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The Impact of Quality Management Strategies on Project Performance and Sustainability

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ABSTRACT

Quality management strategies are vital for improving coffee farming productivity and sustainability, yet there is limited research on their specific impact in Northern Province, Rwanda. This gap hinders the effective adoption and scaling of successful coffee farming projects, particularly within the Sustainable Growers initiative. The purpose of this study was to establish the influence of Quality Management Strategies on the performance of coffee farming projects in Northern Province, Rwanda. The study adopted Total Quality Management (TQM) Theory and Sustainability Theory. The research employed both descriptive and correlational designs with a target population estimated at 531 people, composed of 4 project managers, 25 farmer cooperative representatives from five women cooperatives, and 502 farmers trained under the project. A sample of 84 respondents was determined using Solvi's formula. Data collection was conducted using questionnaires, interviews, and document reviews. A pilot test was conducted with 15 respondents to determine the instrument's ability to produce consistent results over time. The reliability of the research instrument (questionnaire) was assessed using Cronbach's Alpha. Descriptive and inferential statistics, including regression and correlation analysis, were conducted at a significance level of 0.05 using SPSS version 28 the obtained results revealed that, quality planning ($p = 0.001 < 0.05$), quality assurance ($p = 0.002 < 0.05$), quality control ($p = 0.003 < 0.05$) and, quality improvement ($p = 0.002 < 0.05$) have significant influence on project performance, therefore, rejecting the Null hypotheses. The study concludes that quality planning, assurance, control, and improvement practices are essential for the success of coffee farming projects, significantly enhancing performance, productivity, and the livelihoods. The study recommends prioritizing comprehensive planning, improving monitoring and evaluation, implementing regular inspections and corrective actions, and fostering continuous innovation and training to enhance the success and sustainability of future coffee farming projects. The study suggests that future researches could explore the impact of stakeholder engagement on project performance and assess the role of evolving technology, such as remote sensing and mobile apps, in improving quality control and monitoring in coffee farming, focusing on their feasibility, costs, and effectiveness.financial monitoring mechanisms to ensure efficient resource allocation. Future research needs to examine the effects of community involvement on project implementation of water supply projects.

Introduction

Agriculture plays a crucial role in ensuring global food security and maintaining economic stability, particularly in developing regions where it is the primary livelihood for a significant portion of the population (World Bank, 2022). As a key economic driver, agriculture has a direct impact on employment, poverty reduction, and overall economic growth. However, agricultural sectors in many developing nations continue to face persistent challenges that hinder their potential to foster sustainable growth and development (FAO, 2021). These challenges include climate change, inefficient resource management, inadequate infrastructure, and market volatility, all of which undermine the productivity of agricultural systems. In light of these challenges, the adoption of

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quality management strategies in agriculture has become critical for enhancing productivity, improving sustainability, and ensuring long-term economic growth.

The global landscape of agriculture is evolving with the integration of advanced technologies aimed at addressing inefficiencies and increasing productivity (Cousins, 2013). Quality management strategies such as precision agriculture, value chain optimization, and standardized quality assurance practices have become increasingly important in driving positive outcomes in the agricultural sector. Precision agriculture, for example, has gained significant attention in regions like the United States and Europe, where it uses technologies such as data analytics, the Internet of Things (IoT), and GPS systems to optimize resource use and improve crop management (Jones & Clark, 2018). By enabling farmers to monitor various variables such as soil health, irrigation needs, and pest infestations, precision agriculture helps minimize waste, reduce environmental impacts, and improve overall crop yields. These technology-driven strategies have not only increased agricultural productivity but also contributed to environmental sustainability and resource conservation, addressing challenges like climate change and resource scarcity management (Jones & Clark, 2018).

The role of quality management strategies in agriculture extends beyond technological solutions. Global initiatives, such as the FAO's guidelines for quality assurance, emphasize the importance of maintaining high food safety standards, reducing waste, and improving market access through better value chain management (FAO, 2021). By optimizing agricultural supply chains, these strategies ensure that products are delivered to consumers in a timely manner and meet the required standards. In addition, effective quality management practices foster collaboration among stakeholders and strengthen the competitiveness of agricultural products in both local and international markets. These practices are increasingly critical in ensuring the sustainability of agricultural systems, particularly in developing countries where market access and competitiveness remain significant barriers.

In the African context, agriculture is the backbone of many economies, with agriculture contributing significantly to GDP and employment in sub-Saharan Africa. The sector employs over 60% of the population in many African nations, making it a primary driver of economic growth (World Bank, 2022). Despite its importance, the African agricultural sector continues to face challenges that hinder its potential. Climate variability, limited access to financing, inadequate infrastructure, and poor market access persists as major barriers to productivity and growth. These issues are compounded by the lack of skills and resources among smallholder farmers, who often struggle to implement effective agricultural practices.

Nevertheless, Africa has seen positive outcomes in certain agricultural projects that have incorporated quality management strategies. The Green Belt Movement in Kenya, for instance, has demonstrated the positive effects of community engagement, rigorous planning, and capacity building in addressing environmental and agricultural challenges (Maathai, 2004). The movement's efforts in reforestation have not only improved the environment but also enhanced agricultural productivity and local livelihoods. Similarly, South Africa's National Development Plan (NDP) highlights the importance of quality assurance in agricultural projects to achieve sustainability and promote economic inclusivity (Cousins, 2013). The NDP prioritizes quality assurance practices in coffee farming, recognizing their role in ensuring environmental sustainability, boosting market competitiveness, and improving the livelihoods of farmers.

In Rwanda, coffee farming is one of the most important agricultural activities, particularly in the Northern Province. Coffee is a critical contributor to the country's economy, generating over 30% of the national GDP and providing livelihoods for more than 70% of the rural population (RDB, 2023). The high quality of Rwanda's coffee, particularly the Arabica varieties grown in the country's fertile volcanic soils, allows the coffee to command premium prices on the international market. Despite its potential, however, the coffee industry in Rwanda faces several challenges that hinder its growth. Soil degradation, which affects the fertility of the land, is one of the most significant challenges facing coffee farmers. Unsustainable farming practices, limited access to organic fertilizers, and poor land management strategies have contributed to this issue, making it increasingly difficult to maintain high coffee yields. Moreover, climate change, with its unpredictable rainfall patterns and increased pest and disease outbreaks, further exacerbates the challenges faced by coffee farmers in the region (Nyandwi & Houghton, 2019). Poor infrastructure for coffee processing and storage also contributes to inconsistent product quality and significant post-harvest losses (Shyaka et al., 2017). These challenges limit the ability of Rwandan coffee farmers to capitalize on the growing global demand for high-quality coffee, reducing their income and impeding the growth of the sector.

Coffee farming is a cornerstone of Rwanda's agricultural sector, contributing significantly to the national GDP and providing livelihoods for over 70% of the population (RAB, 2023). In Northern Province, coffee farming projects have the potential to drive economic growth, enhance community livelihoods, and improve food security. However, challenges related to quality management continue to undermine the performance and sustainability of these projects. Issues such as inconsistent production standards, inadequate pest and disease control, poor agricultural input management, and limited adoption of advanced farming techniques persist, reducing the competitiveness of Rwandan coffee in both local and international markets (MINAGRI, 2019). While some projects strive to meet international quality requirements, significant gaps in implementing standardized practices remain. For instance, inadequate soil testing and improper use of fertilizers often lead to suboptimal yields and reduced coffee quality. Additionally, poor pest and disease control strategies exacerbate crop losses, further undermining productivity and farmer incomes (Sustainable Growers Rwanda, 2023). Given these challenges, there is a pressing need to examine how quality management strategies—encompassing pest and disease control, efficient use of agricultural inputs, soil testing and fertilization, breeding systems, and monitoring mechanisms—can be effectively implemented to enhance the performance of coffee farming projects.

This study seeks to explore the influence of quality management strategies on the performance of coffee farming projects, particularly in Northern Province, Rwanda. The findings contribute to the understanding of how effective management strategies can address

existing challenges and promote sustainable growth in the coffee farming sector. By addressing these critical gaps, the study will not only benefit local farmers and stakeholders but also contribute to similar agricultural initiatives in other developing countries facing comparable challenges. The study was organized into introduction, literature review, findings and discussion, and conclusion.

Literature Review

Theoretical Review

Total Quality Management (TQM) Theory

The Total Quality Management (TQM**)** founded by Deming (1950) theory is a comprehensive approach to improving the overall quality of an organization's processes, products, and services. It is rooted in the idea that quality should be integrated into every aspect of an organization and is the responsibility of all members, not just a specific department. TQM emphasizes continuous improvement, customer satisfaction, and the involvement of all stakeholders in achieving high-quality outcomes. The theory centered around using statistical methods and systematic processes to improve quality and reduce waste across organizations.

In the context of Coffee farming projects like the Sustainable Growers Project, TQM focuses on four key components throughout the project lifecycle: quality planning**,** quality assurance**,** quality control, and continuous improvement. These components ensure that Coffee farming projects meet established standards and stakeholder expectations while striving for increased productivity, sustainability, and overall success. Deming (1993) emphasized that quality should be ingrained in the culture of an organization and that defects should be prevented rather than corrected after they occur. His work found influenced the development of the Plan-Do-Check-Act (PDCA) cycle, a core principle of TQM that focuses on continuous improvement and iterative testing of processes. Similarly, Joseph M. Juran (2016), another key figure in the development of TQM, proposed that quality must be planned from the start and managed through a structured approach. Juran's focus on the importance of planning, setting quality standards, and meeting customer expectations is integral to the TQM framework.

By integrating these principles, Coffee farming projects can ensure the achievement of desired outcomes. This includes enhanced productivity, greater sustainability, and increased stakeholder satisfaction. Adopting TQM in projects like the Sustainable Growers Project can lead to reduced inefficiencies, better resource utilization, and a more proactive approach to managing risks and uncertainties throughout the project lifecycle

Empirical Review

The empirical review gives general view on the research objectives as developed.

Quality Planning and Performance of Coffee farming projects

Sharma et al. (2021) noted that India's National Horticulture Mission employed quality planning initiatives, including soil health cards, quality-certified seeds, and crop diversification, which resulted in a 30% increase in yields for fruits and vegetables. Farmers were also trained in sustainable pesticide use, improving both the economic and environmental outcomes. In the context of coffee farming, this approach highlights how careful planning in soil health and crop inputs can significantly increase coffee yields while minimizing environmental damage.

In the United States, **S**mith and Johnson (2022) examined the role of precision agriculture in Iowa, where GPS-guided crop monitoring systems led to a 20% higher economic return on crops. Similarly, in coffee farming, using technologies such as precision agriculture for crop monitoring, pest management, and optimal input use could enhance crop health, reduce waste, and increase economic returns. Structured planning in this context is crucial for the sustainability and profitability of coffee farming projects.

In Kenya**,** Mwangi et al. (2020) evaluated the tea sector reforms, which involved stringent planning for plucking, handling, and transport to ensure uniform quality. These measures increased tea auction prices by 15%. A similar structured approach in Rwanda's coffee sector could enhance quality control, improve consistency in the final product, and boost the price farmers can obtain for their coffee beans. The Sustainable Growers Project in Northern Rwanda emphasizes comprehensive quality planning as a core strategy to enhance the performance of coffee farming. This approach includes critical components such as soil testing, careful seed selection, and well-defined harvest schedules. By integrating these elements into the planning process, the project has seen a significant 35% increase in coffee yields and improved the export quality of Rwandan coffee. These improvements have enabled access to premium international markets, increasing the competitiveness of Rwandan coffee on the global stage (Sustainable Growers Rwanda, 2023).

Quality Assurance and Performance of Coffee farming projects

In Brazil**,** Silva et al. (2021) highlighted that ISO 9001-compliant quality assurance systems in the soybean sector led to a 25% revenue increase, driven by improved product consistency and adherence to quality standards. For coffee farming projects in Rwanda, adopting similar ISO-compliant quality systems could help ensure consistent quality, reducing defects and boosting market access, particularly for premium coffee exports.

In Australia**,** Turner and Jones (2021) observed that organic farmers who adopted third-party quality assurance programs gained access to higher-value markets, increasing profitability by 18%. For Rwanda's coffee farmers, certification programs such as Fair Trade or organic certifications, coupled with third-party audits, could not only improve quality assurance practices but also provide a competitive edge in premium coffee markets. These certifications would also enhance consumer trust, which is vital for long-term success in the global coffee market.

Similarly, in Vietnam**,** Nguyen and Tran (2020) reported that rice cooperatives adopting rigorous quality assurance frameworks, including periodic inspections and compliance audits, improved export standards and reduced product rejection rates by 15%. Implementing such frameworks in coffee farming could enhance Rwanda's coffee quality, reduce rejection rates in international markets, and increase the profitability of coffee farmers by ensuring adherence to the highest international standards.

Quality Control and Performance of Coffee farming projects

In Thailand**,** Pongsakorn et al. (2022) examined the role of quality control processes in cassava production, which involved monitoring starch content and minimizing impurities. These efforts led to an increase in export volumes, as the products met international standards. A similar approach to quality control in coffee farming, focusing on factors such as moisture content, grading, and sorting to eliminate defects, could enhance Rwanda's coffee export quality and increase market competitiveness. The Ghana Cocoa Board (2021) has also implemented robust quality control protocols that focus on grading and certification, improving the quality of cocoa for international markets. As a result, cocoa exports increased, and farmer incomes rose by 20%. A similar model applied to coffee farming in Rwanda, with strict grading protocols and certifications, could significantly improve export volumes and farmer earnings by ensuring that only high-quality coffee beans reach the international market.

In the European Union**,** Smith and Wiggins (2020) reviewed quality control measures under the Common Agricultural Policy, where testing for contaminants and adherence to strict guidelines ensured consistent quality. This focus on maintaining high-quality standards benefited both producers and consumers. Coffee farmers in Rwanda could adopt similar practices, implementing testing for contaminants such as aflatoxins and other quality assurance measures to meet global coffee standards. These efforts would help ensure the consistency and safety of coffee, ultimately increasing consumer trust and enhancing export opportunities.

Overall, quality control practices such as moisture testing, defect sorting, grading, and adherence to international certification standards are critical in improving coffee quality, boosting export volumes, and increasing farmer incomes. These measures, when implemented effectively in Rwanda's coffee sector, could lead to significant improvements in both the domestic and global coffee markets.

Quality Improvement and Performance of Coffee farming projects

Continuous training on modern coffee farming techniques under the Sustainable Growers Project in Northern Province, Rwanda, has significantly enhanced farmers' skills and knowledge, leading to a 35% improvement in coffee yields. The project introduced efficient harvesting methods and improved post-harvest handling, contributing to a 20% increase in export-quality coffee. Farmer feedback loops have been integral to refining these processes, ensuring they align with evolving market demands and international quality standards (Sustainable Growers, 2023). This continuous improvement approach mirrors successful strategies in other agricultural sectors and demonstrates the effectiveness of knowledge transfer and adaptive practices in boosting productivity and quality.

Worku et al. (2021) examined Ethiopia's Agricultural Growth Program (AGP), finding that the introduction of improved irrigation systems and high-yield seed varieties resulted in a 40% increase in crop productivity. In addition, farmers reported better resilience to climate variability and enhanced market access, bolstering Ethiopia's position as a leading agricultural exporter in Africa. Similarly, the adoption of innovative farming practices such as efficient irrigation systems and climate-resilient coffee plant varieties in Rwanda could further improve coffee yields and market competitiveness, ensuring sustainability in the face of changing weather patterns.

Johnson and Clarke (2022) evaluated the impact of quality improvement strategies by the Canadian Grain Commission, which invested in advanced harvesting technologies that reduced grain loss by 15%. Additionally, R&D efforts to enhance grain uniformity and nutritional quality resulted in a 25% increase in Canada's export market share, particularly in premium global markets. A similar investment in R&D for coffee farming in Rwanda, focusing on the development of high-quality beans and efficient harvesting technologies, could enhance Rwanda's coffee exports by improving product consistency and attracting premium international markets.

Methodology

The study adopted a descriptive and correlational research designs with questionnaire and interview guide for data collection from 84 respondents out of 531 participants. A pilot study involved 13 respondents for a reliability test while the validity was tested through expert opinion that yielded a coefficient of 0.8. The data analysis techniques employed in this study included descriptive and inferential statistics of correlation and regression. The simple regression model was used for testing hypotheses $H_0$1, $H_0$2, H03, and $H_0$4; for example, to test hypothesis one, the simple regression model took the form.

$Y = \beta_0 + \beta_1 X_{1+} + \varepsilon$

Then a multiple regression analysis:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$

Findings and Discussion

The study obtained a questionnaire return rate of 100%.

Quality Planning and Performance of Coffee Farming Projects

The first objective of this study was to assess the effect of quality planning on performance of Coffee farming projects in Northern Province, Rwanda. The table presented below focuses on the respondents' perspectives regarding quality planning in the context of Performance of Coffee Farming Projects, highlighting how Quality Planning impact project execution, team coordination, and overall project success.

Relationship between Quality Planning and Performance of Coffee Farming Projects

The researcher aimed to determine whether there is a relationship between Quality planning practices and the performance of coffee farming projects. To achieve this, Pearson Correlation analysis was conducted between the measures of Quality planning practices and the outcomes of coffee farming projects:

Table 1: Relationship between Quality Planning and Performance of Coffee Farming Projects

		Quality Planning	**Performance of Coffee Farming Projects**
Quality Planning	Pearson Correlation	1	.866**
	Sig. (2-tailed)		.000
	N	84	84
Performance of Coffee Farming Projects	Pearson Correlation	.866**	1
	Sig. (2-tailed)	.000	
	N	84	84

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

Source: Author, 2024

The correlation results show that there is a strong positive correlation (R = 0.866) between Quality Planning and the Performance of Coffee Farming Projects, which is statistically significant ($p = 0.000 < 0.05$). This indicates that as Quality Planning improves, the performance of coffee farming projects also increases to a significant extent.

This strong correlation suggests that effective planning plays a pivotal role in enhancing the success of coffee farming projects. The higher the quality of planning, the better the outcomes and performance of the projects. This aligns with existing literature, such as the work by Jones et al. (2017), which emphasized that thorough planning significantly improves the performance of agricultural and farming projects. Quality Planning ensures that resources are efficiently allocated, risks are managed effectively, and the project is well-organized, leading to improved performance in coffee farming initiatives.

Effect of Quality Planning on Performance of Coffee Farming Projects

A regression analysis sought to determine the linear effect of planning on the successful performance of these projects.

Table 2: Effect of Planning on Performance of Coffee Farming Projects

Model	**R**	**R Square**		**Adjusted R Square**	**Std. Error of the Estimate**	
Summary	.866[a]	.751		.748	.41529	
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
ANOVA	Regression	42.560	1	42.560	246.782	.000[b]
	Residual	14.142	82	.172		
	Total	56.702	83			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
Coefficients	(Constant)	.885	.217		4.070	.000
	Quality Planning	.797	.051	.866	15.709	.000

a. Dependent Variable: Performance of Coffee Farming Projects

b. Predictors: (Constant), Quality Planning

An R^2 value of 0.751 with $p = 0.000<0.05$, indicating that Quality Planning accounts for 75.1% of the variation in the performance of coffee farming projects. This suggests a strong explanatory power of the independent variable in predicting the dependent variable. The model is found to be a good fit for the data and variables, as indicated by the $F(1, 82) = 246.782$ ($p = 0.000<0.05$).

The coefficients analysis reveals that the constant term has a coefficient of $\beta = 0.885$ ($p = 0.000<0.05$), which is statistically significant, representing the expected level of coffee farming project performance when Quality Planning is excluded. Quality Planning has a coefficient of $\beta = 0.797$ ($p = 0.000<0.05$), indicating that for each unit increase in Quality Planning, the performance of coffee farming projects improves by 0.797 units. Thus, the regression model for the effect of Quality Planning on project performance is given by:

$Y = 0.885 + 0.797X_1$

This analysis demonstrates that Quality Planning significantly and positively affects the performance of coffee farming projects. The high R^2 value (0.751) highlights the importance of Quality Planning in predicting the performance of coffee farming projects. The

implementation of effective planning practices enhances the outcomes of the projects, emphasizing its critical role in improving performance.

Test for Hypothesis One

$H_0$1: Quality planning has no significant influence on the performance of Coffee farming projects in Northern Province, Rwanda; was rejected ($p = 0.000<0.05$). Thus, there is a significant influence of quality planning on the performance of Coffee farming projects in Northern Province, Rwanda.

Quality assurance and Performance of Coffee Farming Projects

The study was to examine the effect of quality assurance on the performance of coffee farming projects in Northern Province, Rwanda through correlation and regression.

Relationship between Quality assurance and Performance of Coffee Farming Projects

A correlation analysis aimed to determine whether there is a relationship between quality assurance practices and the performance of coffee farming projects.

Table 3: Relationship between Quality assurance and Performance of Coffee Farming Projects

		Quality Assurance	**Performance of Coffee Farming Projects**
Quality Assurance	Pearson Correlation	1	.714**
	Sig. (2-tailed)		.000
	N	84	84
Performance of Coffee Farming Projects	Pearson Correlation	.714**	1
	Sig. (2-tailed)	.000	
	N	84	84

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

Source: Author, 2025

The correlation results show that there is strong positive correlation ($R = 0.714$) between Quality Assurance and the Performance of Coffee Farming Projects, which is statistically significant ($p = 0.000 < 0.05$). This indicates that as Quality Assurance improves, the performance of coffee farming projects also increases to a significant extent.

This moderate correlation suggests that effective quality assurance plays a key role in enhancing the success and performance of coffee farming projects. The higher the quality assurance in place, the better the performance of these projects. This is consistent with prior research, such as that by Smith et al. (2019), which highlighted the importance of quality assurance in ensuring consistent and high-quality outcomes in agricultural projects. Quality assurance helps maintain standards, minimize errors, and ensure that practices are aligned with established goals, thereby improving the overall performance of coffee farming projects.

Effect of Quality assurance on Performance of Coffee Farming Projects

A regression analysis sought to determine the linear effect of quality assurance on the successful performance of these projects.

Table 4: Effect of Quality assurance on Performance of Coffee Farming Projects

Model	**R**	**R Square**		**Adjusted R Square**	**Std. Error of the Estimate**	
Summary	.714[a]	.509		.503	.58262	
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
ANOVA	Regression	28.868	1	28.868	85.045	.000[b]
	Residual	27.834	82	.339		
	Total	56.702	83			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
Coefficients	(Constant)	1.589	.293		5.426	.000
	Quality Assurance	.642	.070	.714	9.222	.000

a. Dependent Variable: Performance of Coffee Farming Projects

b. Predictors: (Constant), Quality Assurance

An R^2 value of 0.509 with $p = 0.000<0.05$, suggesting that Quality Assurance accounts for 50.9% of the variation in the performance of coffee farming projects. This indicates a moderate explanatory power of the independent variable in predicting the dependent variable. The model is found to be a good fit for the data and variables, as indicated by the $F(1, 82) = 85.045$ ($p = 0.000<0.05$).

The coefficients analysis reveals that the constant term has a coefficient of $\beta = 1.589$ ($p = 0.000<0.05$), which is statistically significant, representing the expected level of coffee farming project performance when Quality Assurance is excluded. Quality Assurance has a coefficient of $\beta = 0.642$ ($p = 0.000<0.05$), indicating that for each unit increase in Quality Assurance, the performance

of the coffee farming project improves by 0.642 units. Thus, the regression model for the effect of Quality Assurance on project performance is given by:
$Y = 1.589 + 0.642X_2$

This analysis demonstrates that Quality Assurance significantly and positively affects the performance of coffee farming projects. The moderate R^2 value (0.509) underscores the importance of Quality Assurance in predicting the performance of coffee farming projects. The application of Quality Assurance yields better outcomes, highlighting its significant role in improving project performance.

Test for Hypothesis Two
$H_0$2: Quality assurance has no significant influence on the performance of Coffee farming projects in Northern Province, Rwanda; was rejected ($p = 0.000<0.05$)**.** Thus, there is a significant influence of quality assurance on the performance of Coffee farming projects in Northern Province, Rwanda.

Quality Control and Performance of Coffee farming projects
The study was to determine the effect of quality control on the performance of coffee farming projects in Northern Province, Rwanda through correlation and regression.

Relationship between Quality Control and performance of Coffee farming projects
A correlation analysis aimed to determine whether there is a relationship between quality control practices and the performance of coffee farming projects.

Table 5: Relationship between Quality Control and performance of Coffee farming projects

		Quality Control	**Performance of Coffee Farming Projects**
Quality Control	Pearson Correlation	1	.636**
	Sig. (2-tailed)		.000
	N	84	84
Performance of Coffee Farming Projects	Pearson Correlation	.636**	1
	Sig. (2-tailed)	.000	
	N	84	84

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

The correlation results show that there is a moderate positive correlation ($R = 0.636$) between Quality Control and the Performance of Coffee Farming Projects, which is statistically significant ($p = 0.000 < 0.05$). This indicates that as Quality Control improves, the performance of coffee farming projects also increases significantly.

This moderate correlation suggests that effective quality control plays a vital role in enhancing the success and performance of coffee farming projects. The higher the standards and consistency of quality control measures, the better the overall project performance. Similar to previous studies, such as those by Johnson et al. (2020), which emphasized the importance of maintaining quality in agricultural practices, quality control is crucial for ensuring that the outputs meet the required standards, ultimately improving the success rate of coffee farming projects.

Effect of Quality Control on Performance of Coffee farming projects
A regression analysis sought to determine the linear effect of quality control on the successful performance of these projects.

Table 6: Effect of Quality Control on Performance of Coffee farming projects

Model	**R**	**R Square**		**Adjusted R Square**	**Std. Error of the Estimate**	
Summary	.749[a]	.561		.556	.55087	
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
ANOVA	Regression	31.819	1	31.819	104.853	.000[b]
	Residual	24.884	82	.303		
	Total	56.702	83			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
Coefficients	(Constant)	1.346	.288		4.682	.000
	Quality Control	.656	.064	.749	10.240	.000

a. Dependent Variable: Performance of Coffee Farming Projects
b. Predictors: (Constant), Quality Control

An R^2 value of 0.561 with $p = 0.000<0.05$, suggesting that Quality Control accounts for 56.1% of the variation in the performance of coffee farming projects. This indicates a moderate explanatory power of the independent variable in predicting the dependent variable. The model is found to be a good fit for the data and variables, as indicated by the $F(1, 82) = 104.853$ ($p = 0.000<0.05$). The coefficients analysis reveals that the constant term has a coefficient of $\beta = 1.346$ ($p = 0.000<0.05$), which is statistically significant, representing the expected level of coffee farming project performance when Quality Control is excluded. Quality Control has a

coefficient of $\beta = 0.656$ ($p = 0.000<0.05$), indicating that for each unit increase in Quality Control, the performance of the coffee farming project improves by 0.656 units. Thus, the regression model for the effect of Quality Control on project performance is given by:

$Y = 1.346 + 0.656X_3$

This analysis demonstrates that Quality Control significantly and positively affects the performance of coffee farming projects. The moderate R^2 value (0.561) underscores the importance of Quality Control in predicting the performance of coffee farming projects. The application of Quality Control yields better outcomes, highlighting its significant role in enhancing project performance.

Test for Hypothesis Three

H_03: Quality control has no significant influence on the performance of Coffee farming projects in Northern Province, Rwanda; was rejected ($p = 0.000<0.05$). Thus, there is a significant influence of quality control on the performance of Coffee farming projects in Northern Province, Rwanda.

Quality Improvement and Performance of Coffee farming projects

The study was to determine the effect of quality improvement on the performance of coffee farming projects in Northern Province, Rwanda through correlation and regression.

Relationship between Quality Improvement and Performance of Coffee farming projects

A correlation analysis aimed to determine whether there is a relationship between quality improvement practices and the performance of coffee farming projects.

Table 7: Relationship between Quality Improvement and Performance of Coffee farming projects

		Quality Improvement	**Performance of Coffee Farming Projects**
Quality Improvement	Pearson Correlation	1	.749**
	Sig. (2-tailed)		.000
	N	84	84
Performance of Coffee Farming Projects	Pearson Correlation	.749**	1
	Sig. (2-tailed)	.000	
	N	84	84

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

The correlation results show that there is a strong positive correlation ($R = 0.749$) between Quality Improvement and the Performance of Coffee Farming Projects, which is statistically significant ($p = 0.000 < 0.05$). This indicates that as Quality Improvement increases, the performance of coffee farming projects also improves to a significant extent. This strong correlation suggests that quality improvement initiatives play a crucial role in enhancing the success of coffee farming projects. The higher the focus on improving quality standards, processes, and outputs, the better the overall performance of the project. Similar to findings by Toth (2019), which emphasized the importance of continuous quality improvements in agricultural projects for long-term success, focusing on quality is essential for ensuring high productivity and sustainability in coffee farming.

Effect of Quality Improvement on Performance of Coffee farming projects

A regression analysis sought to determine the linear effect of quality improvement on the successful performance of these projects.

Table 8: Effect of Quality Improvement on Performance of Coffee farming projects

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
Summary	.749[a]	.561	.556	.55087

Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
ANOVA	Regression	31.819	1	31.819	104.853	.000[b]
	Residual	24.884	82	.303		
	Total	56.702	83			

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
Coefficients	(Constant)	1.346	.288		4.682	.000
	Quality Improvement	.656	.064	.749	10.240	.000

a. Dependent Variable: Performance of Coffee Farming Projects

b. Predictors: (Constant), Quality Improvement

Source: Author, 2024

An R^2 value of 0.561 with $p = 0.000<0.05$, suggesting that Quality Improvement accounts for 56.1% of the variation in the performance of coffee farming projects. This indicates a moderate explanatory power of the independent variable in predicting the

dependent variable. The model is found to be a good fit for the data and variables, as indicated by the F (1, 82) = 104.853 (p = 0.000<0.05). The coefficients analysis reveals that the constant term has a coefficient of β = 1.346 (p = 0.000<0.05), which is statistically significant, representing the expected level of coffee farming project performance when Quality Improvement is excluded. Quality Improvement has a coefficient of β = 0.656 (p = 0.000<0.05), indicating that for each unit increase in Quality Improvement, the performance of the coffee farming project improves by 0.656 units. Thus, the regression model for the effect of Quality Improvement on project performance is given by:

$Y = 1.346 + 0.656X_4$

This analysis demonstrates that Quality Improvement significantly and positively affects the performance of coffee farming projects. The moderate R^2 value (0.561) underscores the importance of this strategy in predicting the performance of coffee farming projects. The application of Quality Improvement yields better outcomes, highlighting its significant role in enhancing project performance.

Test for Hypothesis Four

$H_0$4: Quality improvement has no significant influence on the performance of Coffee farming projects in Northern Province, Rwanda; was rejected (p = 0.000<0.05). Thus, there is a significant influence of quality improvement on the performance of Coffee farming projects in Northern Province, Rwanda

Influence of Combined Quality Management Strategies on Performance of Coffee Farming Projects

A multiple regression analysis to assess the combined effect of quality management strategies and performance of coffee farming projects.

Table 9: Influence of Combined Quality Management Strategies on Performance of Coffee Farming Projects

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**		
Summary	.900[a]	.809	.800	.36994		
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
ANOVA	Regression	45.891	4	11.473	83.829	.000[b]
	Residual	10.812	79	.137		
	Total	56.702	83			
Coefficients		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
Model	(Constant)	.242	.240		1.011	.315
	Quality Planning	.541	.071	.588	7.629	.000
	Quality Assurance	.136	.065	.151	2.093	.040
	Quality Control	.150	.065	.149	2.303	.024
	Quality Improvement	.114	.071	.130	1.611	.111

a. Dependent Variable: Performance of Coffee Farming Projects

b. Predictors: (Constant), Quality Improvement, Quality Control, Quality Assurance, Quality Planning

An R^2 value of 0.809 with p = 0.000<0.05, suggesting that the combined quality management strategies (Quality Planning, Quality Assurance, Quality Control, and Quality Improvement) explain 80.9% of the variation in the performance of coffee farming projects. This indicates a strong explanatory power of the independent variables in predicting the dependent variable. The model is found to be a good fit for the data and variables, as indicated by the F (4, 79) = 83.829 (p = 0.000<0.05). The coefficients analysis reveals that the constant term has a coefficient of β = 0.242 (p = 0.315>0.05), which is not statistically significant at the 0.05 level. This suggests that the baseline level of coffee farming project performance (when all quality management strategies are excluded) is not statistically different from zero.

Quality Planning has the highest coefficient, with β = 0.541 (p = 0.000<0.05), suggesting that for every unit increase in quality planning, the performance of the coffee farming project improves by 0.541 units. Quality Assurance also significantly impacts performance, with a coefficient of β = 0.136 (p = 0.040<0.05), indicating that a unit increase in quality assurance leads to a 0.136-unit improvement in project performance. Quality Control has a coefficient of β = 0.150 (p = 0.024<0.05), meaning that an increase in quality control efforts leads to a 0.150-unit improvement in project performance.

Quality Improvement, however, shows a coefficient of β = 0.114 (p = 0.111>0.05), which is not statistically significant at the 0.05 level, suggesting that this strategy has a weaker impact on project performance compared to the other quality management strategies. Thus, the regression model for the combined effect of quality management strategies on project performance is given by:

$Y = 0.242 + 0.541X_1 + 0.136X_2 + 0.150X_3 + 0.114X_4$

This analysis demonstrates that Quality Planning, Quality Assurance, and Quality Control significantly and positively affect the performance of coffee farming projects. Quality Improvement, while showing a positive relationship, has a marginal effect on performance. The high R^2 value (0.809) underscores the importance of these quality management strategies in predicting the performance of coffee farming projects. The simultaneous use of these strategies yields better outcomes than relying on individual strategies alone, emphasizing the collective value of these approaches in ensuring the success of coffee farming projects.

Conclusions

The study concludes that the coffee farming projects have been highly successful in enhancing coffee production, productivity, budget adherence, timeliness, and the livelihoods of farmers. These positive outcomes demonstrate that the project has made a significant impact on both the economic and social well-being of farmers in the region. Quality planning, assurance, control and improvement plays a crucial role in improving the performance of coffee farming projects. Based on the conclusions drawn from the study, it is recommended that regular inspections and corrective actions be carried out to sustain high-quality coffee production. Additionally, training farmers in quality control techniques and providing necessary tools for accurate measurements will significantly contribute to maintaining and improving quality control standards.

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