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Farmers Capacity Building and Sustainability of Agricultural Projects in Rwanda: Case Study of Rwanda Agriculture Board

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Abstract: Agriculture continued to play a vital role in Rwanda's social and economic development, serving as a primary source of livelihood for the majority of the population. Despite numerous government and partner-supported initiatives, many agricultural projects had continued to face sustainability challenges, particularly after the withdrawal of external funding. These challenges were largely associated with limited farmer skills, weak institutional frameworks, and inadequate coordination among key stakeholders. The study on Farmers' Capacity Building and Sustainability of Agricultural Projects in Rwanda, with a case study of the Rwanda Agriculture Board (RAB). The specific objectives examining the effect of needs assessment, personnel development, institutional development, policy development, and stakeholder management on the sustainability of agricultural projects implemented by RAB. The study adopted a descriptive and correlational research design, target population comprised 620 participants, while. sample size was 243 respondents. Data were collected using structured questionnaires and key informant interviews. Quantitative data were analyzed using SPSS version 23.0 to generate descriptive statistics, correlation coefficients, and multiple regression results, while qualitative data were analyzed through thematic content analysis. The findings of correlation analysis showed strong positive relationships between the independent variables and project sustainability, with coefficients ranging from $r = 0.68$ to $r = 0.91$ ($p < 0.01$), indicating high to very strong associations. Regression analysis further demonstrated that the model was statistically significant ($F =$ significant at $p < 0.05$) and explained a substantial proportion of the variance in project sustainability, with an R^2 value of approximately 0.78, indicating that 78% of the variation in sustainability was accounted for by the capacity-building variables. Among the predictors, institutional development ($\beta \approx 0.29$) and stakeholder management ($\beta \approx 0.26$) emerged as the most influential factors, followed by personnel development ($\beta \approx 0.18$), needs assessment ($\beta \approx 0.15$), and policy development ($\beta \approx 0.12$), all of which were statistically significant at $p < 0.05$.

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I. INTRODUCTION

Agriculture has long been recognized as a driver of economic growth, food security, and poverty reduction globally. In developed economies, continuous farmer training and strong extension systems have proven effective in sustaining agricultural projects. The capacity building in Europe has been reinforced through the European Union's Common Agricultural Policy (CAP), which allocates resources for farmer advisory networks and climate farm demonstration programs. These programs have enabled knowledge exchange across member states, ensuring that farmers are better prepared to adopt sustainable innovations (World Bank, 2023). In Asia, particularly in India and China, large-scale farmer training programs combined with digital platforms for agricultural extension have proven transformative. Mobile-based advisory services, for example, have reached millions of smallholder farmers, providing timely guidance on drought-tolerant seeds, pest management, and efficient irrigation practices. This has not only improved crop yields but also reduced vulnerability to recurrent climate shocks, making farming systems more resilient (FAO, 2023). Specifically, India's National Rural Livelihoods Project (2022) revealed that capacity-building initiatives focusing on women farmers led to a 20% increase in household incomes, alongside significant improvements in food security resilience. These findings underscore that when farmers especially women, who form the backbone of rural agriculture are equipped with the right skills, both

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productivity and livelihoods can improve substantially (World Bank, 2022).

In Sub-Saharan Africa (SSA), the urgency of capacity building is heightened by persistent productivity gaps. According to the FAO (2023), cereal yields in SSA average 1.5 tons per hectare, far below the global average of 3.9 tons per hectare, primarily due to weak extension systems and limited access to modern technologies. Empirical studies confirm the value of farmer training: a randomized evaluation in Ethiopia (World Bank, 2022) showed that participation in farmer field schools increased adoption of improved seeds by 25% and improved household food security scores by 18%. Similarly, a study in Kenya (Odendo *et al.*, 2023) found that dairy farmers who received structured training on feed formulation and animal health recorded a 30% rise in milk productivity compared to those without training.

Within the East African Community (EAC), the 2024 EAC Agricultural Investment Report highlighted that joint regional farmer training programs on seed quality and pest control improved cross-border maize trade volumes by 12%, indicating that coordinated capacity-building interventions not only improve productivity but also strengthen regional market integration. Agriculture remains a cornerstone of Rwanda's economy, employing approximately 43% of the labor force and contributing about 27% to the national GDP as of 2025. Despite its critical role, agricultural productivity is constrained by challenges such as land fragmentation, limited mechanization, and significant post-harvest losses. The National Institute of Statistics of Rwanda (NISR, 2024) reports that post-harvest losses in staple crops like maize and beans average 17%, undermining both household incomes and national food reserves.

In response to these challenges, the Rwanda Agriculture Board (RAB) has implemented several capacity-building initiatives. For instance, a 2023 pilot training program on post-harvest handling in Eastern Province reduced maize losses from 18% to 9% within two seasons, demonstrating the direct impact of practical farmer training. Similarly, an evaluation by the Ministry of Agriculture and Animal Resources (MINAGRI, 2024) found that farmers trained in climate-smart agriculture techniques achieved 22% higher yields compared to non-trained farmers. Despite these positive outcomes, structural constraints persist. Rwanda's extension system faces a significant gap, with the extension agent-to-farmer ratio currently estimated at 1:600, far above the African Development Bank's recommended 1:200. This limits effective follow-up and technical support for trained farmers. Additionally, limited access to finance, weak market linkages, and climate-related shocks continue to hinder the full translation of capacity-building efforts into sustainable outcomes.

Rwanda's policy frameworks, particularly the Strategic Plan for Agricultural Transformation (PSTA-IV), emphasize farmer capacity building as a cornerstone for sustainable agriculture. Studies and pilot projects have shown that when training interventions are context-specific, continuous, and supported with access to inputs and infrastructure, they significantly enhance sustainability. However, challenges such as inadequate scaling, limited institutional coordination, and weak long-term monitoring still threaten these gains. Against this backdrop, the current study investigates the extent to which farmers' capacity-building initiatives implemented by RAB contribute to the sustainability of agricultural projects in Rwanda.

- *Statement of the Problem*

Despite the efforts of government and its partners in investing in Capacity-building programs for farmers and also its usefulness; the reality on the ground presents several constraints. Evaluations of RAB programs indicate that needs assessments are often insufficient, resulting in training programs that do not fully match farmers' priorities, reducing adoption rates of recommended practices (Munyaneza & Mutangana, 2020; Uwitonze *et al.*, 2021). Personnel development is limited, with extension agent-to-farmer ratios estimated at 1:500-1:600, far above the recommended 1:200, which restricts follow-up support and mentorship (AfDB, 2023). Institutional weaknesses and restricted access to financial services also hinder the scaling up of effective agricultural initiatives (Habimana, 2022).

Moreover, gaps in policy development and implementation persist. While frameworks such as the Strategic Plan for Agricultural Transformation (PSTA-IV) prioritize capacity building, inadequate coordination and insufficient resource allocation compromise program effectiveness (MINAGRI, 2022). Stakeholder management challenges, including fragmented efforts and weak collaboration among actors, further reduce the potential impact of agricultural interventions (World Bank, 2023). Evidence from FAO (2023) highlights that many capacity-building programs remain short-term and output-focused, often emphasizing the number of farmers trained rather than the long-term sustainability of knowledge and practices.

Recent studies also demonstrate that previous interventions have focused heavily on technological adoption while neglecting human and institutional dimensions. For example, Ntakirutimana (2020) and Byiringiro *et al.* (2022) examined improved seeds and irrigation technologies but gave little attention to farmer training, organizational capacity, and social capital. Similarly, Nyiransabimana and Karemera (2023) observed that although digital agriculture platforms are expanding, low digital literacy among farmers limits their effectiveness. This current study seeks to address these gaps by examining how the full spectrum of capacity-building components including needs assessment, personnel development, institutional development, policy development, and stakeholder management affects the sustainability of agricultural projects implemented by RAB.

- *Research Objectives*

To assess the effect of farmers' capacity building on the sustainability of agricultural projects implemented by the Rwanda Agriculture Board (RAB). Specific Objectives:

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- To evaluate the effect of needs assessment on the sustainability of agricultural projects implemented by the RAB;
- To examine the influence of personnel development on the sustainability of agricultural projects supported by RAB;
- To assess the role of institutional development in enhancing the sustainability of agricultural projects under RAB;
- To analyze the effect of policy development on the sustainability of agricultural projects facilitated by RAB;
- To examine the role of stakeholder management in capacity building on the sustainability of agricultural projects under RAB.

➢ *Research Hypotheses*

The following alternative hypotheses (H_1) were tested and verified.

- H_1: Needs assessment has a significant positive effect on the sustainability of agricultural projects implemented by the Rwanda Agriculture and Animal Resources Development Board (RAB);
- H_2: Personnel development significantly influences the sustainability of agricultural projects supported by RAB;
- H_3: Institutional development plays a significant role in enhancing the sustainability of agricultural projects under RAB;
- H_4: Policy development has a significant effect on the sustainability of agricultural projects facilitated by RAB;
- H_5: Stakeholder management in capacity building significantly affects the sustainability of agricultural projects under RAB.

II. THEORETICAL REVIEW

Theoretical review serves as the backbone of any academic investigation because it provides the intellectual foundation that connects the study's concepts, variables, and expected relationships. In research examining farmers' capacity building and the sustainability of agricultural projects, theories help explain why and how certain interventions such as needs assessment, personnel development, institutional strengthening, policy design, and stakeholder management influence project outcomes.

According to Creswell and Creswell (2023), a well-chosen theoretical framework helps transform abstract concepts into measurable research constructs while guiding the formulation of hypotheses and interpretation of findings. In the context of agricultural sustainability, theory clarifies the dynamic relationships between human behavior, institutional arrangements, and policy environments that drive long-term success of development projects (Gibson *et al.*, 2022). This section, therefore, explores three major theories that inform the current study such as human capital theory, diffusion of innovations theory, and institutional theory.

➢ *Human Capital Theory*

The theoretical review links relevant theories to the study topic and conceptual framework by explaining how the independent variables influence the dependent variable. In this study, the independent variables relate to capacity-building dimensions particularly personnel development and needs-based training while the dependent variable is the sustainability of agricultural projects, which is operationalized through indicators such as productivity, income stability, resilience, and long-term project continuity.

Human Capital Theory, first formalized by Gary Becker in 1964, posits that the knowledge, skills, experience, and health embodied in individuals constitute valuable economic assets. According to the theory, investments in education, training, and health enhance workers' productivity, which in turn generates higher returns for both individuals and society. In the agricultural sector, this implies that strengthening the skills and competencies of farmers, extension officers, and project staff leads to improved productivity, greater adoption of innovations, and enhanced resilience of agricultural systems by Becker, 1964.

Recent empirical studies reinforce the relevance of Human Capital Theory in explaining sustainable agricultural outcomes. For instance, Wang (2022) demonstrates that higher levels of human capital among farm laborers are associated with improved technology utilization and more efficient resource management. Klonowska-Matynia (2022) shows that education and locally embedded skills significantly influence farmers' adoption of sustainable agricultural practices. These findings suggest that human capital development is a critical enabler of sustainable agricultural transitions.

One of the major strengths of Human Capital Theory lies in its clear causal logic and practical applicability. Investments in training, education, and capacity-building can be operationalized and measured using indicators such as training frequency, certification levels, and skill acquisition. However, the theory also faces notable limitations. It tends to underemphasize structural and contextual constraints such as land tenure systems, market access, and institutional inefficiencies that may limit the returns on human capital investments. Additionally, the theory often assumes uniform learning outcomes, overlooking how cultural, social, and gender-related barriers can affect the translation of training into practice. Empirical gaps therefore remain regarding the quality, sequencing, and contextual relevance of training interventions, particularly in determining which combinations of technical, managerial, and social skills best support long-term agricultural project sustainability (Wang, 2022; Klonowska-Matynia, 2022).

In the context of the present study, Human Capital Theory provides a primary explanatory lens for understanding why personnel development and needs-based capacity building are essential to the sustainability of agricultural projects. The theory supports the hypothesis that targeted investments in farmers' and extension officers' knowledge and skills increase the likelihood that agricultural

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projects will remain productive and viable over time. When agricultural actors receive appropriate training and continuous support, they are better equipped to apply modern farming techniques, manage resources efficiently, and adapt to challenges such as climate variability and market fluctuations. By framing personnel development as an investment rather than a cost, Human Capital Theory reinforces the study's argument that long-term project success depends not only on financial and physical inputs but also on the competence and commitment of the people involved. Consequently, the theory aligns closely with the study's conceptual framework by explaining how human capacity development contributes to sustainable agricultural performance. Overall, Human Capital Theory underpins the assumption that strengthening human capital is a key pathway to achieving sustainable agricultural transformation, particularly within the Rwandan context.

- *Diffusion of Innovations Theory*

The Diffusion of Innovations Theory, introduced by Everett Rogers in 1962, explains how new ideas, practices, or technologies are communicated and adopted across a social system over time. The model conceptualizes the adoption process in five stages: knowledge, persuasion, decision, implementation, and confirmation. Rogers also identifies key innovation attributes that influence adoption speed, including relative advantage, compatibility with existing practices, complexity (ease of use), trialability (ability to test on a small scale), and observability (visibility of results). In agriculture, this framework is highly relevant for understanding why certain sustainable practices or technologies such as soil conservation methods, precision tools, or improved crop varieties are quickly adopted by some farmers while others lag behind. Adoption is determined not only by individual farmer characteristics but also by social networks, communication channels, and the influence of opinion leaders (Rogers, 2003).

Empirical evidence underscores the practical applicability of the diffusion framework in agricultural contexts. Montes de Oca Munguía (2021) and Penn State Extension (2024) highlight that diffusion strategies such as demonstration plots, farmer champions, and pilot trials effectively accelerate the adoption of innovations. Moreover, recent studies show that understanding local social dynamics, peer influence, and community learning networks is critical to increasing the uptake of sustainable agricultural practices. However, the theory is not without limitations. The traditional model is overly linear and individualistic, often neglecting collective decision-making, institutional barriers, market constraints, and gender dynamics that influence adoption. The classical adopter-category typology (innovators, early adopters, etc.) may not perfectly align with smallholder settings, where shared risk and communal decision-making affect technology uptake. Research gaps remain in integrating diffusion theory with institutional, policy, and socio-ecological factors to explain how incentives, markets, and governance structures interact with social networks to shape adoption patterns (Montes de Oca Munguía, 2021).

For the current study, diffusion of innovations theory provides an actionable lens to examine how needs assessment and personnel development influence the adoption and sustainability of agricultural practices. The theory suggests that interventions such as demonstration plots, tailored messaging, peer learning, and the involvement of trusted extension agents can accelerate farmers' understanding and uptake of new technologies. It further explains how attributes like relative advantage, compatibility, simplicity, trialability, and observability determine whether and how quickly innovations are adopted within farming communities. By focusing on the social and communication aspects of adoption, the theory complements the study's independent variables, particularly personnel development, capacity-building, and targeted training initiatives.

The strength of the theory lies in its practical diagnostic power, offering clear guidance for designing interventions that foster innovation adoption. It emphasizes the importance of communication channels, community engagement, and visible results, which are critical for scaling sustainable practices. Nonetheless, its limitations remind researchers to account for collective dynamics, structural constraints, and contextual factors, especially in smallholder agricultural systems. By grounding this study in diffusion of innovations theory, it becomes possible to analyze not only whether farmers adopt new practices, but also how, why, and at what pace adoption occurs. T

- *Institutional Theory*

Institutional Theory, advanced by Douglass North in 1990, and subsequent scholars, emphasizes how formal rules such as laws, policies, and regulations and informal constraints such as norms, customs, and social networks shape economic behavior and organizational performance. In the agricultural context, this theory highlights how governance structures, property rights, accountability mechanisms, and inter-organizational relationships influence whether project inputs such as training, infrastructure, and financial resources translate into sustainable outcomes. By focusing on the institutional environment, the theory draws attention to the systemic conditions that enable or constrain long-term agricultural success. A key strength of institutional theory is its ability to explain both persistence and change at organizational and systemic levels. Institutions create incentives or disincentives that can either reinforce sustainable practices or perpetuate unsustainable behavior. Contemporary empirical studies demonstrate that the quality of formal and informal institutions along agricultural value chains predicts the capacity to scale and sustain innovations.

Klein *et al.* (2022) show that robust institutional arrangements, including well-coordinated governance and monitoring systems, enhance the adoption and longevity of sustainable practices, while Osei (2024) finds that weak institutional frameworks undermine project outcomes despite similar resource inputs. Nonetheless, operationalizing the theory can be challenging because institutions function across multiple levels and interact in complex, non-linear ways, making causality difficult to isolate. Significant research gaps remain, particularly regarding the micro-level mechanisms

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through which institutional reforms influence day-to-day farming decisions, especially in low-resource settings where informal networks may dominate over formal rules (Klein *et al.*, 2022; Osei, 2024). For the current study, Institutional Theory is indispensable for understanding why institutional development such as strengthening farmer organizations, streamlining resource allocation, and embedding monitoring systems is critical to sustaining agricultural projects. The theory suggests that capacity-building initiatives alone are insufficient; their success depends on supportive policy, governance, and organizational frameworks. In agricultural systems, the strength, transparency, and coordination of institutions determine whether investments in training, infrastructure, and finance lead to long-term sustainability. Strong institutions create incentives that encourage innovation and good practices, whereas weak or poorly aligned institutions can hinder adoption, reduce efficiency, and perpetuate unsustainable behaviors.

This theoretical lens allows the study to examine sustainability beyond individual skills or training by focusing on the broader institutional context. Well-structured farmer organizations, clear mechanisms for resource allocation, and robust monitoring and evaluation frameworks are crucial for ensuring that capacity-building investments translate into measurable, enduring outcomes. Institutional theory also encourages the investigation of how local governance, policies, and organizational arrangements influence project success, complementing the study's focus on human capital and innovation adoption. In summary, Institutional theory grounds this research by demonstrating that sustainable agricultural development depends not only on training and skills development but also on the presence of strong, transparent, and coordinated institutional systems. By shaping actor behavior, providing accountability, and enabling effective resource management, institutions play a central role in ensuring that agricultural projects achieve lasting impact and resilience within the Rwandan context.

➢ *Conceptual Framework*

The conceptual framework presents a visual representation of the assumed relationship between farmers' capacity building and the sustainability of agricultural projects. It demonstrates how the independent variable, farmers' capacity-building components such as needs assessment, personnel development, institutional development, policy development, and stakeholder management directly or indirectly influence the long-term outcomes and sustainability of agricultural projects.

➢ *Independent Variable*

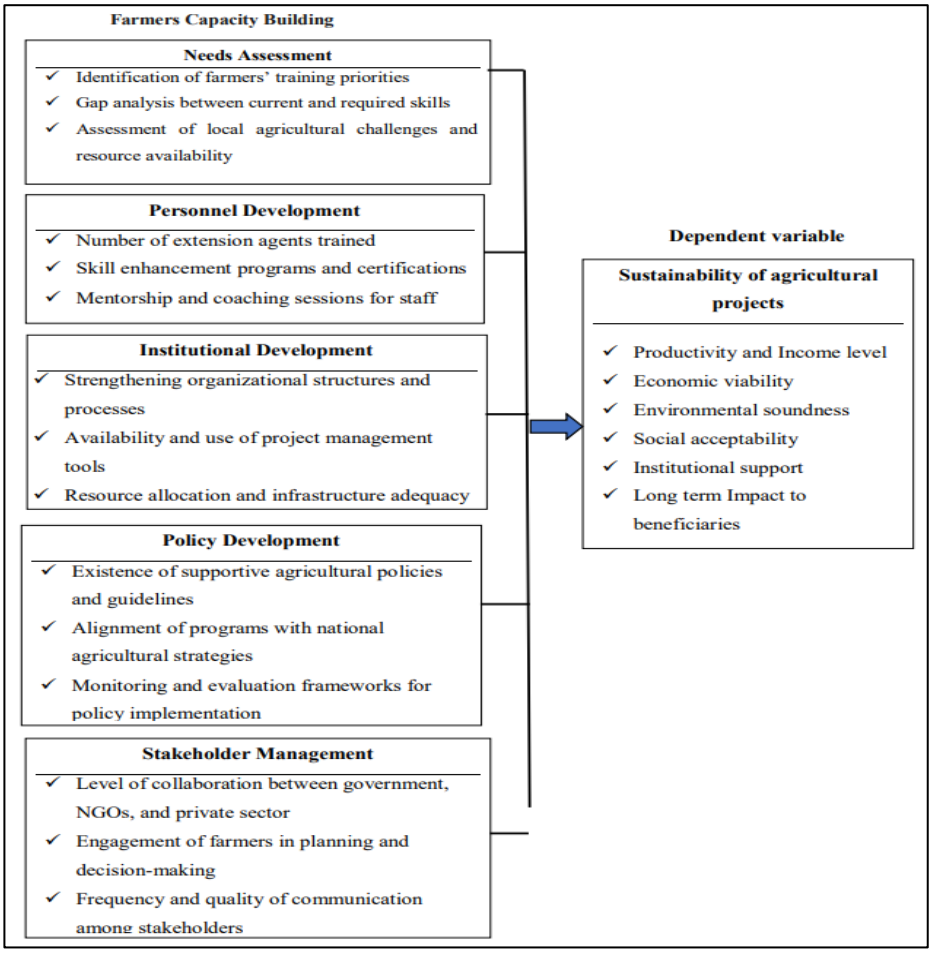


Fig 1 Conceptual Framework
Source: Researcher (2025) conceptualization based on literature reviewed

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III. RESEARCH METHODOLOGY

➢ *Research Design*

This study adopts a descriptive and correlational research design, which allows for both the detailed examination of existing conditions and the assessment of relationships among key variables of the current study. In this study; the descriptive component provides a clear picture of the current state of farmers' capacity building practices such as needs assessment, personnel development, institutional improvement, policy support, and stakeholder management and how these are implemented within selected agricultural projects. By collecting and summarizing data on farmers' experiences, institutional arrangements, and policy environments, the study establishes an accurate data that reflects the realities of capacity-building interventions in the agricultural sector.

➢ *Study Population*

The study population comprises 620 individuals.

Table 1 Study Population Stratification

Stratum	Category Description	Number of Individuals
Extension Officers, Field Agents & technicians	RAB staff who work directly with farmers, providing training, technical guidance, and conducting needs assessments	100
Project coordinators; Managers; & officers	Personnel responsible for planning, supervising, and evaluating agricultural projects under RAB	120
Administrative & Support Staff	Staff involved in institutional management, resource allocation, and coordination of policies and procedures	80
Farmers & Cooperative Leaders	Beneficiaries of RAB-led capacity-building programs; provide feedback and participate in project activities	320
Total Population	All individuals engaged in RAB agricultural projects relevant to this study	**620**

Source: RAB (2025) population relevant from organizational records

➢ *Sample Size and Sampling Techniques*

To determine the appropriate sample size, this study uses Yamane's formula in 1986, which is widely recognized for social and development research. The formula is as follows:

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

N = Total population, n = Sample size, e = error margin (0.05).

$$n = \frac{N}{1 + N(e^2)} = \frac{620}{1 + 620 * (0.05^2)} \approx 243$$

Thus, a sample of 243 respondents is sufficient to represent the entire population with a 95% confidence level and a 5% margin of error. To ensure that the study captures both representativeness and specialized insights, a combination of stratified random sampling and purposive sampling is applied. The population is divided into four strata based on their roles within RAB such as Extension officers and field agents; project coordinators and managers; administrative and support staff and farmers and cooperative leaders. Within each stratum, respondents are randomly selected in proportion to the stratum's size. In addition to random selection, certain respondents are deliberately chosen based on their expertise, experience, and level of involvement in agricultural projects. This includes senior RAB officers, lead project coordinators, and prominent farmers who have extensive knowledge of needs assessments, personnel development programs, institutional practices, policy execution, and stakeholder engagement. Purposive sampling ensures that the study captures in-depth, specialized perspectives that may not be evenly distributed across the population but are crucial for understanding the mechanisms driving sustainable project outcomes.

➢ *Data Collection Instruments*

In this research, primary data was gathered from RAB personnel and farmers/cooperative leaders who are actively involved in agricultural projects. The focus was on obtaining insights into needs assessment, personnel development, institutional development, policy formulation, and stakeholder management, and how these factors contribute to the sustainability of agricultural projects. To collect this data, the study used structured questionnaires for the wider sample to capture quantitative information on the implementation and effectiveness of capacity-building interventions. The questionnaire was in the form of five Likert scales where the scaling is composed of the following 1=Strongly Disagree (SD), 2=Disagree (D), 3=Neutral, 4=Agree (A) and 5=Strongly Agree (SA).

➢ *Data Processing and Analyzing*

Processing ensures that the data is accurate, complete, and systematically organized, enabling meaningful interpretation of results regarding the effects of capacity-building interventions on agricultural project sustainability. The study employed both descriptive and inferential statistical techniques to analyze the processed data, using SPSS Version 23.0. This dual approach ensured a comprehensive understanding of respondents' perceptions of capacity-building practices and the statistical relationships between the independent variables and the dependent variable (sustainability of agricultural projects). The coefficient of correlation is numerical value ranges from +1.0 to -1.0. In general, r > 0 indicates positive relationship, r < 0 indicates negative relationship while r = 0 indicates no relationship (or that the variables are independent and not related). r = +1.0 describes a perfect positive correlation and r = -1.0 describes

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a perfect negative correlation. Closer the coefficients are to +1.0 and -1.0, greater is the strength of the relationship between the variables.

Multiple linear regression analysis models were adopted to show relationships using equation econometric models where x is independent variable (capacity-building interventions) while y is dependent variable (sustainability of agricultural projects). They assessed whether the questions are clear, relevant to the objectives:

- x1: needs assessment,
- x2: personnel development,
- x3: institutional development
- x4: policy formulation,
- x5: stakeholder management,

$$y=f(x);\ Y= \beta 0+ \beta 1\chi 1+ \beta 2\chi 2+ \beta 3\chi 3+ \beta 4\chi 4+ \beta 5\chi 5+\varepsilon,$$

- β0: is the y-intercept;
- β1-β5: are the slopes of the line;
- ε: is an error term

Regression analysis tested the hypotheses as follows:

- H_1: Needs assessment significantly affects the sustainability of agricultural projects;
- H_2: Personnel development significantly influences the sustainability of agricultural projects;
- H_3: Institutional development significantly impacts the sustainability of agricultural projects;
- H_4: Policy formulation significantly affects the sustainability of agricultural projects;
- H_5: Stakeholder management significantly influences the sustainability of agricultural projects.

A p-value < 0.05 was considered statistically significant, indicating that the independent variable has a measurable effect on sustainability. Regression coefficients (β) showed the magnitude and direction of these effects, allowing the study to determine which capacity-building interventions most strongly predict project sustainability.

IV. DATA ANALYSIS, AND INTERPRETATION OF FINDINGS

The study involved a total of 243 respondents, representing a response rate of 100%, which demonstrates full participation of the sampled population. Data collection was conducted over a period of two weeks, after which the responses were carefully checked for completeness, cleaned, coded, and tabulated to ensure accuracy and reliability. Statistical analysis was performed using SPSS version 23.0, allowing for both descriptive and inferential examination of the data.

➢ *Reliability Statistics Results*

In this study, the internal consistency of the questionnaire items was evaluated using Cronbach's Alpha, a widely used measure for assessing reliability in social science research.

Table 2 Reliability Statistics Results

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N
.884	.971	15

Source: Primary Data from field (2026)

The results indicate a Cronbach's Alpha value of 0.884, while the Cronbach's Alpha based on standardized items was 0.971 across 15 items. These values exceed the commonly accepted threshold of 0.70 by Nunnally & Bernstein in 1994, suggesting that the instrument demonstrates a high level of internal consistency. This implies that the questionnaire items reliably measure the intended constructs, and the data collected are suitable for further statistical analysis. The high reliability of the instrument provides confidence that the subsequent findings and interpretations reflect accurate and consistent responses from the participants.

➢ *Demographics of Respondents*

Understanding the socio-demographic characteristics of respondents provides essential context for interpreting the study's findings. This section presents an analysis of the age, gender, education level, and experience of the participants involved in agricultural projects under investigation. A total of 243 respondents participated in this study, offering a robust sample to draw meaningful insights.

Table 3 Socio-Demographic Characteristics of Respondents

Demographic	Category	Frequency (fi)	Percent (%)	Cumulative (%)
Age of Respondent	20-29 years	28	11.5	11.5
	30-39 years	71	29.2	40.7
	40-49 years	74	30.5	71.2
	50-59 years	63	25.9	97.1
	Above 60 years	7	2.9	100
	Total	**243**	**100**	
Gender	Male	156	64.2	64.2
	Female	87	35.8	100

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	Total	**243**	**100**	
	Primary level	27	11.1	11.1
Level of Education	Secondary school certificate (A2)	87	35.8	46.9
	Diploma	69	28.4	75.3
	Bachelor's degree	51	21.0	96.3
	Master's degree and above	9	3.7	100.0
	Total	**243**	**100**	
Experience in Agricultural Projects	Less than 1 year	28	11.5	11.5
	1-5 years	90	37	48.6
	6-10 years	94	38.7	87.2
	Over 10 years	31	12.8	100
	Total	**243**	**100**	

Source: Primary Data from field (2026)

Regarding age distribution, the results indicate that the majority of respondents fall within the economically active and productive age brackets. Specifically, 30.5% of respondents are aged between 40-49 years, followed closely by 29.2% in the 30-39 years category. Additionally, 25.9% fall within 50-59 years, while only 11.5% are between 20-29 years and a minimal 2.9% are above 60 years.

In terms of gender, the findings reveal that 64.2% of respondents are male, while 35.8% are female. This indicates a higher level of male participation in agricultural projects within the study area. However, the presence of a substantial proportion of female respondents reflects increasing gender inclusivity in agricultural initiatives, which is essential for sustainable development.

With respect to the level of education, the data shows that most respondents possess at least a basic level of formal education. The largest group (35.8%) holds a secondary school certificate (A2), followed by those with diplomas (28.4%) and bachelor's degrees (21.0%). A smaller proportion (11.1%) has primary education, while only 3.7% have attained a master's degree or higher.

Concerning experience in agricultural projects, the findings indicate that a significant proportion of respondents have considerable practical exposure. The majority fall within 6-10 years (38.7%) and 1-5 years (37%) of experience, while 12.8% have over 10 years of experience and 11.5% have less than one year.

➢ *Descriptive Statistics Results on Study Objectives*

The descriptive analysis of the study findings was focusing on how farmers' capacity building influences the sustainability of agricultural projects implemented by the Rwanda Agriculture Board (RAB). The analysis is structured around the study's specific objectives, which explore the roles of institutional development, policy frameworks, and stakeholder management in promoting sustainable agricultural interventions.

Table 4 Overall Average Descriptive Statistics of the Study Variables

Study Variable	**N**	**Mean**	**Std. Deviation**	**Skewness**	**Kurtosis**	**Interpretation**
Needs Assessment	243	4.5926	0.6804	-1.8028	3.3745	High Agreement
Personnel Development	243	4.7346	0.5413	-2.3253	6.9660	Very High Agreement
Institutional Development	243	4.7202	0.5200	-1.7818	2.7843	Very High Agreement
Policy Development	243	4.7202	0.5200	-1.7818	2.7843	Very High Agreement
Stakeholder Management	243	4.7202	0.5200	-1.7818	2.7843	Very High Agreement
Project Sustainability (Dependent Variable)	243	4.6656	0.6634	-2.2758	5.8250	Very High Agreement
Grand Overall Average	**243**	**4.6922**	**0.5742**	**-1.9589**	**4.0864**	**Very High Agreement**

Source: Computed from Primary Data (2026).

The overall descriptive statistics indicate that respondents expressed very high agreement with all dimensions of farmers' capacity building and project sustainability, as reflected by a grand overall mean of 4.6922 (SD = 0.5742). Among the independent variables, Personnel Development recorded the highest mean (M = 4.7346), followed by Institutional Development, Policy Development, and Stakeholder Management (each M = 4.7202), while Needs Assessment had the lowest, though still very high, mean (M = 4.5926). The dependent variable, Project Sustainability, achieved a high overall mean of 4.6656, demonstrating strong respondent agreement that agricultural projects implemented by RAB are sustainable. The negative skewness values across all variables indicate that responses were concentrated toward the "Agree" and "Strongly Agree" categories, while the positive kurtosis values suggest relatively peaked distributions with strong consensus among respondents. Overall, the findings demonstrate that farmers' capacity-building practices were perceived to contribute substantially to the sustainability of agricultural projects implemented by the Rwanda Agriculture Board (RAB).

➢ *Inferential Statistics Analysis Results*

The results are presented in terms of normality testing, correlation analysis, and multiple linear regression to offer a

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comprehensive understanding of the dynamics between the study variables.

➢ *Normality Test*

The descriptive statistics, confidence intervals, and stem-and-leaf plots suggested that the data were approximately normally distributed, albeit with slight skewness. This step validated that the dataset was appropriate for subsequent inferential tests, providing a solid foundation for examining relationships between capacity-building practices and project outcomes.

Table 5 Descriptive Statistics

			Statistic	**Std. Error**
Sustainability of agricultural projects	Mean		75.2963	.43771
	95% Confidence Interval for Mean	Lower Bound	74.4341	
		Upper Bound	76.1585	
	5% Trimmed Mean		75.9369	
	Median		80.0000	
	Variance		46.556	
	Std. Deviation		6.82323	
	Minimum		44.00	
	Maximum		80.00	
	Range		36.00	
	Interquartile Range		9.00	
	Skewness		-1.498	.156
	Kurtosis		2.392	.311

The descriptive analysis of the sustainability of agricultural projects under the Rwanda Agriculture Board (RAB) provides a detailed understanding of how respondents perceive project performance across multiple dimensions. The mean score of 75.30 (Std. Error = 0.438) indicates that, on average, respondents rate the sustainability of RAB-supported agricultural projects highly, reflecting a generally positive evaluation of project outcomes and long-term impacts.

The 95% confidence interval for the mean, ranging from 74.43 to 76.16, suggests that the true average perception of project sustainability in the population is likely to fall within this range, highlighting the reliability of the collected data. Furthermore, the 5% trimmed mean of 75.94 slightly exceeds the overall mean, implying that a small number of lower ratings slightly reduced the average but that most responses were concentrated at the higher end of the scale. The median value of 80.00 further supports this interpretation, indicating that at least half of the respondents gave the maximum possible rating for sustainability.

Variability in responses, captured by the variance (46.556) and standard deviation (6.823), suggests moderate differences among respondents' perceptions, though the concentration of ratings at higher values shows general agreement on the positive sustainability of projects. The observed range of 36.00 (minimum = 44; maximum = 80) and interquartile range of 9.00 indicate that while most respondents are in strong agreement, a few provided comparatively lower ratings, reflecting minor variations in experiences or expectations.

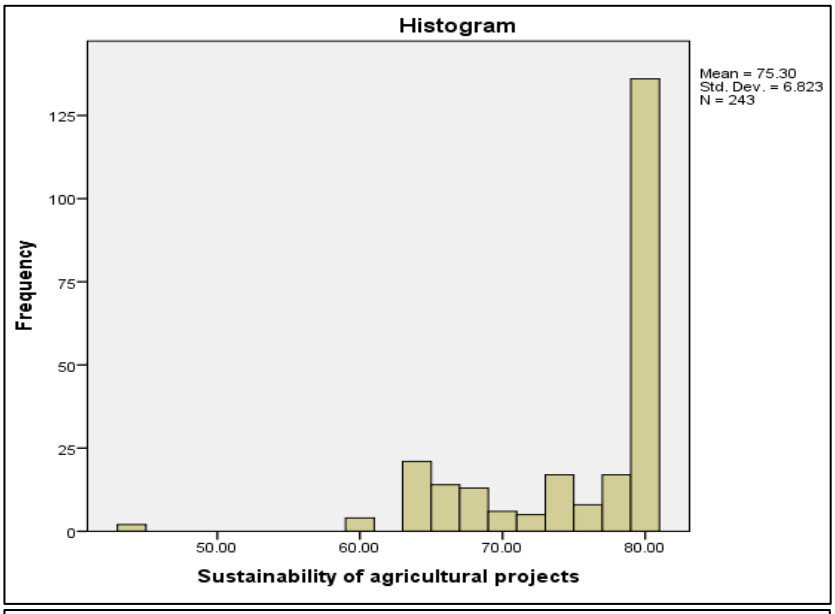
The negative skewness (-1.498, Std. Error = 0.156) indicates that the distribution of responses is skewed to the left, meaning the majority of respondents provided high ratings, with fewer respondents reporting lower perceptions of project sustainability. The positive kurtosis of 2.392 suggests that the distribution is moderately peaked, reflecting a clustering of responses around the upper values, further demonstrating a consensus that RAB projects are effective and sustainable.

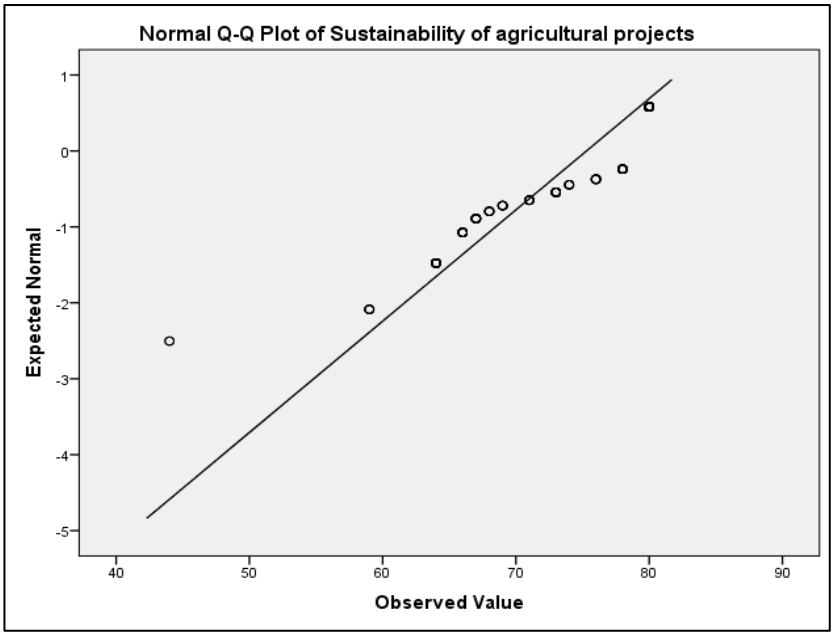
Table 6 Tests of Normality

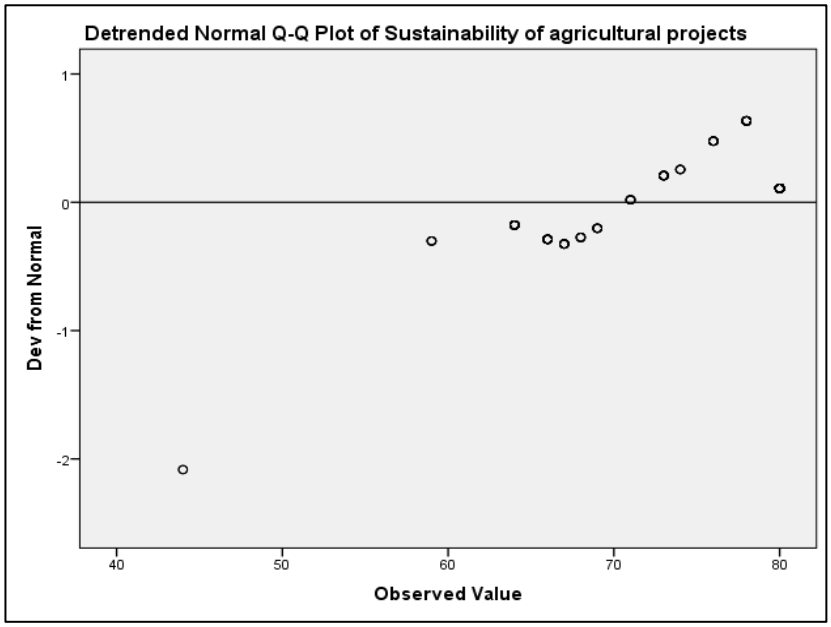
	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	df	Sig.	Statistic	df	Sig.
Sustainability of agricultural projects	.314	243	.000	.716	243	.000
a. Lilliefors Significance Correction						

In this study, the sustainability of agricultural projects was evaluated using both the Kolmogorov-Smirnov and Shapiro-Wilk tests. The Kolmogorov-Smirnov statistic for sustainability of agricultural projects was 0.314 with a significance value of 0.000, while the Shapiro-Wilk test yielded a statistic of 0.716, also with a significance of 0.000. Both results are statistically significant at the 0.05 level, indicating that the data do not follow a perfectly normal distribution. This outcome suggests that respondents' perceptions of project sustainability are slightly skewed, which aligns with the previously observed negative skewness in the descriptive statistics (-1.498).

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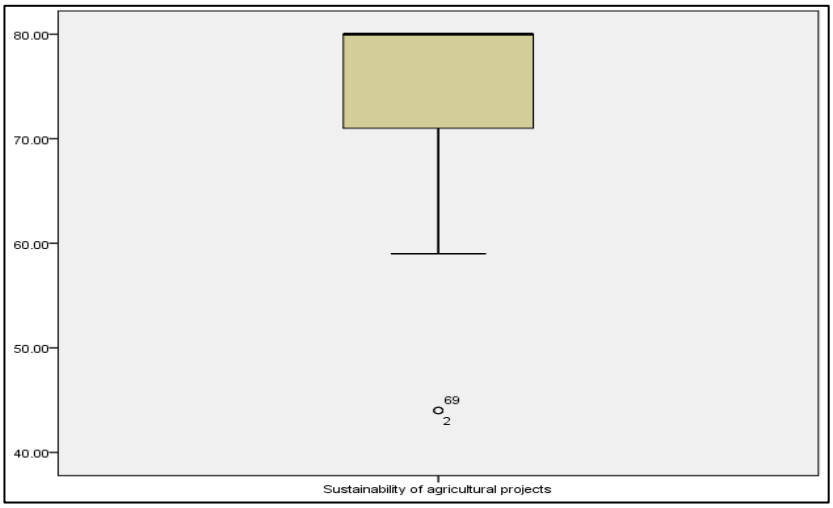


Fig 2 Sustainability of Agricultural Projects Stem-and-Leaf Plot

The normality tests indicate that while the sustainability data deviate from perfect normality, the results are robust and can be confidently used in subsequent inferential statistical analyses to explore the relationships between capacity-building practices and project sustainability outcomes.

➢ *Correlation Coefficient Analysis*

The correlation analysis was conducted to investigate the strength and direction of relationships among the study variables, including needs assessment, personnel development, institutional development, policy formulation, stakeholder management, and overall capacity-building practices

Table 7 Correlations Coefficient Matrix Results

		x1: Needs assessment	**x2: Personnel development**	**x3: Institutional development**	**x4: Policy formulation**	**x5: Stakeholder management**	**Capacity-building practices**	**Sustainability of agricultural projects**
x1: Needs assessment	Pearson Correlation	1						
	Sig. (2-tailed)							
	N	243						
x2: Personnel development	Pearson Correlation	.723**	1					
	Sig. (2-tailed)	.000						
	N	243	243					
x3: Institutional development	Pearson Correlation	.835**	.758**	1				
	Sig. (2-tailed)	.000	.000					
	N	243	243	243				
x4: Policy formulation	Pearson Correlation	.876**	.724**	.840**	1			
	Sig. (2-tailed)	.000	.000	.000				
	N	243	243	243	243			
x5: Stakeholder	Pearson Correlation	.754**	.824**	.791**	.755**	1		

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management	Sig. (2-tailed)	.000	.000	.000	.000			
	N	243	243	243	243	243		
Capacity-building practices	Pearson Correlation	.932**	.877**	.930**	.935**	.864**	1	
	Sig. (2-tailed)	.000	.000	.000	.000	.000		
	N	243	243	243	243	243	243	
Sustainability of agricultural projects	Pearson Correlation	**.854****	**.746****	**.835****	**.858****	**.779****	**.897****	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	243	243	243	243	243	243	243
***. Correlation is significant at the 0.01 level (2-tailed).*								

The analysis demonstrates that all sub-variables such as needs assessment, personnel development, institutional development, policy formulation, and stakeholder management are positively and significantly associated with project sustainability at the 0.01 level. Needs assessment exhibits a strong positive correlation with sustainability ($r = 0.854$, $p < 0.01$), suggesting that systematically evaluating farmers' training requirements, identifying skill gaps, and understanding local agricultural challenges plays a critical role in enhancing the long-term outcomes of projects.

Personnel development also shows a strong positive relationship with project sustainability ($r = 0.746$, $p < 0.01$), indicating that continuous training, mentorship, and skill enhancement for extension agents and project staff are pivotal.

The correlation between institutional development and project sustainability is notably high ($r = 0.835$, $p < 0.01$).

Similarly, policy formulation shows a significant positive correlation with sustainability ($r = 0.858$, $p < 0.01$), emphasizing that well-crafted, supportive agricultural policies and alignment with national development strategies enhance the ability of projects to achieve long-term objectives.

The stakeholder management is positively correlated with sustainability ($r = 0.779$, $p < 0.01$).

The composite of these capacity-building practices demonstrates a very strong correlation with the sustainability of agricultural projects ($r = 0.897$, $p < 0.01$), confirming that projects are more likely to endure when needs assessment, personnel development, institutional development, policy formulation, and stakeholder management are effectively integrated.

➢ *Multiple Linear Regression Analysis*

To determine the combined effect of the identified capacity-building factors on project sustainability, multiple linear regression was performed. The model demonstrated a high predictive power, explaining a substantial proportion of the variation in sustainability outcomes.

Table 8 Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.901[a]	.812	.808	2.98626	1.997
a. Predictors: (Constant), *x5: Stakeholder management, x1: Needs assessment, x2: Personnel development, x3: Institutional development, x4: Policy formulation*					
b. Dependent Variable: *Sustainability of agricultural projects*					

The model shows a correlation coefficient (R) of 0.901, indicating a very high positive association between the set of capacity-building practices and project sustainability. This suggests that as the effectiveness of these capacity-building activities increases, the sustainability of agricultural projects also tends to improve substantially.

The coefficient of determination (R^2) is 0.812, meaning that approximately 81.2% of the variation in project sustainability can be explained collectively by the five capacity-building practices included in the model. The adjusted R^2 (0.808) further confirms that the model accounts for most of the variability while adjusting for the number of predictors, demonstrating a strong explanatory power and minimal overfitting.

The standard error of the estimate (2.986) reflects the average distance between the observed sustainability scores and the predicted values, indicating that the model predictions are reasonably precise. Additionally, the Durbin-Watson statistic of 1.997 is very close to the ideal value of 2.0, suggesting that the residuals are independent and there is no serious autocorrelation problem in the data.

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Table 9 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9153.166	5	1830.633	205.280	.000[b]
	Residual	2113.501	237	8.918		
	Total	11266.667	242			
a. Dependent Variable: Sustainability of agricultural projects						
b. Predictors: (Constant), x5: Stakeholder management, x1: Needs assessment, x2: Personnel development, x3: Institutional development, x4: Policy formulation						

The sum of squares for regression (9153.166) compared to the residual sum of squares (2113.501) indicates that a large proportion of the total variability in sustainability is accounted for by the predictors. This reinforces the strength of the model identified in the model summary, confirming that the independent variables explain most of the differences in how respondents perceive the sustainability of agricultural projects.

The mean square for regression (1830.633) versus the residual mean square (8.918) further highlights the substantial impact of the predictors in driving project outcomes. The significant F-test demonstrates that the regression model is a reliable tool for predicting sustainability and that none of the observed relationships are due to random chance.

Table 10 Regression Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.301	2.323		1.851	.005		
	x1: Needs assessment	1.057	.244	.277	4.333	.000	.193	5.170
	x2: Personnel development	.298	.198	.079	1.505	.003	.286	3.493
	x3: Institutional development	.792	.256	.189	3.094	.002	.212	4.727
	x4: Policy formulation	1.126	.240	.305	4.692	.000	.189	5.305
	x5: Stakeholder management	.494	.224	.125	2.205	.008	.247	4.054
a. Dependent Variable: Sustainability of agricultural projects								

The constant (intercept) of 4.301 represents the predicted sustainability score when all capacity-building variables are at zero. Although this scenario is theoretical, it provides a baseline for interpreting the effects of each predictor.

Needs assessment (B = 1.057, $p < 0.001$) has a strong positive effect on sustainability. This implies that for every one-unit improvement in needs assessment such as more thorough identification of farmers' skill gaps, agricultural challenges, or training priorities, the sustainability score of agricultural projects is expected to increase by 1.057 units, holding other factors constant.

Personnel development (B = 0.298, p = 0.003) also positively contributes to sustainability. A one-unit increase in personnel development through enhanced training, mentorship, or certification programs for staff would increase project sustainability by 0.298 units, assuming other variables remain unchanged.

Institutional development (B = 0.792, p = 0.002) indicates that strengthening organizational structures, providing adequate infrastructure, and applying project management tools can raise sustainability by 0.792 units for every one-unit improvement.

Policy formulation (B = 1.126, $p < 0.001$) has the largest positive effect among the sub-variables. This means that aligning projects with supportive agricultural policies and national strategies is expected to increase sustainability by 1.126 units per unit improvement in policy development.

Finally, stakeholder management (B = 0.494, p = 0.008) shows that enhanced collaboration among government agencies, NGOs, the private sector, and farmers would increase sustainability by 0.494 units for each one-unit improvement.

For instance, if RAB improves both needs assessment and policy formulation by one unit each, the combined sustainability score would increase by 2.183 units (1.057 + 1.126), demonstrating the additive and synergistic impact of these capacity-building practices. Moreover, the standardized Beta values indicate the relative influence of each sub-variable, showing that policy formulation (β = 0.305) and needs assessment (β = 0.277) are the most influential predictors, followed by institutional development, stakeholder management, and personnel development.

➢ *Collinearity Diagnostics*

Collinearity diagnostics are essential for understanding whether the independent variables like needs assessment, personnel development, institutional development, policy formulation, and stakeholder management are too closely related to each other, which could distort the regression results.

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Table 11 Collinearity Diagnostics

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions					
				(Constant)	x1: Needs assessment	x2: Personnel development	x3: Institutional development	x4: Policy formulation	x5: Stakeholder management
1	1	5.987	1.000	.00	.00	.00	.00	.00	.00
	2	.006	31.419	.90	.02	.01	.00	.03	.00
	3	.003	42.237	.04	.08	.33	.01	.09	.11
	4	.001	63.658	.02	.03	.65	.06	.02	.70
	5	.001	69.061	.03	.17	.01	.91	.03	.18
	6	.001	72.400	.01	.70	.00	.02	.82	.00
a. Dependent Variable: Sustainability of agricultural projects									

The eigenvalues range from 5.987 for the first dimension to 0.001 for the smallest dimensions, while the condition indices span from 1.000 to 72.400. According to standard guidelines, condition indices above 30 may indicate moderate to high multicollinearity, and indices above 100 suggest severe collinearity. In this model, the highest condition index is 72.400, which is below the threshold for severe collinearity, suggesting that although some variables share moderate relationships, they do not compromise the validity of the regression model.

The variance proportions provide additional insight. For example, in dimension 4, a high proportion of variance is observed for institutional development (0.65) and stakeholder management (0.70), while other variables contribute minimally to the same dimension. Similarly, in dimension 5, personnel development shows a high variance proportion (0.91), indicating some shared variance among predictors.

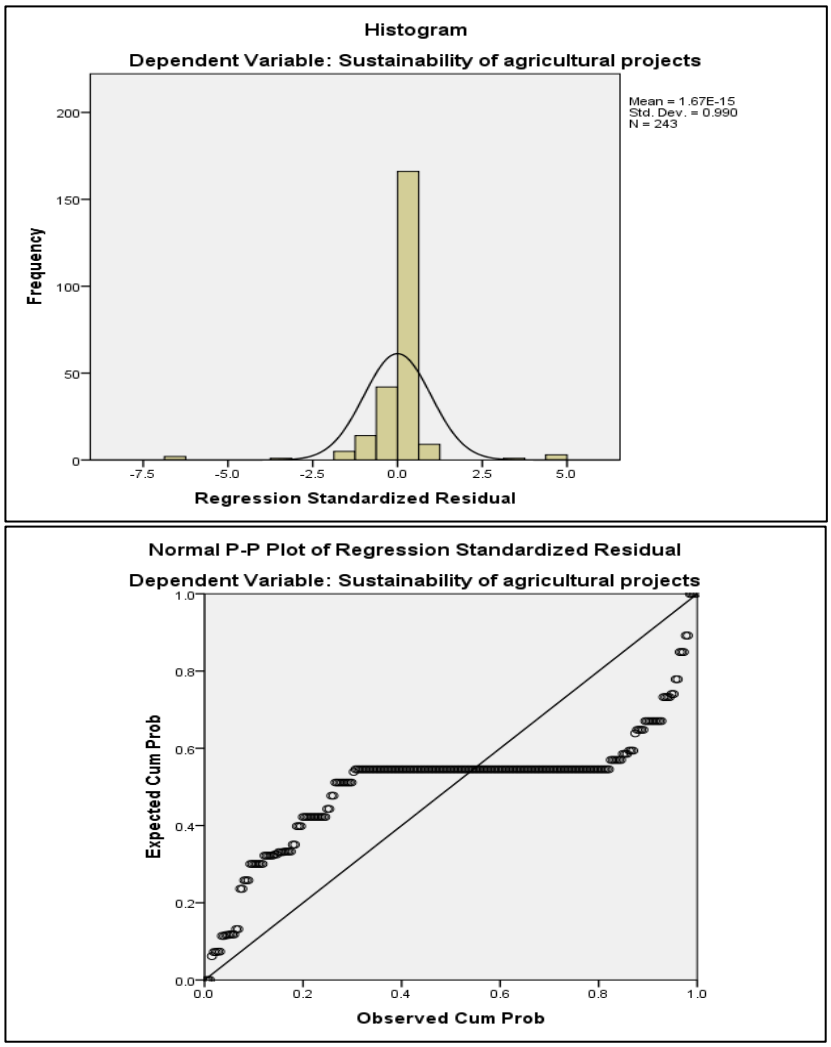


Fig 3 Normal P-P Plot of Regression Standardized Residual

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These findings align with previous research emphasizing the importance of independent contributions of capacity-building practices. Kumwenda *et al.* (2024) and Mensah & Osei (2023) also found that moderate correlations among predictors did not undermine the predictive validity of models examining agricultural project sustainability, reinforcing the robustness of multi-dimensional capacity-building frameworks. The inferential analysis confirms that capacity-building practices have a significant and positive impact on the sustainability of agricultural projects. Each dimension ranging from personnel development to stakeholder management contributes uniquely to ensuring that projects achieve long-term benefits. These findings reinforce the importance of holistic approaches, where training, policy alignment, institutional strengthening, and collaborative engagement work together to promote sustainable agricultural development.

V. CONCLUSION AND RECOMMENDATIONS

➢ *Conclusion*

Based on the empirical evidence, the study concludes that farmers' capacity building is a fundamental pillar for achieving sustainable agricultural development in Rwanda. The findings clearly demonstrate that all five components of capacity building LIKE needs assessment, personnel development, institutional development, policy development, and stakeholder management have significant and positive effects on the sustainability of agricultural projects. The strong correlations and regression results confirm that improvements in these areas lead to enhanced productivity, increased income levels, improved environmental practices, and long-term project viability. The study further concludes that sustainability cannot be achieved through isolated interventions but requires an integrated and coordinated approach that addresses both human and institutional dimensions. In essence, the success and continuity of agricultural projects depend on how well capacity-building strategies are designed, implemented, and supported by strong institutional and policy frameworks.

➢ *Recommendations*

In light of the findings and conclusions, the following recommendations are proposed:

- RAB and relevant stakeholders should adopt standardized and participatory needs assessment frameworks to ensure that capacity-building interventions are context-specific and demand-driven;
- Continuous professional development programs should be implemented for extension officers and project staff to enhance their technical and managerial competencies;
- Agricultural institutions should be strengthened through improved governance structures, efficient resource allocation, and adoption of modern management systems;
- Government agencies should focus on strengthening policy enforcement, monitoring, and evaluation systems to ensure that agricultural policies translate into tangible outcomes;
- There is a need to enhance coordination and partnerships among stakeholders to improve resource utilization, knowledge sharing, and project sustainability;
- Continuous monitoring and evaluation should be integrated into project implementation to track progress, identify challenges, and inform decision-making;
- Regular and practical training programs should be provided to farmers to enhance their skills, adaptability, and resilience.

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