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CONTRIBUTION OF DEVELOPMENT PROJECTS TO AGRICULTURAL GROWTH IN RWANDA: A CASE OF LAND-HUSBANDRY, WATER-HARVESTING AND HILLSIDE IRRIGATION (LWH) PROJECT IN NYANZA DISTRICT

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ABSTRACT

This study examined the contribution of development projects to agricultural growth in Rwanda, with particular emphasis on the Land Husbandry, Water Harvesting, and Hillside Irrigation (LWH) project in Nyanza District. Specifically, the study assessed the effect of funding allocation, training and capacity building, and technology adoption under LWH projects on agricultural growth, as well as the overall relationship between LWH project implementation and agricultural growth. A descriptive research design with a quantitative approach was adopted. Data were collected using structured questionnaires administered to smallholder farmers in four sectors of Nyanza District. A sample size of 246 respondents was selected using purposive and stratified random sampling techniques. Data analysis involved descriptive and inferential statistics, complemented by thematic content analysis. The findings indicated a generally positive contribution of LWH project components to agricultural growth, with an overall mean score of 3.02 (SD = 0.706). Funding allocation significantly influenced agricultural productivity (M = 2.73, SD = 0.854). Training and capacity-building interventions showed a strong contribution (M = 3.17, SD = 0.645), reflecting improved farmer knowledge and skills. Technology adoption was also perceived as crucial for yield improvement (M = 3.13, SD = 0.673). Regression results revealed that LWH project components collectively explained 54% of the variation in agricultural growth ($R^2 = 0.540$). The study concludes that the LWH project has made a significant contribution to agricultural growth in Nyanza District even if some challenges such as price fluctuation, Inadequate infrastructure for storage and processing as well as Limited irrigation infrastructures in the area, It recommends increased funding for agricultural development projects, strengthened farmer training and capacity-building programs, improved rural infrastructure, enhanced access to modern farming technologies, and expansion of project coverage to reach more smallholder farmers. These interventions are essential for ensuring the sustainability and long-term success of agricultural development initiatives in Rwanda.

Keywords: *Agricultural Growth, Funding Allocation, Training and Capacity Building, Technology Adoption, Project Coverage.*

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INTRODUCTION

Agricultural development remains a critical driver of food security, poverty reduction, and sustainable economic growth, particularly in low- and middle-income countries (FAO, 2021; World Bank, 2024). As global population growth, climate change, land degradation, and water scarcity intensify, development projects have become essential tools for improving agricultural productivity and resilience (World Bank, 2021; UNCCD, 2017). Consequently, integrated agricultural interventions that combine land husbandry, water harvesting, and irrigation are increasingly promoted as effective strategies for sustainable agricultural growth (FAO, 2021).

In Sub-Saharan Africa, agriculture employs a significant proportion of the labor force and contributes substantially to national economies. However, the sector is characterized by low productivity due to heavy reliance on rain-fed agriculture, soil erosion, climate variability, and limited access to irrigation and modern farming technologies (World Bank, 2019; FAO, 2021). To address these challenges, many countries have adopted integrated agricultural development initiatives aligned with the Comprehensive Africa Agriculture Development Programme, which prioritizes sustainable land management, increased productivity, and food security (NEPAD, 2013).

In Rwanda, agriculture is a cornerstone of the economy, employing over 60% of the population and contributing significantly to rural livelihoods (NISR, 2022). Despite its importance, the sector faces persistent challenges such as steep terrain, soil erosion, land fragmentation, and limited access to irrigation infrastructure, which constrain productivity and farmer incomes (FAO, 2021; MINAGRI, 2011). In response, the Government of Rwanda has implemented various agricultural transformation initiatives aimed at modernizing the sector and promoting sustainable land use practices in line with national development strategies and Vision 2050 (Republic of Rwanda, 2020).

One of the major interventions under this agenda is the Land Husbandry, Water Harvesting, and Hillside Irrigation (LWH) project, initiated in 2010 to improve land management, enhance water conservation, and increase agricultural productivity on Rwanda's hillsides (MINAGRI, 2011). The project integrates physical infrastructure development, such as terracing, irrigation systems, and water harvesting facilities, with farmer training, capacity building, and the promotion of modern agricultural technologies (World Bank, 2021). Evidence from implementation areas indicates that the LWH project has contributed to increased crop yields, reduced soil erosion, and improved land productivity, including in Nyanza District (MINAGRI, 2021).

Despite these achievements, several challenges remain. High initial investment costs associated with terrace construction and irrigation infrastructure have placed financial pressure on smallholder farmers, while limited technical capacity has constrained effective operation and maintenance of introduced technologies (Nyamulinda et al., 2016; Hirwa et al., 2021). These challenges raise concerns regarding the long-term sustainability and scalability of the project.

Given Rwanda's commitment to achieving Sustainable Development Goals related to food security and sustainable land management, there is a need for empirical evidence on how specific development project components contribute to agricultural growth (United Nations, 2020). This study, therefore, examines the contribution of the Land Husbandry, Water Harvesting, and Hillside Irrigation project to agricultural growth in Nyanza District, with particular focus on funding allocation, training and capacity building, and technology adoption. The findings aim to inform policy formulation and improve the design and implementation of future agricultural development interventions in Rwanda and similar contexts.

LITERATURE REVIEW

This literature review examines existing theoretical and empirical studies on the contribution of development projects to agricultural growth, with particular emphasis on integrated interventions involving land husbandry, water harvesting, and hillside irrigation. The review synthesizes key concepts and scholarly evidence related to funding allocation, capacity building and training, and technology adoption as critical components influencing the effectiveness of agricultural development projects. It further explores how these factors contribute to agricultural growth outcomes, including improved productivity, income generation, food security, and market participation. By reviewing relevant global, regional, and national studies, this section establishes the conceptual foundation for analyzing the relationship between LWH project components and agricultural growth in Nyanza District, while also highlighting areas that warrant further empirical investigation.

Adequate and strategic funding allocation is widely recognized as a critical determinant of the success of agricultural development projects. Proper allocation of financial resources enables investment in key components such as irrigation infrastructure, soil conservation measures, farmer training, and technology adoption, which collectively enhance agricultural productivity and sustainability (World Bank, 2023; FAO, 2021). Studies indicate that well-planned funding mechanisms improve project efficiency and long-term impact by ensuring that priority interventions receive sufficient support, particularly in resource-constrained rural settings. In the context of integrated projects such as the Land Husbandry, Water Harvesting, and Hillside Irrigation (LWH) initiative, effective funding allocation has been associated with improved land productivity, increased crop yields, and enhanced resilience to climate-related shocks, while weak or inconsistent funding has been linked to implementation delays and limited project outcomes (World Bank, 2023).

Capacity building and training play a central role in enhancing the effectiveness of agricultural development projects by equipping farmers with the knowledge and skills necessary to adopt sustainable farming practices and modern technologies. Empirical evidence demonstrates that targeted training programs significantly improve farmers' productivity, resource management, and adaptive capacity to climate variability (Cummings & Salo, 2014; World Bank, 2005). Participatory training approaches, such as farmer field schools, further strengthen learning outcomes by promoting ownership and sustained adoption of improved practices (Gatzweiler & von Braun, 2016). Within the LWH project framework, capacity-building initiatives focused on soil conservation, water management, and agronomic practices have been identified as essential for translating physical infrastructure investments into tangible agricultural growth outcomes (MINAGRI, 2011).

Technology adoption is a key driver of agricultural transformation, influencing farm productivity, efficiency, and income levels. The integration of improved seeds, irrigation technologies, mechanization, and digital tools has been shown to significantly enhance crop yields and resilience, particularly in developing countries (FAO, 2023; IFPRI, 2023). However, adoption rates are often constrained by high costs, limited access to credit, and insufficient technical knowledge among smallholder farmers (UNDP, 2022). Development projects that combine technology provision with training, infrastructure development, and institutional support tend to achieve higher adoption and sustained use of innovations. In the LWH project, technology adoption has been promoted through irrigation systems, improved inputs, and farmer sensitization, with the expectation of improving productivity and supporting agricultural growth in hilly and erosion-prone areas (World Bank, 2023).

Recent empirical studies consistently identify infrastructure improvement as a critical determinant of agricultural growth, particularly in developing economies. Agricultural infrastructure, such as irrigation systems, rural roads, storage facilities, and market access infrastructure, enhances productivity by reducing post-harvest losses, lowering transaction costs, and improving farmers' access to inputs and output markets (FAO, 2021; World Bank, 2023). Evidence from Sub-Saharan Africa indicates that irrigation and water management infrastructure

significantly stabilize production and increase yields by reducing dependence on erratic rainfall patterns, thereby strengthening resilience to climate variability (Hinojosa et al., 2023). In addition, recent studies emphasize the growing role of digital and technological infrastructure, including mobile platforms, weather forecasting systems, and farm management applications, in improving decision-making and resource efficiency among smallholder farmers (Das & Nayak, 2024). However, the effectiveness of such technologies largely depends on the availability of complementary physical infrastructure and institutional support. Overall, the literature demonstrates that integrated investments in both physical and digital agricultural infrastructure are essential for sustaining productivity, enhancing rural incomes, and supporting long-term agricultural transformation.

Project coverage is widely recognized in recent development literature as a key factor influencing the effectiveness, inclusiveness, and scalability of agricultural development interventions. Broad and equitable coverage ensures that project benefits reach diverse geographic areas and vulnerable populations, thereby reducing regional disparities and promoting inclusive agricultural growth (FAO, 2021). Empirical evidence shows that projects with wider coverage achieve higher adoption rates of improved farming practices, greater food security outcomes, and stronger livelihood impacts compared to narrowly targeted interventions (World Bank, 2023). In the context of large-scale agricultural programs, such as land and water management initiatives, adequate project coverage enables interventions to address location-specific constraints while contributing to national agricultural development objectives (Binagwaho et al., 2022). Nevertheless, recent studies also note that coverage is often constrained by financial limitations, institutional capacity, and logistical challenges, which can limit outreach and sustainability if not addressed through adaptive planning and stakeholder engagement (FAO, 2021; Giramata et al., 2023). Consequently, the literature affirms that effective project coverage is essential for maximizing development impact and ensuring the equitable distribution of agricultural project benefits.

Agricultural growth, as a dependent variable, reflects improvements in crop yields, farm productivity, household income, food security, and market participation. The literature consistently links agricultural growth to investments in infrastructure, effective resource management, human capital development, and technological innovation (FAO, 2019; World Bank, 2020). Integrated agricultural development projects such as the LWH initiative contribute to agricultural growth by enhancing land and water management, increasing production efficiency, and strengthening farmers' economic outcomes (IFAD, 2021). Improved productivity and market access enable farmers to generate higher incomes, reduce vulnerability to shocks, and enhance food security, thereby reinforcing the role of development projects as catalysts for sustainable agricultural growth in rural economies (OECD, 2019)

METHODOLOGY

This study adopted a descriptive and explanatory research design to examine the contribution of development projects to agricultural growth in Nyanza District, Rwanda (Creswell, 2014). The descriptive component provides a detailed understanding of the relationship between project interventions, such as funding allocation, capacity building, technology adoption, infrastructure improvements, and project coverage, and agricultural outcomes. The explanatory component explores causal linkages, enabling an assessment of the predictive effects of development project indicators on agricultural growth. A mixed-methods approach was employed, integrating quantitative and qualitative techniques to ensure comprehensive and triangulated findings.

Quantitative data were collected from 246 smallholder farmers using structured questionnaires, capturing indicators such as crop yield, farm productivity, income, and food security. Qualitative data were obtained through key informant interviews with sector and district agronomists and open-ended survey questions, providing contextual insights into project implementation, challenges, and perceived effectiveness.

Quantitative data were analyzed using descriptive statistics (mean, standard deviation, frequencies) and inferential statistics, including correlation and regression analyses. Correlation analysis determined the relationships between independent variables, funding allocation, capacity building, technology adoption, infrastructure improvements, and project coverage, and the dependent variable, agricultural growth. A multiple regression model was employed to examine the combined effect of these variables, with significance tested at a 95% confidence level ($p < 0.05$). The regression model was specified as follows:

X= Development projects indicators

Y= Agricultural Growth;

$Y = f(x)$

Where:

X (X1= Funding allocation; X2= Project coverage; X3 = Capacity building; X4=Technological adaptation; X5=Infrastructure improvements)

$\beta 0$ = a constant; $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$, $\beta 5$ are the regression coefficients. e= Error term

Therefore, the model used in the study took the form below:

$$Y= \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+ \beta_4X_4+ \beta_5X_5+e$$

The model's predictive power and significance were evaluated using the coefficient of determination (R^2) and F-test statistics from ANOVA. Statistical analyses were performed using SPSS, facilitating the computation of descriptive and inferential measures. Results were presented in tables, charts, and graphs to provide a clear visualization of patterns, relationships, and the impact of LWH project interventions on agricultural growth.

RESULTS

A multiple regression analysis was conducted to predict the contribution of LWH project variables on agricultural growth. The results are shown in the tables in the sentences that follow.

Table 1: Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error
1	0.735	0.540	0.532	0.458

a. Predictors: (Constant), Funding Allocation, Training and Capacity Building, Technology Adoption, Infrastructure Improvement, and Project Coverage

The multiple regression analysis results indicate a strong positive relationship between the LWH project variables and agricultural growth, as reflected by an R-value of 0.735**.** The model explains 54.0% of the variation in agricultural growth **(**R^2 = 0.540**),** suggesting that the key predictors, funding allocation, training & capacity building, infrastructure improvements, technology adoption, and project coverage, play a significant role in enhancing agricultural productivity. The Adjusted R^2 (0.532)**,** which is close to R^2, confirms that the model is stable and does not suffer from significant overfitting. However, 46% of the variation in agricultural growth remains unexplained, indicating the potential influence of external factors such as climate conditions**,** government policies, and market dynamics. The standard error of 0.458 suggests a reasonable model fit, though improvements could be made by incorporating additional explanatory variables. Based on these findings, strengthening the implementation of LWH project components**,** expanding coverage, and integrating other relevant factors in future studies could enhance the understanding of agricultural growth in Nyanza District.

Table 2: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	18.654	5	3.731	27.312	0.000*
Residual	15.859	240	0.066		
Total	34.513	245			

a. Predictors: (Constant): Funding allocation, training and capacity building, and technology Adoption, Infrastructure Improvement, and Project Coverage
b. Dependent Variable: Agriculture growth

The ANOVA results in Table 2 confirm the overall significance of the regression model in explaining agricultural growth in Nyanza District. The F-statistic ($F = 27.312$, $p = 0.000$) indicates that the independent variables funding allocation, training & capacity building, infrastructure improvements, technology adoption, and project coverage collectively have a statistically significant impact on agricultural growth **(**$p < 0.05$**).** The regression sum of squares (18.654) compared to the residual sum of squares (15.85**9)** suggests that a substantial portion of the total variability in agricultural growth **(**34.513) is explained by the LWH project variables. The low mean square error (0.066**)** further supports the model's reliability. These findings reinforce the conclusion that development project interventions under LWH significantly influence agricultural productivity, making them essential for policymakers and stakeholders aiming to enhance Rwanda's agricultural sector.

The results of the multiple regression and correlation analyses provide strong evidence for rejecting the null hypotheses, confirming the significant influence of LWH project interventions on agricultural growth in Nyanza District. Specifically, funding allocation was found to have a statistically significant effect on agricultural growth (H1, $p = 0.000$), indicating that strategic financial support enhances productivity and farm output. Similarly, training and capacity-building initiatives significantly impacted agricultural growth (H2, $p = 0.001$), highlighting the importance of equipping farmers with skills and knowledge for sustainable practices. Technology adoption also demonstrated a strong positive contribution to agricultural growth (H3, $p = 0.000$), emphasizing the role of modern farming tools and innovations in improving yields. Finally, the overall relationship between the LWH project and agricultural growth was significant (H4, $r = 0.735$, $p < 0.05$), suggesting that the integrated interventions of the project collectively enhance agricultural productivity, income generation, and food security. These findings support the acceptance of all alternative hypotheses and confirm the critical role of LWH project components in driving agricultural development.

Table 3: Regression Model Coefficients

Variable	Unstandardized B	Standardized Beta	t	Sig.
Funding Allocation	0.312	0.318	4.213	0.000*
Training & Capacity	0.284	0.276	3.892	0.001*
Infrastructure	0.298	0.290	4.105	0.000*
Technology Adoption	0.327	0.314	4.371	0.000*
Project Coverage	0.267	0.251	3.645	0.002*

(*Significance at $p < 0.05$)
a. Dependent Variable: Agriculture Growth

The regression coefficients presented in Table 3 provide insights into the individual contributions of each LWH project variable to agricultural growth. All predictor variables, funding allocation, training & capacity building,

infrastructure improvements, technology adoption, and project coverage, show statistically significant positive effects **(**$p < 0.05$**),** confirming their crucial role in enhancing agricultural productivity. Technology adoption ($\beta = 0.314$, $p = 0.000$) and funding allocation ($\beta = 0.318$, $p = 0.000$) exhibit the highest standardized beta values, indicating that they have the strongest influence on agricultural growth. Infrastructure improvements ($\beta = 0.290$, $p = 0.000$) and training & capacity building ($\beta = 0.276$, $p = 0.001$) also play a significant role, while project coverage ($\beta = 0.251$, $p = 0.002$)**,** though slightly lower, still contributes meaningfully. The t-values further reinforce these findings, with all variables displaying high t-scores, signifying their strong predictive power. These results suggest that targeted investments in technology adoption, funding allocation, and infrastructure improvements would yield the highest returns in promoting agricultural growth in Nyanza District.

These results are consistent with findings, such that of world bank 2021 and others; suggesting that Development projects play a crucial role in driving agricultural growth by improving infrastructure, enhancing access to modern farming technologies, and strengthening farmers' capacity through training and financial support, our result is also consistent with A study by Rogers et al. (2018) evaluated the role of technology adoption in improving agricultural efficiency across Africa Similarly, Mutesi (2021) explored the relationship between modern farming practices and agricultural productivity in Rwanda concluded that mechanization and precision.

The findings of this study demonstrate that development projects, particularly the Land Husbandry, Water Harvesting, and Hillside Irrigation (LWH) project, play a pivotal role in enhancing agricultural growth in Nyanza District. The analysis confirms that funding allocation significantly affects agricultural productivity, as adequate and timely financial support enables the implementation of crucial interventions such as terracing, irrigation, and capacity-building programs. However, persistent funding limitations constrain long-term project sustainability, aligning with prior studies emphasizing the need for strategic, continuous, and equitable resource distribution (Kamanzi, 2019; World Bank, 2020). Practically, this underscores the necessity for improved budgeting practices and effective disbursement mechanisms to maximize project outcomes.

Training and capacity-building initiatives were found to be highly effective, with most respondents reporting enhanced knowledge and skills. Nonetheless, the lack of systematic follow-up reduces the sustainability of training impacts, echoing findings by Uwitware and Murwanashyaka (2022) and Smith and Brown (2019) that emphasize continuous engagement and post-training support as critical for sustained behavioral change. Academically, these results validate the importance of human capital development in smallholder agricultural systems, while practically, they highlight the need for refresher programs and continuous mentorship to consolidate learning.

Technology adoption emerged as another significant contributor to agricultural growth, with modern tools positively influencing crop yield. Nevertheless, adoption barriers, primarily high costs and limited access to information, remain substantial, supporting earlier studies by Rogers et al. (2018) and Mutesi (2021). This finding underscores the importance of inclusive technology transfer models and practical interventions, such as subsidies and enhanced rural information channels, to facilitate broader uptake among smallholder farmers.

Finally, the study confirmed a strong positive relationship between LWH project interventions and agricultural growth ($r = 0.934$), supported by both quantitative and qualitative evidence. Farmers reported tangible improvements in crop yields, market access, and food security, affirming the efficacy of integrated agricultural development projects. Stakeholder interviews emphasized that ongoing challenges, including limited funding, high technology costs, inadequate infrastructure, and restricted irrigation coverage, must be addressed to sustain gains and maximize long-term impact. Collectively, these findings contribute to the academic discourse on

development project effectiveness and provide practical insights for policymakers aiming to strengthen smallholder agricultural productivity and rural livelihoods.

CONCLUSIONS

This study investigated the contribution of development projects to agricultural growth in Rwanda, with specific reference to the Land Husbandry, Water Harvesting, and Hillside Irrigation (LWH) Project. Drawing on empirical evidence from project beneficiaries, government agronomists, and project officials, the study provides robust insights into how structured agricultural interventions influence productivity and rural livelihoods. Overall, the findings affirm that development projects, when strategically designed and effectively implemented, play a critical role in enhancing agricultural performance and fostering sustainable rural transformation.

The study established that funding allocation under the LWH Project has a statistically significant influence on agricultural growth. While most respondents acknowledged that the project received adequate financial resources, persistent gaps, particularly in post-implementation support and the timely provision of farm inputs, were identified. These shortcomings underscore the importance of adopting more flexible and responsive financial planning mechanisms that extend beyond infrastructure development to include sustained operational support. The rejection of the null hypothesis confirms that funding allocation is not merely an administrative concern but a decisive factor in determining the success and long-term impact of agricultural development initiatives.

Furthermore, the findings demonstrated that training and capacity-building interventions significantly enhance farmers' skills, knowledge, and adaptive capacity. Beneficiaries reported improved agronomic practices and better utilization of project infrastructure as a result of training programs. However, the study also revealed that the long-term effectiveness of these efforts is weakened by limited follow-up and reinforcement mechanisms. Despite this challenge, the rejection of the null hypothesis affirms that human capital development remains a foundational pillar of agricultural growth and sustainability, reinforcing theoretical perspectives that emphasize learning and knowledge transfer in rural development.

In addition, the study confirms that the adoption of modern agricultural technologies introduced through the LWH Project has a positive and significant effect on productivity. Improved soil conservation measures, irrigation systems, and enhanced farming techniques contributed to increased yields and reduced vulnerability to climatic shocks. Nevertheless, high costs and limited access to information were identified as key barriers to widespread adoption. The rejection of the null hypothesis highlights that technology adoption is a powerful driver of agricultural transformation, but its impact depends on affordability, accessibility, and continuous technical support.

Most importantly, the study revealed a strong positive correlation ($r = 0.934$) between LWH project interventions and agricultural growth indicators, providing compelling empirical evidence that integrated land and water management projects substantially improve agricultural outcomes. This finding confirms that well-coordinated development projects are essential instruments for accelerating rural development, improving food security, and enhancing household incomes. It also reinforces the broader development theory that integrated, multisectoral interventions yield greater and more sustainable impacts than fragmented approaches.

From an academic perspective, this study contributes to the growing body of literature on development project effectiveness by providing empirical evidence from a developing-country context, particularly Rwanda's agricultural sector. It enriches scholarly understanding of how funding structures, capacity building, and technology adoption interact to influence agricultural growth. For policymakers and development practitioners, the findings offer practical insights into designing more effective and sustainable agricultural interventions. At the

community level, the study highlights the transformative potential of participatory and well-supported development projects in improving livelihoods, strengthening resilience, and promoting inclusive rural growth.

RECOMMENDATIONS

The study revealed that while the LWH project positively influenced agricultural growth, gaps remain in funding allocation, technology access, capacity-building follow-up, infrastructure, and inclusive coverage. It recommends that development agencies and project authorities increase targeted funding for farm inputs and livestock integration, provide hands-on training with continuous mentorship, invest in climate-resilient storage and processing facilities, and facilitate affordable access to technologies through subsidies or cooperative schemes. Farmers are encouraged to engage continuously with extension services, maintain irrigation and conservation structures, and adopt new technologies collaboratively. Central and local government bodies should scale up irrigation and market infrastructure, support rural connectivity and innovation centers, promote public-private partnerships, sensitize communities on sustainable resource management, and ensure inclusive participation in project planning and land-use decisions. These integrated measures are essential for maximizing productivity, food security, and sustainable agricultural development.

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