



Project Management Practices and Sustainability of Small-Scale Irrigation Agribusinesses in Nyagatare District

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Abstract: *This study investigated the effect of project management practices on the sustainability of small-scale irrigation agribusinesses in Nyagatare District, Rwanda. The study employed a descriptive and cross-sectional survey research design to examine the influence of project management practices on the performance. Of a target population of 210, 138 respondents were sampled, and 114 valid questionnaires were analysed (82.6% response); 11 key informants contributed qualitative insights. The study applied descriptive statistics, Pearson correlation, multiple regression and thematic analysis. The primary regression tables reported a significant model ($R = .771$, $R^2 = .594$, adjusted $R^2 = .583$; $F = 53.708$, $p < .001$). Project planning ($\beta = .342$, $p < .001$), resource management ($\beta = .298$, $p < .001$) and monitoring and evaluation ($\beta = .261$, $p = .001$) were positive, significant predictors. The findings point to the value of seasonal plans, maintenance financing, and participatory monitoring for sustained irrigation operations. Based on these findings, it was recommended that local agriculture authorities (MINAGRI, RAB, District Agriculture Office) institutionalize mandatory project management training and quarterly technical audits for Water Users Associations, that cooperatives establish transparent, ring-fenced maintenance funds, and that development partners integrate hardware provision with long-term technical support.*

Keywords: *Project Planning, Resource Management, Monitoring and Evaluation, Stakeholder Coordination, Agribusiness Sustainability*

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1. Introduction

At the global and Sub-Saharan African levels, irrigation had increasingly been regarded as an important component of climate-resilient agricultural development. Nevertheless, irrigation expansion alone did not guarantee sustainable outcomes. The practical challenge involved ensuring that water resources, infrastructure, energy, labour, agricultural inputs, finances, and farmer knowledge were coordinated in ways that generated sufficient agricultural returns. Recent research on

community smallholder irrigation in Rwanda illustrated this challenge particularly clearly. Chandra, Heeren, Odhiambo, and Brozović (2023) found that farmers in a community-based irrigation scheme applied only about 31% of modeled irrigation water requirements for dry beans and 27% for maize, while irrigation decisions varied considerably from field to field. The researchers associated the observed situation with inadequate irrigation planning and showed that water, machinery, fertilizer, energy, and crop production were interconnected. This evidence was relevant to the present study because it demonstrated that having irrigation infrastructure available did not necessarily mean that

farmers used water efficiently or that the infrastructure automatically generated sustainable agricultural outcomes.

The practical problem was reflected in the gap between irrigation potential, infrastructure investment, and actual management and utilization outcomes. Evidence from Rwanda showed that irrigation users could substantially underuse available water relative to modeled crop requirements. Chandra et al. (2023), for example, found that farmers in a community irrigation scheme applied only about 31% of modeled water requirements for dry beans and 27% for maize, with substantial field-to-field variation and weaknesses in irrigation planning. At the same time, national agricultural statistics continued to show productivity differences between small-scale and large-scale farmers. These conditions suggested that the challenge was not merely the availability of irrigation infrastructure but also the capacity to plan production, allocate resources, maintain facilities, monitor performance, and coordinate users. In practical terms, an irrigation project could have pumps, pipes, reservoirs, land, and farmers but still fail to produce sustainable results if the project was poorly planned or inadequately managed.

The empirical problem was therefore the limited district-specific evidence explaining how project management practices influenced the sustainability of small-scale irrigation agribusinesses in Nyagatare District. Existing research and agricultural reports had generated important information about irrigation expansion, climate resilience, agricultural productivity, water management, and technology adoption, but these dimensions did not necessarily explain how project planning, resource management, and monitoring and evaluation jointly affected sustainability at the level of small-scale irrigation agribusinesses. This was important because national programmes such as PSTA 5 were simultaneously pursuing irrigation expansion, rehabilitation of existing schemes, improved water efficiency, and stronger irrigation-management institutions. Without district-level empirical evidence on the management practices associated with sustainability, authorities and implementing organizations could have limited evidence for deciding which management dimensions required the greatest attention.

1.1 General Objective

The general objective of the study was to assess the influence of project management practices on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.

1.2 Specific Objectives

The study was guided by the following specific objectives:

1. To examine the effect of project planning on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.
2. To assess the influence of resource management on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.
3. To evaluate the effect of monitoring, evaluation, and stakeholder coordination on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.

1.4 Research Hypotheses

The study was guided by the following null hypotheses:

H₀₁: Project planning has no statistically significant effect on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.

H₀₂: Resource management has no statistically significant effect on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.

H₀₃: Monitoring, evaluation, and stakeholder coordination has no statistically significant effect on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.

2. Literature Review

2.1 Theoretical Review

The theoretical review provided the intellectual foundation for understanding why project management practices could influence the sustainability of small-scale irrigation agribusinesses.

2.1.1 Project Management Theory

Project Management Theory emphasized the systematic organization, planning, execution, monitoring and control of activities undertaken to achieve predetermined objectives within specified constraints. Project management was therefore concerned not merely with completing activities but with coordinating resources, schedules, costs, risks, quality requirements and stakeholders in order to achieve intended outcomes. The Project Management Institute (2021) emphasized the importance of structured approaches to planning, delivery, measurement and adaptation in project environments. From this perspective, project planning established the basis upon which project activities were sequenced, resources were anticipated, responsibilities were allocated and risks were considered. In agricultural projects, these functions were particularly important because production cycles were time-sensitive and were affected by rainfall, water availability, input availability, market conditions and climatic uncertainty.

The relevance of Project Management Theory to irrigation agribusinesses was evident because irrigation activities involved multiple interconnected activities that had to occur at appropriate times. Farmers and project managers had to plan land preparation, water distribution, seed and fertilizer procurement, planting, irrigation scheduling, pest management, harvesting, marketing, infrastructure maintenance and financial management. A weakness at the planning stage could consequently generate problems at later stages. Inadequate planning of irrigation schedules could result in insufficient water reaching crops during critical growth periods, while poor budgeting could delay the purchase of fuel, electricity, spare parts, seeds or fertilizers. Recent research by Gasana and Njenga (2024) on the Sustainable Agriculture Intensification and Food Security Project in Rwanda emphasized the importance of material resource planning, personnel planning, stakeholder involvement and beneficiary-oriented planning in agricultural project performance.

Project Management Theory was therefore directly relevant to the first objective of the present study, which examined the effect of project planning on the sustainability of small-scale irrigation agribusinesses. The theory suggested that sustainability was more likely when irrigation projects had clearly defined objectives, realistic schedules, appropriate budgets, risk-management arrangements, operational plans and mechanisms for anticipating future requirements. Recent research on agricultural projects in Rwanda similarly demonstrated that project planning was treated as an important determinant of project performance, while research on irrigation systems emphasized the importance of appropriate planning and management of water resources. Chandra et al. (2023), for example, found that farmers using a shared center-pivot irrigation system in Rwanda applied only a fraction of modeled irrigation water requirements for dry beans and maize, illustrating the importance of irrigation decision-making and planning for efficient use of water resources.

Thus, Project Management Theory provided a strong explanation for why project planning was expected to influence sustainability. A well-planned irrigation agribusiness could anticipate operational requirements, allocate responsibilities, establish schedules, identify risks and organize maintenance activities before problems became severe. Conversely, weak planning could contribute to delays, resource wastage, unplanned costs and deterioration of irrigation infrastructure. In the context of Nyagatare District, where irrigation was used for crops including rice, maize, beans and horticultural products, planning was particularly important because production activities had to be coordinated with water availability, agricultural seasons, input supplies and market opportunities.

2.1.2 Resource-Based View Theory

The Resource-Based View (RBV) Theory explained organizational performance by emphasizing the importance of resources and capabilities controlled by an organization or project. The foundational argument associated with Barney (1991) was that resources could generate sustained competitive advantage when they were valuable, rare, difficult to imitate and difficult to substitute. Although the theory was originally developed within strategic management, its principles were applicable to agricultural projects because irrigation agribusinesses depended on combinations of physical, financial, human, technical and organizational resources. In this context, irrigation infrastructure alone did not guarantee sustainability. Rather, the value of infrastructure depended on whether farmers and project managers possessed the financial resources, technical knowledge, human skills, institutional arrangements and management capabilities necessary to operate and maintain it.

The RBV therefore provided the theoretical basis for the second objective of this study, which examined the influence of resource management on sustainability. Effective resource management involved ensuring that available resources were allocated to the activities that created the greatest agricultural and economic value. Financial resources needed to support routine operations and maintenance; human resources needed to possess appropriate technical and managerial capabilities; and physical resources needed to be maintained and used efficiently. Poor resource management could cause irrigation equipment to remain idle, maintenance to be postponed, water to be wasted, or agricultural inputs to be acquired at inappropriate times. Recent research by Chandra et al. (2023) illustrated the interconnected nature of water, machinery and agricultural inputs in smallholder irrigation systems in Rwanda, showing that irrigation, machinery and fertilizer had important effects on crop outcomes.

RBV further suggested that sustainability depended on the ability of farmers and irrigation organizations to develop capabilities rather than merely acquire physical assets. This distinction was particularly important for small-scale irrigation projects because infrastructure could deteriorate when users lacked financial capacity, technical knowledge or appropriate maintenance systems. Dirwai et al. (2024) similarly emphasized that effective agricultural water management was important for improving water productivity, climate adaptation and resilience in smallholder farming systems across Africa. The implication for Nyagatare was that resource management had to extend beyond the initial provision of irrigation infrastructure to include continuous allocation, maintenance, capacity building and efficient utilization of resources.

Consequently, RBV provided a strong explanation of how resource management could contribute to sustainability. Where farmers and irrigation management structures possessed and effectively utilized appropriate financial, physical and human resources, they were better positioned to maintain irrigation operations, respond to breakdowns, sustain production and generate economic returns. The theory therefore complemented Project Management Theory by explaining that good plans could only produce sustainable results when the resources and capabilities required to implement those plans were available and effectively managed.

2.1.3 Systems Theory

Systems Theory was particularly appropriate for irrigation because agricultural water management involved strong relationships between water, energy, agricultural production, financial resources, human decisions and environmental conditions. Chandra et al. (2023) explicitly demonstrated the importance of the water-energy-food relationship in a community smallholder irrigation scheme in Rwanda. Their study showed that irrigation, machinery and fertilizer interacted with agricultural outcomes, illustrating that irrigation performance could not be understood by examining water provision alone. Similarly, a 2025 study on institutional and technological innovations in smallholder irrigation in Southern and Eastern Africa emphasized the importance of combining institutional and technological interventions, adapting water-management systems and creating multi-stakeholder platforms to sustain irrigation benefits.

Systems Theory complemented Project Management Theory and RBV by explaining the interaction between planning, resources, monitoring, farmers, institutions and environmental conditions. It suggested that sustainability could not be attributed to one management practice in isolation. Rather, sustainable outcomes emerged when the different components of the irrigation system functioned together and when feedback mechanisms allowed managers and beneficiaries to identify problems and adapt their practices. This perspective was particularly suitable for examining small-scale irrigation agribusinesses in Nyagatare District, where agricultural sustainability depended on the interaction of technical, managerial, financial, environmental and institutional factors.

2.2 Empirical Review

The empirical evidence was therefore relevant to Nyagatare District because it showed that infrastructure investment needed to be accompanied by management practices capable of maintaining agricultural and economic benefits over time. The following subsections reviewed the evidence according to the three study objectives.

2.2.1 Project Planning and Sustainability of Small-Scale Irrigation Agribusinesses

Evidence from Rwanda supported the relationship between planning and agricultural project outcomes. Gasana and Njenga (2024), in their study of the Sustainable Agriculture Intensification and Food Security Project, examined project planning in relation to material resources, personnel management, stakeholder involvement and beneficiary satisfaction. Their findings and recommendations emphasized the importance of effective planning tools, timely provision of resources, personnel training and stakeholder participation in agricultural project performance. This evidence was important because it demonstrated that agricultural project planning was multidimensional and extended beyond the preparation of a timetable.

Similarly, Tuyisenge and Kabanda (2024) examined the impact of project planning on agricultural projects in Rwanda and considered budget planning, resource planning, risk planning and scheduling. Their study highlighted the importance of planning because agricultural projects were exposed to resource, time and risk-related challenges. Such findings were relevant to irrigation agribusinesses because irrigation operations required advance decisions concerning water requirements, crop choices, input procurement, equipment use and expected production outcomes.

Research on irrigation in Rwanda provided additional evidence concerning the importance of planning. Chandra et al. (2023) examined a community smallholder center-pivot irrigation scheme and found that farmers applied approximately 31% of modeled irrigation water requirements for dry beans and 27% for maize. The study also identified irrigation, machinery and fertilizer as important contributors to maize yield. These findings indicated that the presence of irrigation infrastructure did not automatically translate into optimal water use or agricultural performance; decisions about when, how much and where to apply water were also important.

At the regional level, Higginbottom et al. (2021) assessed 79 large-scale irrigation schemes in Sub-Saharan Africa and found considerable differences between planned and delivered irrigated areas. Their findings pointed to management and institutional weaknesses as important explanations for poor scheme performance. Although their study focused on large-scale rather than small-scale irrigation, its findings remained relevant because they demonstrated that infrastructure investment could produce limited outcomes when planning assumptions, institutional arrangements and maintenance capacity were weak.

2.2.2 Resource Management and Sustainability of Small-Scale Irrigation Agribusinesses

The importance of resource management was demonstrated by Chandra et al. (2023), whose study of community smallholder irrigation in Rwanda showed that irrigation, machinery and fertilizer influenced agricultural production outcomes. Their findings indicated that irrigation systems operated within a broader resource environment in which water, energy, machinery and agricultural inputs had to be coordinated. Inefficient use of any one resource could therefore affect productivity and profitability. This was especially relevant to smallholder farmers who often operated under financial and technical constraints.

Dirwai et al. (2024) similarly argued that effective agricultural water management was central to improving water productivity and climate resilience in African smallholder systems. Since much of Sub-Saharan African agriculture remained dependent on rainfed production, irrigation represented an important opportunity for increasing resilience; however, inefficient water management could reduce the benefits of irrigation investments. The implication was that sustainable irrigation agribusinesses required farmers and management institutions to treat water as a scarce productive resource rather than merely as an input that could be used without systematic allocation.

2.2.3 Monitoring and Evaluation and Sustainability of Small-Scale Irrigation Agribusinesses

Recent Rwandan evidence strongly supported the importance of M&E for sustainability. Muvunyi (2025), in a study of the Rubona Water Supply Project in Kirehe District, found a strong positive relationship between M&E practices and project sustainability. The study examined M&E budgeting, partnerships, communication, human-resource capacity and information sharing and utilization. Its findings indicated that M&E practices contributed substantially to sustainability, reinforcing the importance of using monitoring information not simply for reporting but for decision-making and corrective management.

Similarly, Kamugisha (2024) examined M&E practices and sustainability in the WASAC project in Kigali and identified M&E planning, stakeholder involvement and M&E training as important dimensions. The study emphasized the need for M&E control plans to be aligned with project plans and for stakeholders to be involved throughout the project cycle. This was relevant to irrigation agribusinesses because monitoring could only support sustainability when information was collected systematically and used by the people responsible for operational decisions.

Evidence from Tanzania also demonstrated the importance of M&E in irrigation-specific sustainability.

Lyimo (2021) examined sustainability determinants of local-government irrigation projects in Mkuranga District and found that monitoring and evaluation practices, institutional factors and financial factors significantly influenced irrigation project sustainability. The study recommended effective M&E and stakeholder involvement throughout the project cycle. Although conducted in Tanzania, the study was highly relevant because it directly addressed irrigation project sustainability rather than general agricultural project performance.

More recent evidence from Western Kenya further reinforced the relationship between participatory M&E and irrigation project performance. Ouma and Odhiambo-Abuya (2025) found that participatory M&E practices had a statistically significant combined effect on the performance of community-based irrigation projects. Their findings emphasized that involving communities in monitoring could contribute to accountability, ownership and long-term project effectiveness. This finding was relevant to small-scale irrigation agribusinesses because farmers were not simply beneficiaries but active users and managers of irrigation resources.

Evidence from Tanzania also showed that participatory monitoring and evaluation could contribute to sustainability through goal understanding, activity identification, progress measurement and results reporting. Faraja and Mtae (2025) found positive and significant contributions of these participatory M&E dimensions to the sustainability of rural water projects. Although the study focused on rural water supply rather than irrigation, its findings supported the broader proposition that community participation in monitoring could strengthen accountability and informed decision-making.

Recent research in Rwanda further showed that M&E was relevant to the sustainability of development projects beyond the water sector. Mpuhwe and Niyonkuru (2024) examined monitoring and evaluation in the Rwanda Urban Development Project and emphasized beneficiary participation, accountability, communication, partnerships and resource allocation as components supporting sustainability. Such evidence suggested that effective M&E was not limited to technical measurement but also involved organizational learning, participation and the use of information to improve future planning.

3. Methodology

3.1 Research Design

The study used a descriptive, cross-sectional mixed-methods design involving irrigation farmers, cooperative

leaders, water-user representatives and local authorities in Nyagatare District.

3.2 Population and Sample Design

Its target population was 210 stakeholders, and a sample of 138 was derived using the Taro Yamane formula at a 5% level of precision. Questionnaire respondents included 118 farmers, 13 cooperative leaders and 7 local authorities. Stratified random sampling was used for irrigation farmers, while purposive selection was applied to knowledgeable cooperative and local-authority respondents.

3.3 Data Collection and Pilot Testing

The study used both primary and secondary data sources to obtain information relevant to project management practices and the sustainability of small-scale irrigation agribusinesses in Nyagatare District. Primary data were collected from the selected irrigation farmers, cooperative leaders, and local authorities using structured questionnaires. The questionnaires provided quantitative information on project planning, resource management, monitoring and evaluation, and the sustainability of irrigation agribusinesses.

3.4 Pilot Testing

A pilot study involved 14 respondents outside the main survey. Expert review and pilot feedback supported instrument clarity and content validity. The dissertation reported a Content Validity Index (CVI) of .875 and Cronbach's alpha coefficients ranging from .841 to .891. Completed questionnaires were checked, coded and processed in SPSS; 114 validated questionnaires were available for quantitative analysis.

3.5 Measurement and Analytical Procedures

The five-point questionnaire assessed project planning through crop scheduling, budgeting, task allocation and risk preparation; resource management through water,

labour, finance, equipment and maintenance; and monitoring, evaluation, and stakeholder coordination through performance tracking, feedback, joint reviews and corrective actions. Sustainability was evaluated through production continuity, financial viability, operational longevity and resource-use outcomes. Frequencies, percentages, means, standard deviations, Pearson correlations and multiple linear regression were used for quantitative analysis.

The regression model was $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$, where Y denotes sustainability, X_1 project planning, X_2 resource management and X_3 monitoring and evaluation. Regression assumptions were checked through normality, multicollinearity, heteroskedasticity and Durbin-Watson diagnostics. The significance threshold was .05. Since the survey was cross-sectional, coefficient estimates are best understood as conditional statistical associations rather than experimental proof of causation.

3.6 Ethical Considerations

The researcher reported securing university authorisation and institutional permission, explaining voluntary participation to respondents, obtaining informed consent, protecting confidentiality and anonymity, and using the collected data for academic purposes. Participants were informed about withdrawal rights and the handling of their responses.

4. Results and Discussion

4.1 Response Rate

The response rate was assessed to establish the extent to which the sampled respondents participated in the study. A satisfactory response rate was important because it provided a sufficiently large empirical basis for analysing project management practices and sustainability among small-scale irrigation agribusinesses.

Table 1. Response Rate

Response Category	Frequency	Percentage (%)
Questionnaires administered	138	100.0
Questionnaires successfully retained	114	82.6
Unreturned/incomplete questionnaires	24	17.4
Total	138	100.0

Source: Primary Data (2026)

A total of 138 questionnaires were administered, of which 114 were successfully completed and retained for analysis, representing an effective response rate of 82.6%. The remaining 24 questionnaires represented 17.4% of the administered questionnaires and were not included in the final statistical analysis.

The response rate of 82.6% indicated that a substantial majority of the targeted participants had provided usable information. More than four-fifths of the administered questionnaires were therefore available for analysis. This strengthened the empirical basis of the findings because

the results were not derived from a small proportion of the intended respondents.

4.2 Pilot Test and Reliability

This section presented the reliability and pilot-testing results and the demographic characteristics of the respondents. Reliability analysis was undertaken to establish whether questionnaire items consistently measured their respective constructs, while pilot testing was conducted to assess the adequacy and clarity of the instrument before the main survey.

Table 2. Reliability and Pilot Test Results

Construct	Number of Items	Cronbach's Alpha	Interpretation
Project Planning	5	0.884	High internal consistency
Resource Management	5	0.862	High internal consistency
Monitoring & Evaluation	4	0.841	High internal consistency
Agribusiness Sustainability	4	0.891	High internal consistency
Pilot Test	14 cases	CVI = 0.875	Acceptable content validity

Source: Primary Data (2026)

The Cronbach's alpha coefficients ranged from 0.841 to 0.891, indicating high internal consistency among the questionnaire items. Project planning recorded an alpha of 0.884, resource management 0.862, monitoring and evaluation 0.841, while sustainability recorded the highest coefficient of 0.891.

The results suggested that the items measuring each construct had been sufficiently consistent for composite analysis. This was important because the study measured multidimensional concepts. Such as project planning included crop scheduling, budgeting, risk management and task allocation rather than relying on a single question.

The pilot test involving 14 cases produced a Content Validity Index of 0.875, indicating that the questionnaire items had adequately represented the concepts under investigation. The combination of satisfactory reliability and content validity provided methodological support for using the instrument in the main study.

4.3. Pearson Correlation Analysis

Pearson correlation analysis was conducted to establish the strength and direction of the relationships between the three project management practices and agribusiness sustainability.

Table 3. Pearson Correlation Matrix

Variables	Sustainability	Project Planning	Resource Management	Monitoring & Evaluation
Sustainability	1.000			
Project Planning	0.684**	1.000		
Resource Management	0.642**	0.512**	1.000	
Monitoring & Evaluation	0.618**	0.486**	0.448**	1.000

Source: Primary Data (2026)

**Note: ** Correlation was significant at the 0.01 level, two-tailed.

Project planning had the strongest direct correlation with sustainability, $r = 0.684$, $p < 0.001$. This represented a strong positive association, indicating that higher levels of project planning tended to be associated with higher levels of agribusiness sustainability.

Resource management also had a strong positive relationship with sustainability, with $r = 0.642$, $p < 0.001$. This indicated that better management of water, labour, equipment and financial resources tended to coincide with better sustainability outcomes.

Monitoring and evaluation recorded a positive correlation of $r = 0.618$, $p < 0.001$. Although slightly lower than the other two relationships, it remained a substantial positive association. Importantly, the correlations among the independent variables themselves were lower than their respective relationships with sustainability, supporting the earlier multicollinearity diagnostics.

Overall, the correlation results demonstrated a consistent positive pattern: better project management practices were associated with better sustainability outcomes. The evidence was also substantively plausible because recent studies had shown that irrigation performance depended on planning, water-use management, institutional coordination and maintenance.

4.4. Regression Analysis

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	0.771	0.594	0.583	0.38421

Source: Primary Data (2026)

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he model produced a multiple correlation coefficient of $R = 0.771$, indicating a strong positive combined relationship between project management practices and sustainability. The R^2 of 0.594 indicated that project planning, resource management and monitoring/evaluation collectively explained 59.4% of the variation in sustainability.

The adjusted R^2 of 0.583 indicated that approximately 58.3% of the variation remained explained after adjustment for the number of predictors and sample size. The relatively small difference between R^2 and adjusted

R^2 suggested that the predictors collectively contributed meaningful explanatory information rather than the model's explanatory power being substantially inflated by the number of variables.

The remaining 40.6% of variation was attributable to factors not included in the model. Such factors could have included market prices, climate conditions, access to agricultural finance, input prices, farmer skills, land conditions and external institutional support. The result therefore indicated a strong project-management contribution while also demonstrating that irrigation sustainability was multidimensional.

Table 5. Analysis of Variance

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	23.784	3	7.928	53.708	<0.001
Residual	16.238	110	0.148		
Total	40.022	113			

Source: Primary Data (2026)

The ANOVA results produced an F-statistic of 53.708 with $p < 0.001$. Since the significance value was below 0.05, the overall regression model was statistically significant. This indicated that the three project management practices jointly explained a statistically significant proportion of the variation in agribusiness sustainability.

The result provided strong evidence that sustainability was systematically associated with project management practices rather than the observed relationship occurring

merely through sampling variation. The combination of planning, resource management and monitoring/evaluation therefore provided a meaningful statistical model for explaining sustainability among the sampled irrigation agribusinesses.

The practical implication was that interventions focusing on only one management function might not fully address sustainability challenges. The significant overall model supported an integrated approach in which irrigation projects were planned properly, resources were managed efficiently, and implementation was continuously monitored and coordinated.

Table 6. Regression Coefficients

Predictor	B	Std. Error	Beta (β)	t	Sig.
<i>Constant</i>	0.412	0.158	—	2.608	—
Project Planning	0.328	0.081	0.342	4.049	<0.001
Resource Management	0.284	0.076	0.298	3.737	<0.001
Monitoring & Evaluation	0.246	0.074	0.261	3.324	0.001

Source: Primary Data (2026)

The regression equation was:

$$Y = 0.412 + 0.328X_1 + 0.284X_2 + 0.246X_3 + \varepsilon$$

Project planning recorded the largest standardized coefficient ($\beta = 0.342$), followed by resource management ($\beta = 0.298$) and monitoring/evaluation ($\beta = 0.261$). All three coefficients were positive and statistically significant.

The coefficient for project planning indicated that, holding the other predictors constant, a one-unit increase in project planning was associated with a 0.328-unit increase in sustainability. The result was consistent with the descriptive mean of 4.15 and the strong correlation between planning and sustainability.

Resource management also produced a positive coefficient of 0.284, indicating that improved

management of water, labour, equipment and finances was associated with higher sustainability. Monitoring and evaluation recorded a positive coefficient of 0.246, demonstrating that systematic monitoring and stakeholder coordination also contributed independently to sustainability.

The positive signs across all three coefficients were particularly important because they demonstrated consistency between the descriptive, correlation and regression results. However, the standardized beta values should be interpreted as relative statistical contributions rather than proof that one practice alone determined sustainability.

4.5 Decision on Null Hypotheses

The hypotheses were tested at the 5% significance level. The decision rule was that a null hypothesis was rejected when its p-value was below 0.05.

Table 7. Hypothesis Testing

Null Hypothesis	Relationship	β	t	p-value	Decision
H₀₁: Project planning has no statistically significant effect on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.	$X_1 \rightarrow Y$	0.342	4.049	<0.001	Rejected
H₀₂: Resource management has no statistically significant effect on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.	$X_2 \rightarrow Y$	0.298	3.737	<0.001	Rejected
H₀₃: Monitoring, evaluation, and stakeholder coordination has no statistically significant effect on the sustainability of small-scale irrigation agribusinesses in Nyagatare District.	$X_3 \rightarrow Y$	0.261	3.324	0.001	Rejected

Source: Primary Data (2026)

The first null hypothesis was rejected because project planning produced $\beta = 0.342$, $t = 4.049$ and $p < 0.001$. The result established a statistically significant positive effect of project planning on sustainability. The finding was reinforced by the correlation coefficient of $r = 0.684$, showing that planning was strongly positively associated with sustainability.

The second null hypothesis was also rejected because resource management produced $\beta = 0.298$, $t = 3.737$ and $p < 0.001$. This demonstrated that resource management had a statistically significant positive effect on sustainability. The correlation result of $r = 0.642$ provided additional evidence of the positive association.

The third null hypothesis was rejected because monitoring, evaluation and stakeholder coordination produced $\beta = 0.261$, $t = 3.324$ and $p = 0.001$. The result demonstrated a statistically significant positive effect,

which was consistent with the correlation coefficient of $r = 0.618$.

Collectively, the hypothesis results demonstrated that all three project management dimensions had statistically significant positive effects on the sustainability of small-scale irrigation agribusinesses. The findings therefore supported the study's conceptual proposition that sustainability was associated with effective planning, resource management and continuous monitoring and coordination.

4.6 Discussion of Research Findings

4.6.1 Project Planning and Agribusiness Sustainability

The result supports Project Management Theory, which holds that clear goals, task structuring and scheduling improve resource use and reduce execution failures (Kerzner, 2017; PMI, 2021). Pinto and Slevin (1987)

identified a clear mission and detailed schedules among the critical factors of implementation success, and the Nyagatare result shows the same logic operating in a smallholder setting. In irrigation, planning has a distinctive weight because water is a shared, time-bound input: a late or clashing planting decision by one member changes what is available to everyone downstream.

The finding is consistent with evidence that pre-season crop scheduling raises yields and household income in Rwandan schemes, while uncoordinated planting creates water bottlenecks (MINAGRI, 2018). Reviews of schemes in Kenya and Uganda report better operational continuity where seasonal planning is formalised. The likely mechanism is lower transaction cost. When cooperatives agree crop rotations and maintenance funds before planting, disputes are settled in advance, emergency repairs fall and yields become more predictable.

4.6.2 Resource Management and Agribusiness Sustainability

The result validates the Resource-Based View (Barney, 1991), which argues that survival depends on how efficiently valuable internal resources are deployed. For an irrigation agribusiness, the valuable resources are pumps, canals, cash reserves and the water itself. A scheme that wastes water or lets equipment fail is destroying the asset base on which its members' incomes rest.

Studies in Ethiopia and Tanzania attribute infrastructure deterioration mainly to weak maintenance budgeting and input control rather than design faults [insert sources]. Evaluations of Rwanda's Small-Scale Irrigation Technology (SSIT) programme link transparent fee collection and dedicated maintenance funds to higher efficiency and longer scheme life [insert MINAGRI/RAB source]. The result also fits Ostrom's (1990) design principles for common-pool resources, which stress clear rules on use, cost-sharing proportional to benefit and monitoring by users themselves.

The lower coefficient relative to the other two practices may be explained by the nature of resource management itself. Good management of resources is largely a maintenance activity. It prevents decline but does not by itself create the coordination that lifts performance, so its measurable contribution may look smaller. A second reading is that resource discipline depends on the other two practices, since without a plan and without monitoring, rules on funds and equipment are seldom enforced.

Institutional support should shift from capital subsidies toward operational frameworks. Standardised audits, preventive maintenance schedules and cooperative-level water metering protect physical capital, lower long-run operating costs and secure production across seasons.

4.6.3 Monitoring, Evaluation, and Stakeholder Coordination

The result supports Systems Theory (von Bertalanffy, 1968), which treats irrigation schemes as interdependent socio-technical systems that need feedback loops to stay stable, and Stakeholder Theory (Freeman, 1984; Mitchell, Agle and Wood, 1997), which holds that performance depends on managing the claims of every party with a stake in the system. Crawford and Bryce (2003) argue in the same direction that M&E improves the efficiency and effectiveness of project implementation.

Research on community-managed schemes in Rwanda and East Africa indicates that top-down structures suffer poor fee compliance, water conflicts and neglect, whereas participatory models that involve local government, cooperative leaders and farmers retain assets better [insert sources]. Meinzen-Dick (2007) cautions that no single institutional blueprint works and that locally adapted, accountable arrangements matter, which is the pattern Nyagatare respondents describe. The underlying mechanism is trust and accountability. Continuous monitoring exposes distribution inequities or technical faults early, before they grow into system failures or social conflict.

5. Conclusions and Recommendations

5.1 Conclusions

The findings from the principal inferential tables showed statistically significant positive associations between all three project management practices and sustainability of small-scale irrigation agribusinesses in Nyagatare District. Project planning contributed the largest standardised coefficient in that model, followed by resource management and monitoring and evaluation. The combined model accounted for 59.4% of variation in the observed sustainability score, indicating substantial explanatory power within the surveyed sample while leaving room for climatic, technical, market and institutional influences not captured by the model.

5.2 Recommendations

The recommendations focus on strengthening project planning, improving resource management, and enhancing monitoring, evaluation, and stakeholder coordination.

1. Nyagatare District agriculture authorities, MINAGRI and RAB should reinforce practical training in crop scheduling, water allocation, operations budgeting and contingency planning for irrigation cooperative leaders.
2. Cooperatives and Water User Associations should maintain transparent water-user fee

records and dedicated maintenance reserves, supported by preventive servicing schedules for pumps, pipes and associated equipment.

3. Participatory monitoring should combine routine performance reviews, joint canal inspections, documented conflict-resolution procedures and feedback to farmers.
4. Development partners should couple infrastructure financing with ongoing managerial and technical capacity support.

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