FARMER'S PERCEPTIONS ON THE IMPACT OF SUSTAINABLE AGRICULTURE PRACTICES ON CROP PRODUCTION, A CASE STUDY OF KAMONYI DISTRICT (2021-2025)

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Abstract: *Sustainable agricultural practices play a significant role in influencing crop production. However, the effectiveness of these practices remains a subject of debate. In Rwanda, especially, despite the in Kamonyi District has diverse sustainable practices, but the district faces multiple agricultural challenges, including lack of organics, low productivity, declining soil fertility, and limited access to modern farming technologies. The research was conducted is to assess the farmer's perception on impact of sustainable agriculture practices on crop production, specifically, to assess the sustainable agriculture practices used by farmers in increasing crop production, to identify the changes introduced by sustainable agriculture practices on crop production, and to evaluate the relationship between sustainable agriculture practices and crop production in Kamonyi district. The study adopted descriptive research design to explore its objectives. A sample size of 397 was drawn from 63369 individuals, utilizing a simple random sampling for participant selection. Data collection was conducted through the use of questionnaire. Data collected were analyzed using descriptive statistics, correlation matrix and regression analysis. The results show that sustainable agriculture practices used by farmers are soil health and efficient water management, climate smart agriculture, food system, and crop rotation and diversification management. Further, the changes introduced by sustainable agriculture practices on crop production are identified, including increased food production level, increased crop yields, increased food stock, and improved market prices, and the results show that there is relationship between sustainable agriculture practices and crop production in Kamonyi district. The study recommends that sustainable agriculture institutions should provide education and training programs and create new types of crops that are more resistant to pests and climate change. Local authorities should create a more convenient market access to farmers, it means that it is possible to ensure that farmers get good prices on their produce hence an incentive of producing more. Farmers should diversify crop varieties to improve resilience against pests and diseases, as well as adapt to changing climate conditions.*

Keywords: Farmer's Perceptions, Sustainable Agriculture Practices, Crop Production, Kamonyi District, Rwanda.

1. INTRODUCTION

Crop production is the concept, which deals with the heightened food production rate, heightened crop yields, heightened food stock, market price, food availability, food access and utilization of food resources in such a manner that the resources are used without jeopardizing the future generations (Bouis & Saltzman, 2024). Pachapur et al. (2020) added that crop production plays a significant role in making sure that everyone has equal access to adequate, safe and nutritious food to sustain healthy living.

Globally, Sustainable agriculture practices are important factors that have a great influence on crop production (IFAD, 2020). Further, Sustainable agriculture practices are international standards of sustainable and secure farming activities, enhancing food safety, environmental and existence (FAO, 2022). The efficacy of these practices is a controversial one. Therefore, crop production can be considered as a topical global problem which affects billions of people globally. It involves the provision, access and consumption of food which is vital in ensuring health and well-being (UNICEF, 2024). Nevertheless, there is a challenge on crop production, the World Bank reports further decrease in the prices of food commodities worldwide which is mostly due to the rising production. There is a decline in Food Price Index of about 20 percent in terms of cereal and vegetable oil prices. It is important to note that the prices of wheat have decreased, owing to large harvests in black sea and high exports in Russia (World Bank, 2024).

Sustainable agricultural practices help African countries to boost their crop production and environmental protection. The crop production crisis however is a major issue in Africa where it is believed there are 868 million moderate to severely food insecure individuals in the continent. A percentage of over one-third or 342 million individuals are severely food-insecure, especially in Central, Eastern, and Western Africa (FAO, 2023). This is where sustainable agricultural practices urgently require interventions to overcome the food security issues that are facing the continent. According to Kinyili and Ndunda (2022) the agricultural sector remains the most vital industry, employing approximately 65 to 70 percent of the active population and supporting the livelihoods of 90 percent of the populace. This sector is also a key contributor to foreign exchange reserves and represents an average of 15% of Africa's gross domestic product (GDP), although this figure varies significantly across different countries. For instance, in Uganda, agriculture accounted for 21% of the total GDP in the fiscal year 2016/2019 (Atugonza, F. (2019).).

The sustainable agricultural practices are important because they reinforce responsible farming methods from site selection and land preparation to harvesting and handling (Hussain et al., 2024). Warinda et al. (2020) noted that sustainable agriculture projects in Rwanda and Burundi focus on improving crop yields, building climate resilience, and enhancing food security through a variety of practices. Additionally, World Bank is intensifying both short- and long-term strategies aimed at enhancing food and nutrition security while also by comprehensive set of crop management strategies land preparation, variety selection, crop establishment, weed management, and fertilizer management. The aid program has helped 1.8 million people in Burkina Faso, Chad, and Mali, 8 million in Ethiopia, and 3.3 million hectares of land in Kenya, Djibouti, and Ethiopia. It also protected 1.6 million pastoralists from drought impacts and increased households' ability to consume two meals per day in Somalia post-2017 drought (World Bank, 2024). The Kenya Climate Smart Agriculture Project, supported by the World Bank, focuses on enhancing agricultural productivity and resilience to climate change for smallholder farmers and pastoral communities. The initiative aims to implement sustainable agricultural practices that can withstand the impacts of climate variability (Anyango et al.,2022). This means that by promoting climate-smart techniques, the project seeks to improve food security and livelihoods while addressing environmental challenges.

In Rwanda, agriculture plays a vital role in the economy, employing over 70% of the population and contributing approximately 30% to the GDP (MINAGRI, 2022). This sector is essential for food production, rural livelihoods, and overall economic growth, with key crops including maize, beans, potatoes, and bananas (Izza & Anisa, 2024). However, smallholder farmers encounter significant challenges, such as limited access to finance, climate variability, and low productivity (IFAD, 2020; FAO, 2022). In response, Rwanda is implementing sustainable agricultural practices to enhance crop production and improve the livelihoods of farmers. This strategic initiative aims to tackle the existing challenges within the agricultural sector (Singirankabo et al., 2022). The overarching goal is to establish a resilient agricultural system that not only addresses current needs but also ensures long-term viability and productivity for farmers. Supporting these farmers is crucial for maintaining the nation's food production and economic stability (Muhamadi & Boz, 2022). According to Weatherspoon et al. (2021) the economy of the country is heavily reliant on agriculture, with a significant 69 percent of rural households engaged in small-scale farming on limited land.

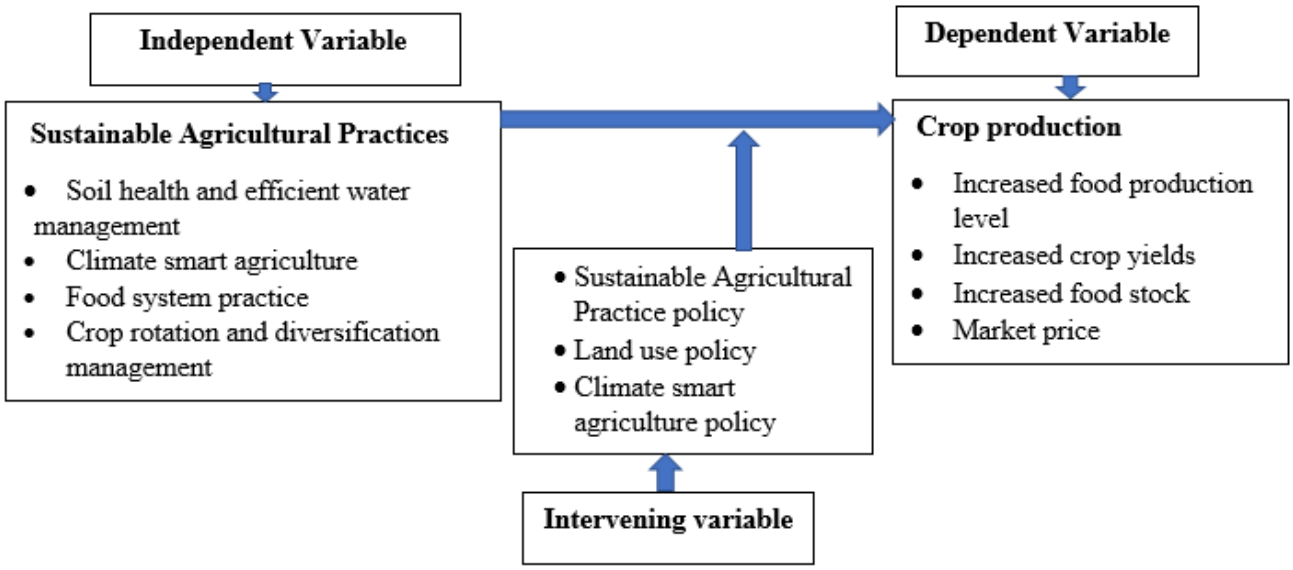
Kamonyi District's agricultural practices are a blend of traditional and modern techniques, with smallholder farmers relying on subsistence farming. Techniques like crop rotation, intercropping, and terracing are used to reduce soil erosion and improve productivity. However, challenges like limited access to inputs, inadequate irrigation infrastructure, and climate variability hinder sustainable productivity. Government-led initiatives like land use consolidation have been studied, but there is a knowledge gap in understanding their long-term impact on food security (Batamuliza, 2020). Therefore, this study assesses the farmer's perception on impact of sustainable agriculture practices on crop production in Kamonyi district.

2. STATEMENT OF THE PROBLEM

In Rwanda, especially in Kamonyi District, the agricultural landscape is characterized by the cultivation of diverse crops, including maize, beans, bananas, and cassava. Despite this diversity, the district faces significant agricultural challenges such as low productivity, declining soil fertility, and limited access to modern farming technologies. These issues have led to decreased crop production, highlighting the urgent need for the adoption of sustainable agriculture practices. For rural households that depend on farming for their livelihoods, these challenges exacerbate cycles of poverty and malnutrition, underscoring the critical importance of addressing these agricultural constraints to improve crop production and overall well-being in the region. It is in this perspective that the current research assessed the farmer's perception on impact of sustainable agriculture practices on crop production, a case study of Kamonyi District.

3. CONCEPTUAL FRAMEWORK

Figure 1: Conceptual Framework of the Study



Source: Researcher, 2025

A conceptual framework is essential in research as it provides a structured approach to understanding and analyzing complex phenomena. In this study, it serves as a guiding map that outlines the relationships between two variables, facilitating a clearer focus on the research objectives. This study presents a schematic diagram that illustrates the relationship between sustainable agricultural practices as independent variable and crop production as dependent variable. SAPs is evaluated using soil health and efficient water management, climate smart agriculture, food system practice, and crop rotation and diversification management practices as independent variables influencing crop production, which is treated as the dependent variable. Crop production is assessed using increased food production level, increased crop yields, increased food stock, and market price. The analysis aims to highlight how these agricultural practices contribute to enhancing crop production, emphasizing the importance of effective management in agriculture to ensure sustainable food production. Additionally, intervening variables such as sustainable agricultural practice policy, land use policy, and climate smart agriculture policy play a crucial role in shaping agricultural outcomes. these policies serve as frameworks that guide the implementation of sustainable practices, influencing both sustainable agriculture practices and crop production.

4. STUDY OBJECTIVE AND QUESTIONS

The general objective of this study is to assess the farmer's perception on impact of sustainable agriculture practices on crop production in Rwanda. Specifically, this study addressed the following specific objectives:

i. To assess the sustainable agriculture practices used by farmers in increasing crop production in Kamonyi district;
ii. To identify the changes introduced by sustainable agriculture practices on crop production in Kamonyi district;
iii. To evaluate the relationship between sustainable agriculture practices and crop production in Kamonyi district.

Based on the research objectives, the research questions are:

i. What are the sustainable agriculture practices used by farmers in increasing crop production in Kamonyi district?
ii. What are the changes introduced by sustainable agriculture practices on crop production in Kamonyi district?
iii. Is there the relationship between sustainable agriculture practices and crop production in Kamonyi district?

5. RESEARCH METHODOLOGY

This study employs a descriptive and correlational research designs, descriptive research design facilitates a comprehensive understanding of the opinions of respondents while correlational research design determines the association between farmer's perception of impact of sustainable agriculture practices and crop production in Rwanda.

5.1 Sample size

A sample size of 397 respondents was drawn from 63369 individuals, utilizing a simple random sampling for participant selection. The study utilized Yamane formula to determine the appropriate sample size. This approach ensures a statistically valid representation of the population under investigation. The formula as follows:

$$n = \frac{N}{1 + N(e^2)}$$

where: n= Sample size
N=Total population
Error (e)= 0.05 (95%)
Therefore:

$$n = \frac{N}{1+N(0.05)^2} = \frac{63369}{1+63369(0.05)^2} = =397.49 \approx \textbf{397 respondents.}$$

5.2 Data Collection tool

Data collection was conducted through the use of questionnaire. The questionnaire is structured into two distinct sections. Section A focuses on gathering general demographic information about the respondents, while Section B uses a Likert scale to assess various practices and opinions. The Likert scale employs a range of responses from 1 to 5, where 1=Strongly disagree (SD), 2= Disagree (D), 3=Neutral (N), 4=Agree (A) and 5=Strongly agree (SA). The study aims to collect quantitative data from the respondents (393 farmers).

5.3 Data Analysis

Data collected were analyzed using descriptive analysis, correlation matrix and regression analysis. The data processing involves the data editing, coding, and tabulation. Firstly, data editing is essential for ensuring data accuracy by identifying and correcting errors, secondly, data coding will be another vital step that involves assigning numerical codes to responses, simplifying the analysis of raw data. Lastly, data tabulation systematically presents numeric data in rows and columns (tables), aiding in statistical analysis and interpretation. The analysis was processed using SPSS version 25.

Further, the mean score was served as a critical metric for researcher to assess the level of agreement among participants in this study. Moreover, standard deviation is a statistical measure that reflects the extent to which data points cluster around the mean. The measure was crucial for researcher as it helps in assessing the degree of heterogeneity or homogeneity in opinions.

Moreover, correlation matrix and regression analysis were used to assesses the relationship between two variables. The analysis was conducted using SPSS version 25. The study utilized multiple linear regression model below:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3PX3 + \beta 4PX4 + \varepsilon$$

Where: Y = Crop production
β0 = Constant
β1 … β3 = Regression coefficients for independent variables
X1 = Soil health and efficient water management
X2 = Climate smart agriculture
X3 = Food system
X4 = Crop rotation and diversification management
ε = Error term

6. RESULTS AND DISCUSSION

The purpose of this study was to assess the farmer's perception on the impact of sustainable agriculture practices on crop production in Kamonyi district. Specifically, to assess the sustainable agriculture practices used by farmers in increasing crop production, to identify the changes introduced by sustainable agriculture practices on crop production, and to evaluate the relationship between sustainable agriculture practices and crop production in Kamonyi district. This chapter deals with data presentation, data analysis and results discussion.

6.1 Results

Means and standard deviation functions were of great benefit to the statistical observations made in a Likert scale assessment that was done on the respondents. The mean is an indicating average score of all propositions and statement to consider the overall inclination in the responses of the respondents. The 1–5-point Likert scale was used by respondents who had to describe their degree of congruence as 1, which is Strongly disagree and 5 which is Strongly agree. Mean scores were defined into certain ranges, 0.01-1.00 rank as very low mean, 1.01-2.00 as low mean, 2.01-3.00 as medium mean, 3.01-4.00 as high mean and 4.01-5.00 as very high mean. Further, the standard variation was calculated in order to determine homogeneity or heterogeneity of the data. When standard deviation is less than or equal to 0.5 the homogeneity is noted and vice-verse. Data were presented as collected from the respondents per each objective:

6.1.1 Sustainable agriculture practices used by farmers on crop production

The assessment of sustainable agriculture practices in Kamonyi district highlights the various methods employed by farmers to enhance crop production while minimizing environmental impact. The practices identified include Soil health and efficient water management practice, climate smart agriculture practice, food system practice, and crop rotation and diversification management.

Table 1: Soil health and efficient water management practice on crop production

	Mean	Std. Dev.	Comments
Conservation tillage minimizes soil disturbance or preserves the soil structure	4.01	1.220	Very high heterogeneity
Soil cover using mulch or keeping the soil covered with vegetation limits weed and prevents compaction from rain	3.94	1.212	High mean and heterogeneity
Rainwater harvesting using collecting and storing rainwater provides an additional water source for crops	3.89	1.060	High mean and heterogeneity
Organics management using adding compost improvs the soil's ability to hold water	4.15	1.026	Very high mean and heterogeneity
Overall	3.99	1.129	High mean and heterogeneity

Source: Field data, 2025

Table above shows descriptive findings on soil health and efficient water management practice used by farmers in Kamonyi district. Respondents agreed the statement that the Conservation tillage minimizes soil disturbance or preserves the soil structure, as indicated by very high mean score of 4.01 designating a very strong positive agreement and standard deviation of 1.220 signifying heterogeneity in opinions among respondents. Similarly, they agreed the statement that soil cover using mulch or keeping the soil covered with vegetation limits weed and prevents compaction from rain high mean score of 3.94 signifying a strong positive agreement and standard deviation of 1.212 indicating heterogeneity in opinions among respondents.

Furthermore, respondents agreed the statement that Rainwater harvesting using collecting and storing rainwater provides an additional water source for crops as evidenced by high mean score of 3.89 signifying a strong positive agreement and standard deviation of 1.060 indicating heterogeneity in opinions among respondents. Moreover, respondents agreed the statement that organics management using adding compost improvs the soil's ability to hold water with very high mean score of 4.15 signifying a strong positive agreement and standard deviation of 1.026 indicating heterogeneity in opinions among respondents. Overall, the high mean score of 3.99 for the combined statements indicate a strong positive agreement that there are exist the Soil health and efficient water management, with the standard deviation of 1.129 designating heterogeneity in opinions among participants.

Table 2: Climate smart agriculture practice affected crop production

	Mean	Std. Dev.	Comments
Pest control helps regulation or management of any species, such as insects, rodents, or fungus, that adversely affects human activities or the environment	3.99	1.165	High mean and heterogeneity
Weed control helps the process of managing unwanted plants that compete with desirable crops or plants	3.93	1.392	High mean and heterogeneity
Planting trees prevents soil erosion, improves water absorption, and raising productivity	3.84	1.280	High mean and heterogeneity
Composting helps restore soil nutrients, and can also help mitigate the impact of droughts by helping retain soil moisture	4.00	1.353	High mean and heterogeneity
Overall	3.94	1.297	High mean and heterogeneity

Source: Field data, 2025

Table above presents descriptive results on climate smart agriculture practice used by farmers in Kamonyi district. The statement that pest control helps regulation or management of any species, such as insects, rodents, or fungus, that adversely affects human activities or the environment agreed to mean score of 3.99 that represents a very strong level of positive agreement and a standard deviation characteristic of 1.163 that describes homogeneous opinions among the respondents. On the same line, they consented with the assertion that Weed control helps the process of managing unwanted plants that compete with desirable crops or plants with high mean score of 3.93 and standard deviation of 1.392 indicating normal dispersion (heterogeneity) in the views among the respondents.

Moreover, respondents had an agreement in the statement that planting trees prevents soil erosion, improves water absorption, and raising productivity since the mean score of 3.84 was high which implies high positive agreement and standard deviation of 1.280 indicates the same level of heterogeneity in opinions among respondents. In addition, there was agreement by the respondents that composting helps restore soil nutrients, and can also help mitigate the impact of droughts by helping retain soil moisture with high mean score of 4.00 indicating a strong positive response and standard deviation of 1.353 indicating a heterogenous opinion among respondents as regards the statements. Comprehensively, the combination of statements mean score of 3.94 and standard deviation of 1.297 as the measure of heterogeneity in opinions of the participants shows high positive agreement that there exist climate smart agriculture practices in Kamonyi district.

Table 3: Food system practice affected crop production

	Mean	Std. Dev.	Comments
Agriculture production practice helps farmers in farming, cultivating grains	4.00	1.155	High mean and heterogeneity
Agriculture products are processed from your raw ingredients into food products	4.02	1.048	Very high mean and heterogeneity
Agriculture products are distributed to the final consumers by collecting, storing and transporting through various channels	4.17	1.042	Very high mean and heterogeneity
Agriculture products are consumed and accessible	3.99	1.083	High mean and heterogeneity
Overall	4.04	1.082	Very high mean and heterogeneity

Source: Field data, 2025

Table above presents descriptive results on the food system practice on crop production in Kamonyi district. Respondents also agreed to the statement that agriculture production practice helps farmers in farming, cultivating grains since the mean summated score stands at 4.00 which represents a high degree of agreement and standard deviation of 1.155 which indicates heterogeneity among the respondents. On the same note they concurred on the statement that agriculture products are processed from your raw ingredients into food products with high mean score of 4.02 which symbolizes high positive agreement and standard deviation of 1.048 which symbolizes heterogeneity in view-points among the respondents.

Moreover, the respondents showed agreement to the statement that agriculture products are distributed to the final consumers by collecting, storing and transporting through various channels, which have mean score of 4.17 indicating high positive mean score agreement as well as standard deviation of 1.042 grouping respondents who have mixed opinion on the statement. Besides, the statement that agriculture products are consumed and accessible had high mean score of 3.99 signifying that there is strong positive agreement and high standard deviation of 1.083 indicating that many respondents have different views. In general, the extremely high mean score value of 4.04 of the additive statements evidence a high positive agreement that there is the study on the food system practice on crop production in Kamonyi district, and the standard deviation value of 1.082 denotes the heterogeneity of the opinion among the respondents.

Table 4: Crop rotation and diversification management practice affected crop production

	Mean	Std. Dev.	Comments
Crops are rotated by grouping crops into families to avoid planting the same family in successive seasons	4.03	1.052	Very high mean and heterogeneity
Farmers grow multiple crops at the same time in the same field to increase crop production	3.86	1.074	High mean and heterogeneity
Farmers altern the crops with varying root depths that helps prevent soil depletion and improves its physical structure	3.79	1.151	High mean and heterogeneity
Rotating crops allows for the use of different herbicides with varied modes of action, which prevent the development of herbicide-resistant weeds	4.00	1.087	High mean and heterogeneity
Overall	3.92	1.091	High mean and heterogeneity

Source: Field data, 2025

Table above presents descriptive results on crop rotation and diversification management practice on crop production in Kamonyi district. The statement that crops are rotated by grouping crops into families to avoid planting the same family in successive seasons agreed to mean score of 4.03 that represents a very strong level of positive agreement and a standard deviation characteristic of 1.052 that describes homogeneous opinions among the respondents. On the same line, they consented with the assertion that farmers grow multiple crops at the same time in the same field to increase crop production with high mean score of 3.86 and standard deviation of 1.074 indicating normal dispersion (heterogeneity) in the views among the respondents.

Moreover, respondents had an agreement in the statement that Farmers altern the crops with varying root depths that helps prevent soil depletion and improves its physical structure since the mean score of 3.79 was high which implies high positive agreement and standard deviation of 1.151 indicates the same level of heterogeneity in opinions among respondents. In addition, there was agreement by the respondents that rotating crops allows for the use of different herbicides with varied modes of action, which prevent the development of herbicide-resistant weeds with high mean score of 4.00 indicating a strong positive response and standard deviation of 1.087 indicating a heterogenous opinion among respondents as regards the statements. Comprehensively, the combination of statements on crop rotation and diversification management practice on crop production in Kamonyi district with mean score of 3.92 and standard deviation of 1.091 as the measure of heterogeneity in opinions of the participants shows high positive agreement that there exist climate smart agriculture practices in Kamonyi district.

6.1.2 The changes introduced by sustainable agriculture practices on crop production

The study focuses on the impact of sustainable agriculture practices on crop production in the Kamonyi district. It aims to identify specific changes that these practices have introduced to enhance agricultural productivity. This includes the improvement in increased food production level, increased crop yields, increased food stock, and improved market prices.

Table 5: Increased food production level

	Mean	Std. Dev.	Comments
Agriculture products are grown primarily to meet the food needs of the farming family	3.86	1.074	High mean and heterogeneity
Agriculture products are produced for domestic consumption, either to meet the household's own food needs or for sale to generate income	4.17	1.042	Very high mean and heterogeneity
Agriculture products are produced with the intent of having a surplus for trade, which is crucial for the global economy and supports the livelihoods of farmers	3.86	1.074	High mean and heterogeneity
Agricultural products are produced for export, which involves selling goods to other countries for a profit	3.84	1.280	High mean and heterogeneity
Overall	3.93	1.117	High mean and heterogeneity

Source: Field data, 2025

The table above reflects descriptive information stating the on increased food production level. The statement that agriculture products are grown primarily to meet the food needs of the farming family was agreeable whereby the mean score was high indicating strong positive agreement at 3.86 and standard deviation was also high at 1.074 implying there is anger of peoples with different opinions. In the same vein, they consented to the statement which stated that agriculture products are produced for domestic consumption, either to meet the household's own food needs or for sale to generate income with high mean score of 4.17 denoting a firm positive concurrence and standard deviation of 1.042 showing variability in opinions of the respondents.

Moreover, the respondents also approved the statement that agriculture products are produced with the intent of having a surplus for trade, which is crucial for the global economy and supports the livelihoods of farmers with a high mean score of 3.86 that indicates a strong positive agreement and a standard deviation of 1.074 indicating opinion variability among the respondents. In addition, the statement that agricultural products are produced for export, which involves selling goods to other countries for a profit had high mean score of 3.84 indicating a strong positive agreement and standard deviation of 1.280 out of 5 points which imply that there is disparity of

opinions among the respondents. Thus, the positive strong mean (3.93) of the composite statement implies that there is the increased food production level, where standard deviation (1.117) identifies those participants have varying opinions.

Table 6: Increased crop yields

	Mean	Std. Dev.	Comments
Each unit of land is more productive to meet growing demand	4.00	1.155	High mean and heterogeneity
The use methods like fertilizers and pesticides, applying precision irrigation is improved crop production	4.17	1.042	Very high mean and heterogeneity
Genetic selection and engineering are powerful tools for creating better crop varieties	3.86	1.074	High mean and heterogeneity
Farm mechanization, better farming tools, and advanced data analysis techniques have helped crop production	4.17	1.042	Very high mean and heterogeneity
Overall	4.05	1.078	Very high mean and heterogeneity

Source: Field data, 2025

The table above reflects descriptive information stating the increased crop yields. The fact that each unit of land is more productive to meet growing demand was acceptable where the mean rating was high 4.00 and the standard deviation was also high 1.155, that is, the people are angry of different views. Similarly, they agreed to the statement saying that the use methods like fertilizers and pesticides, applying precision irrigation is improved crop production with high mean score of 4.17 indicating a strong positive agreement and standard deviation of 1.042 indicating heterogeneity in beliefs of the respondents.

In addition, the statement that Genetic selection and engineering are powerful tools for creating better crop varieties with the mean score of 3.86, the standard deviation score of 1.074that indicates the variability of opinion among the respondents. Besides, the mean of the statement that farm mechanization, better farming tools, and advanced data analysis techniques have helped crop production had a high score of 4.17 showing strong positive agreement and standard deviation of 1.042 showing that there is a difference of opinions among the respondents. Therefore, the overall mean score of 4.05 of the composite statement note that there is the descriptive information stating the increased crop yields and standard deviation (1.1078) is used to identify the participants who hold different opinions.

Table 7: Increased food stock

	Mean	Std. Dev.	Comments
The food supply is adequate in both quantity and quality, effectively meeting the needs of the population	4.00	1.155	High mean and heterogeneity
Physical distance that exists between individuals and their food sources, such as grocery stores and farmers' markets is geographical proximately	3.84	1.280	High mean and heterogeneity
The stabilization of food markets is crucial for crop production, ensuring food security and economic stability	3.86	1.074	High mean and heterogeneity
Food stock is managed to lead more predictable pricing, benefiting both consumers and producers	3.84	1.280	High mean and heterogeneity
Overall	3.88	1.197	High mean and heterogeneity

Source: Field data, 2025

Table above demonstrates the results of a descriptive study on increased food stock in Kamonyi district. The respondents also concurred with the statement that the food supply is adequate in both quantity and quality, effectively meeting the needs of the population because the mean summated score is 4.00 that demonstrates a high level of agreement and standard deviation of 1.155 that depicts that the respondents are diverse. They also agreed on the same statement mentioning that physical distance that exists between individuals and their food sources, such as grocery stores and farmers' markets is geographical proximately with a high mean score of 3.84 representing high positive agreement and a standard deviation of 1.280 representing heterogeneity in view-points of respondents. Furthermore, there was agreement amongst the respondents on the statement that food stock is managed to lead more predictable pricing, benefiting both consumers and producers with the mean score of 3.86 showing high positive mean score agreement and standard deviation of 1.074 of the respondents having mixed opinion on the statement.

In addition, the statement that the stabilization of food markets is crucial for crop production, ensuring food security and economic stability had high mean score of 3.84 that means that there is a strong positive agreement and a high standard deviation of 1.280 that means that many respondents have varied opinions. Overall, the huge mean score value of 3.88 of the additive statements testifies about the high level of positive agreement that there is increased food stock in Kamonyi district, and the value of the standard deviation (SD) of 1.197 attests to the heterogeneity of the opinion among the respondents.

Table 8: Improved market prices

	Mean	Std. Dev.	Comments
Crop selection is based on market value rather than solely on productivity levels	4.15	1.026	Very high mean and heterogeneity
Farmers are achieved better financial outcomes, even if the quantity of produce remains unchanged	3.86	1.074	High mean and heterogeneity
Price information aids farmers in determining the optimal timing for planting crops, and selecting the most profitable markets for selling their produce	4.00	1.155	High mean and heterogeneity
The leveraging market price information, farmers enhance their returns and make more informed choices regarding their agricultural practices	4.15	1.026	Very high mean and heterogeneity
Overall	4.04	1.070	Very high mean and heterogeneity

Source: Field data, 2025

Table above has provided descriptive findings on increased market prices in Kamonyi district. The excerpt that crop selection is based on market value rather than solely on productivity levels was agreed to have a mean score of 4.15 which is a very strong level of positive agreement and homogeneous opinions by the respondents as depicted by the standard deviation of 1.026.

In the same line, they agreed with the statement that farmers are achieved better financial outcomes, even if the quantity of produce remains unchanged with a high mean score of 3.86 and standard deviation of 1.074 that shows normal dispersion (heterogeneity) in the perceptions of the respondents.

In addition, respondents agreed on the statement that price information aids farmers in determining the optimal timing for planting crops, deciding when to store their harvest, and selecting the most profitable markets for selling their produce because the mean of 4.00 was high that suggests the high levels of positive agreement and the standard deviation of 1.155 was high that indicates the similar levels of heterogeneity in the opinion of the respondents. Moreover, the respondents agreed that the leveraging market price information, farmers enhance their returns and make more informed choices regarding their agricultural practices with average score of 4.15 due to a strong positive response and standard deviation of 1.026 that implies a heterogenous view on the statements to the respondents. Altogether, the set of statements that cover increased market prices in Kamonyi district with the mean score of 3.92 and the standard deviation of 1.091 as the measure of heterogeneity in opinions of the respondents demonstrate high positive agreement that there are climate smart agriculture practices in the Kamonyi district.

6.1.3 Relationship between sustainable agriculture practices and crop production

The correlation matrix, model summary, ANOVA and coefficients were used to determine the relationship between sustainable agriculture practices and crop production in Kamonyi district.

Table 9: Correlation matrix

		Sustainable agriculture practices	Crop production
Sustainable agriculture practices	Pearson Correlation	1	.965**
	Sig. (2-tailed)		.000
	N	363	363
Crop production	Pearson Correlation	.965**	1
	Sig. (2-tailed)	.000	
	N	363	363

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Field data, 2025

The correlation matrix in the Table above presents strong positive relationship between independent variables (sustainable agriculture practices) on crop production as dependent variable. The sustainable agriculture practices show a strong positive relationship ($r=0.965$, $p=0.000<0.01$) indicating increased utilization of sustainable agriculture practices are linked with improved crop production in Kamonyi.

Table 10: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.978[a]	.957	.956	.20251

a. Predictors: (Constant), Crop rotation and diversification management, Soil health and efficient water management, Climate smart agriculture, Food system

Source: Field data, 2025

Table above shows the Model Summary for regression analysis. R-value of 0.978 designates the association between independent variable (Crop rotation and diversification management, Soil health and efficient water management, Food system, Climate smart agriculture) and crop production in Kamonyi district as dependent variable.
R Square value of 0.957 indicates that 95.7% of the variability in the crop production in Kamonyi district can be explained by the independent variable (sustainable agriculture practices) in the model.

Table 11: Analysis of Variance

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	325.226	4	81.307	1982.510	.000[b]
	Residual	14.682	359	.041		
	Total	339.908	363			

a. Dependent Variable: Crop production
b. Predictors: (Constant), Crop rotation and diversification management, Soil health and efficient water management, Climate smart agriculture, Food system

Source: Field data, 2025

Analysis of variance (ANOVA) is displayed on table above. ANOVA gives a p-value of 0.000 (less than 0.05), significant F-statistic value of 1982.510. The F-statistic determines how well the regression model is significant in general. In this research, the model including predictors (Crop rotation and diversification management, Soil health and efficient water management, Food system, Climate smart agriculture) has significance with crop production which is dependent variable. The results show that the independent variable is significant in concluding the changes in crop production which is evidenced by the p=value of 0.000 which is less than acceptance value of 0.05.

Table 12: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.120	.049		2.483	.014
	Soil health and efficient water management	.006	.018	.006	.331	.741
	Climate smart agriculture	.201	.015	.254	13.204	.000
	Food system	.332	.027	.341	12.377	.000
	Crop rotation and diversification management	.433	.026	.434	16.467	.000

a. Dependent Variable: Crop production

Source: Field data, 2025

Based on the results generated in the above table, the equation:
Y=b0+b1X1+b2X2+b3X3+b4X4+e
Becomes:
Y=0.227+ 0.006 (Soil health and efficient water management) + 0.201 (Climate smart agriculture) + 0.332 (Food system) + 0.433 (Crop rotation and diversification management) + 0.097
Table above shows the coefficients for the regression model predicting the crop production in Kamonyi district based on the predictors of crop rotation and diversification management, soil health and efficient water management, food system, climate smart agriculture. The constant term has an unstandardized coefficient (B) of 0.120 with a standard error of 0.049.
On the predictors, the result of the study revealed that soil health and efficient water management produces positive relationship and significance predictors (B=0.006, p-value=0.000<0.05) with the crop production in the district of Kamonyi. This implies that a unit increase in the soil health and efficient water management causes enhanced crop production in Kamonyi district by 0.006 unit.
Besides, the findings show that the practice of climate smart agriculture has a positive correlation and influential contribution with the crop production in the Kamonyi district (B=0.201, p-value=0.000<0.05). It implies that by a unit increase in the practice of the climate smart agriculture, crop production at the district of Kamonyi positively changes by 0.201 unit.
In addition, the outcome indicates that the practice of food system is positively connected and significant contribution to the crop production in Kamonyi district (B=0.332, p-value=0.000<0.05). This means that a unit rise in unit of food system practice, the crop production in Kamonyi district improves by 0.332. Lastly, the result shows that crop rotation and diversification management practices have a positive and significant relationship and contribution to the crop production in the Kamonyi district (B=0.433, p-value=0.000<0.05). This implies that an increase in unit of Crop rotation and diversification management practice by a unit increases the crop production of Kamonyi district by 0.433.

6.2 Discussion of the findings

The discussion of findings in research plays a crucial role in interpreting and contextualizing the results obtained from a study. It serves as a platform for researchers to analyze their findings in relation to existing literature, thereby highlighting the significance and implications of their work. This section focuses on specific objectives.

6.2.1 Sustainable agriculture practices used by farmers on crop production

The high mean score of 3.99 for the combined statements indicate a strong positive agreement that there are exist the Soil health and efficient water management, with the standard deviation of 1.129 designating heterogeneity in opinions among participants. The findings on sustainable agriculture practices used by farmers to increase crop production are aligned Hashakimana et al. (2023) recognizing the variations in soil types is crucial for developing tailored strategies that effectively address specific environmental conditions. In addition, the combination of statements mean score of 3.94 and standard deviation of 1.297 as the measure of heterogeneity in opinions of the participants shows high positive agreement that there exist climate smart agriculture practices. The findings on climate smart agriculture practices are supported by Attri et al. (2022) noted that SAPs and proper irrigation management are crucial for enhancing soil health, which in turn leads to improved nutrient availability for crops.

Furthermore, in general, the extremely high mean score value of 4.04 of the additive statements evidence a high positive agreement that there is the study on the food system practice on crop production, and the standard deviation value of 1.082 denotes the heterogeneity of the opinion among the respondents. The findings on the food system practice on crop production in Kamonyi district align with studies by Belmain et al. (2022) food system practices are essential for maintaining agricultural productivity and ensuring food security. Effective management of pests and diseases helps to protect crops from damage, thereby maximizing yield and quality. Lastly, the combination of statements on crop rotation and diversification management practice on crop production in Kamonyi district with mean score of 3.92 and standard deviation of 1.091 as the measure of heterogeneity in opinions of the participants shows high positive agreement that there exist climate smart agriculture practices in Kamonyi district. The findings are aligned with a study of Xu et al. (2020) asserted that the crop rotation and diversification management are essential practices in sustainable agriculture that enhance soil health, increase crop yields, and reduce pest and disease pressures.

6.2.2 The changes introduced by sustainable agriculture practices on crop production

The positive strong mean (3.93) of the composite statement implies that there is the increased food production level, where standard deviation (1.117) identifies those participants have varying opinions. The findings on increased food production level align with Mugisha et al. (2024) who asserted that crop production and food security are intricately connected to several critical factors, including effective agricultural practices, the impacts of climate change, and the complexities of global trade. Moreover, the mean score of 4.05 of the composite statement note that there is the descriptive information stating the increased crop yields and standard deviation (1.1078) is used to identify the participants who hold different opinions. The findings are supported by Wei and Xu (2025) who noted that crop production refers to the process of growing and harvesting crops for food, fiber, and other agricultural products.

Further, the mean score value of 3.88 of the additive statements testifies about the high level of positive agreement that there is increased food stock, and the value of the standard deviation of 1.197 attests to the heterogeneity of the opinion among the respondents. The findings are supported by Mwankemwa et al. (2023) noted that crop production plays a vital role in addressing food security, which includes the dimensions of availability, access, utilization, and stability of food resources. It is crucial for ensuring that all individuals have access to sufficient, safe, and nutritious food necessary for maintaining a healthy lifestyle. Lastly, the statements that improved market prices with the mean score of 3.92 and the standard deviation of 1.091 as the measure of heterogeneity in opinions of the respondents demonstrate high positive agreement that there are improved market prices. The findings are supported by Muhamadi and Boz (2022) noted that effective management of crop production is essential not only for meeting current food demands but also for sustaining future food systems in the face of challenges such as climate change and population growth.

6.2.3 Relationship between sustainable agriculture practices and crop production in Kamonyi district

The study evaluates the relationship between sustainable agriculture practices and crop production in Kamonyi district. according to table 14, the increased utilization of sustainable agriculture practices is linked with improved crop production in Kamonyi. The findings are supported by Batamuliza (2020) sustainable agriculture practices are critical practices that significantly influences agricultural outcomes. The arrangement of soil particles into aggregates plays a vital role in determining water infiltration and drainage capabilities. In the same line, Table 15 shows the Model Summary for regression analysis. R-value designates the association between independent variable (Crop rotation and diversification management, Soil health and efficient water management, Food system, Climate smart agriculture) and crop production in Kamonyi district as dependent variable.

Further, F-statistic in Table 16 determines how well the regression model is significant in general. In this research, the model including predictors (Crop rotation and diversification management, Soil health and efficient water management, Food system, Climate smart agriculture) has significance with crop production which is dependent variable. lastly, on the predictors, the result of the study revealed that each predictor produces positive relationship and significance predictors with the crop production in the district of Kamonyi. The findings are supported by studies of Izza and Anisa (2024) agree with the findings that selecting soil is a vital activity that severely determines the fate of agriculture. The structure of soil particles, which is in form of aggregates, is crucial in defining the ability to receive water and drain the same.

7. Conclusion

The research was aimed at evaluating the role the sustainable agriculture practices as a contributor to the crop production in Kamonyi district. In particular, assessing the sustainable agriculture practices used by farmers in increasing crop production, identifying the changes introduced by sustainable agriculture practices on crop production, and evaluating the relationship between sustainable agriculture practices and crop production in Kamonyi district.

To begin with the specific objective, researcher used one of the following objectives to assess the sustainable agriculture practices used by farmers in increasing crop production, based on the findings of this study, it concludes that there is effect of sustainable agriculture

practices used by farmers in increasing crop production in Kamonyi district.
Secondly, according to the particular purpose which is to consider the identifying the changes introduced by sustainable agriculture practices on crop production. Based on the findings, this research concludes that indeed there is the changes introduced by sustainable agriculture practices on crop production in Kamonyi district.
Finally, basing on the following purpose that to evaluate the relationship between sustainable agriculture practices and crop production. Based on the findings, this concludes that there is relationship between sustainable agriculture practices and crop production in Kamonyi district.

8. Recommendations

The findings of this study revealed that there is there is effect of sustainable agriculture practices used by farmers in increasing crop production. There are the changes introduced by sustainable agriculture practices on crop production, and there is relationship between sustainable agriculture practices and crop production in Kamonyi district. based on conclusion of this study, it recommends to the sustainable agriculture institutions, local authorities, farmers.

8.1 To the sustainable agriculture institutions

The sustainable agriculture institutions should introduce agricultural technologies that are highly developed like precision farming and biotechnology can be of great help to boost the efficiency of yield and resource utilization. In addition, they should promote healthier soil and biodiversity and result in more resilient agricultural systems. further, they should provide education and training programs to help farmers have the knowledge and skills to practice these practices and should create new types of crops that are more resistant to pests and climate change.

8.2 To the local authorities

The study recommends that the local authorities should increase the level of crop production by introducing modern agricultural technologies. In addition, they should enhance irrigation systems to guarantee the availability of water all year round particularly in areas that are vulnerable to drought. Further, they should create a more convenient market access to farmers, it means that it is possible to ensure that farmers get good prices on their produce hence an incentive of producing more. They should help in creating many cooperatives of sustainable agriculture and group of research organizations that can contribute to the creation of innovative solutions that would fit the local conditions.

8.3 To the farmers

The study recommends that the farmers should implement advanced agricultural techniques and utilize technology for soil analysis and crop monitoring, which helps in making informed decisions regarding planting and fertilization. In addition, they should diversify crop varieties to improve resilience against pests and diseases, as well as adapt to changing climate conditions. Further, the farmers should invest in sustainable practices, such as organic farming and conservation tillage, ensuring both the environment and crop productivity. These methods not only enhance soil fertility but also promote biodiversity.

8.4 Suggestions for further research

This study on assessing the effect of sustainable agriculture practices on crop production in Kamonyi district, focusing on sustainable agriculture practices used by farmers in increasing crop production, the changes introduced by sustainable agriculture practices on crop production, and the relationship between sustainable agriculture practices and crop production in Kamonyi district. Future research should consider a more diverse sample that includes farmers from various regions to enhance the applicability of the findings across different contexts by focusing on soil selection practice on crop production, evaluating the effect of irrigation method practice on crop production, and investigating the effect of pest and disease control practice on food security in Kamonyi district.

References

Anyango, L. (2022). Effect of Risk Management Practices on the Financial Performance of Agricultural Companies Listed at the Nairobi Securities Exchange (Doctoral dissertation, University of Nairobi).
Attri, M., Bharti, V., Ahmad Nesar, N., Mehta, S., Bochalya, R. S., Kumar Bansal, K., & Sandhu, R. (2022). Improved irrigation practices for higher agricultural productivity: A review. International Journal of Environment and Climate Change, 12(9), 51-61.
Atugonza, F. (2019). Effect of government spending on economic growth (focuses on agricultural sector) in Uganda (2016-2019) (Doctoral dissertation, Kampala International University, College of Economics and Management).
Batamuliza, G. (2020). Women's participation in agricultural extension services: a case study of Kamonyi district, southern province of Rwanda (Doctoral dissertation, University of Rwanda, CMHS).
Belmain, S. R., Tembo, Y., Mkindi, A. G., Arnold, S. E., & Stevenson, P. C. (2022). Elements of agroecological pest and disease management. Elem Sci Anth, 10(1), 1-14.
Bouis, H. E., & Saltzman, A. (2024). Improving food security through better nutrition: Role of biofortification. Agricultural Economics, 55(3), 202-215.
FAO (2022). The State of Food Security and Nutrition in the World: Towards Climate-Resilient Food Systems. Rome: Food and Agriculture Organization of the United Nations.
FAO (2023). The State of Food Security and Nutrition in the World: Urbanization, Inequalities, and Food Security. Rome: Food and Agriculture Organization of the United Nations.
Hashakimana, L., Tessema, T., Niyitanga, F., Cyamweshi, A. R., & Mukuralinda, A. (2023). Comparative analysis of monocropping and

mixed cropping systems on selected soil properties, soil organic carbon stocks, and simulated maize yields in drought-hotspot regions of Rwanda. Heliyon, 9(9), 1-25.
Hussain, A., Elkarmout, A. F., Mansour, E. Z., Awais, M., Usman, M., Ahmad, H., ... & Ahmad, T. (2024). An environment friendly practice, the climate smart agriculture crop production and soil management systems: a review. Journal of Sustainable Agricultural and Environmental Sciences, 3(3), 101-124.
IFAD (2020). Smallholder Farmers and Sustainable Agriculture in Asia and Africa. Rome: International Fund for Agricultural Development.
Izza, A., & Anisa, F. (2024). Rwanda's Partnership with The FAO: Advancing Agricultural Sustainability And Meeting The SDGS. Journal of Social Political Sciences, 5(1), 1-18.
Kinyili, B. M., & Ndunda, E. (2022). Chapter 1. Adoption of sustainable agroforestry practices in sub-Saharan Africa. Research Trends in Forestry Sciecnes, 1(1), 1-29.
MINAGRI. (2022). Agricultural Policy in Rwanda: A Pathway to Food Security. Kigali: Ministry of Agriculture and Animal Resources.
Mugisha, D., Manirere, J. D. A., Mutamuliza, E., & Ufitinema, B. (2024) Effect of good agricultural practices on Irish potato production: A case study of Jyambere Muhinzi Kinoni Cooperative in Burera District in Rwanda. African Journal of Agricultural and Resource Economics, 19(4), 339–352.
Muhamadi, S., & Boz, I. (2022). Factors influencing farmers' perception of sustainable agriculture: a case study of Musanze District, Rwanda. International Journal of Sustainable Agricultural Management and Informatics, 8(4), 408-424.
Mwankemwa, L. S., Silayo, V. C., Lazaro, E. L., & Mrema, G. C. (2023). Tomato post-harvest losses as influenced by improper handling facilities in Morogoro, Tanzania. Tanzania Journal of Agricultural Sciences, 22(2), 394-403.
Pachapur, P. K., Pachapur, V. L., Brar, S. K., Galvez, R., Le Bihan, Y., & Surampalli, R. Y. (2020). Food security and sustainability. *Sustainability: Fundamentals and Applications*, 1(1), 357-374.
Singirankabo, U. A., Ertsen, M. W., & van de Giesen, N. (2022). The relations between farmers' land tenure security and agriculture production. An assessment in the perspective of smallholder farmers in Rwanda. Land Use Policy, 118 (1), 1-14.
UNICEF. (2024). The state of food security and nutrition in the world 2024: Financing to end hunger, food insecurity and malnutrition in all its forms.
Warinda, E., Nyariki, D. M., Wambua, S., Muasya, R. M., & Hanjra, M. A. (2020, February). Sustainable development in East Africa: impact evaluation of regional agricultural development projects in Burundi, Kenya, Rwanda, Tanzania, and Uganda. In Natural Resources Forum, *Oxford, UK: Blackwell Publishing Ltd. 44*(1), 3-39).
Weatherspoon, D. D., Miller, S. R., Niyitanga, F., Weatherspoon, L. J., & Oehmke, J. F. (2021). Rwanda's commercialization of smallholder agriculture: implications for rural food production and household food choices. Journal of Agricultural & Food Industrial Organization, 19(1), 51-62.
Wei, T., & Xu, L. (2025). China food security comprehensive assessment dataset 2012–2022. Scientific Data, 12(1), 621.
World Bank. (2024). Food Security and Agricultural Resilience in Africa: Policy and Investment Frameworks. Washington, DC: World Bank.
Xu, Q., Ling, N., Chen, H., Duan, Y., Wang, S., Shen, Q., & Vandenkoornhuyse, P. (2020). Long-term chemical-only fertilization induces a diversity decline and deep selection on the soil bacteria. Msystems, 5(4), 10-1128.