initiatives, and investment in agricultural research and development to contribute to achieving the sustainable development.

VI.CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

V.II.ACKNOWLEDGEMENT

Firstly, I would like to thank God for His guidance and protection not only during this study but in my entire life. And without the direction, collaboration, and support of many people, scientific research is virtually impossible to complete. I greatly appreciate Dr. Richard MIND'JE for his dedication in supervising my work.

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