INTERNATIONAL JOURNAL OF SOCIAL Sciences and Information Technology
ISSN 2412-0294 www.ijssit.com
http://www.ijssit.com

COMMUNITY ENGAGEMENT AND THE SUSTAINABILITY OF MICRO-IRRIGATION PROJECTS IN ARID LANDS: EVIDENCE FROM TURKANA COUNTY, KENYA

[1*] **Franciscar Rionokou Ekal**
franciscarekal@gmail.com

[2**] **Dr. Jennifer Wangari Wairiuko**
jenniferw@cuea.edu

[3***] **Dr. James Sankale**
jsankale@cuea.edu

[1, 2, 3] *Faculty of Arts and Social Sciences, Department of Social science and development studies, The Catholic University of Eastern Africa, Kenya*

Abstract: *Micro-irrigation projects are promoted to strengthen food security in arid and semi-arid lands (ASALs), yet their sustainability remains uncertain. This study examined how community engagement influences the sustainability of micro-irrigation initiatives, focusing on the Kenyans for Kenya Irrigation Project in Turkana County, Kenya. Data were collected from 85 households, six beneficiary groups, and six key informants using questionnaires, focus group discussions, and interviews. Quantitative data were analyzed using descriptive statistics, correlation, and regression, while qualitative data were thematically examined. The findings revealed that community engagement was widely regarded as central to sustainability, with descriptive results indicating near-universal agreement on its value. Engagement was strongly associated with ownership, collaboration, and local knowledge integration with mean scores exceeding 4.5 across key indicators. A Pearson correlation analysis confirmed a moderate positive relationship between engagement and sustainability ($r = 0.36$) and regression analysis showed that community engagement was positively associated with sustainability outcomes ($\beta = 0.33$), accounting for 13% of the variance. Qualitative insights reinforced these results, highlighting four themes: participatory planning and inclusive decision-making reduced exclusion and strengthened ownership; integration of traditional knowledge improved project relevance; capacity building and co-investment enhanced skills and reduced dependency; while governance and communication gaps—such as unclear roles and uneven information sharing—limited effectiveness. The study concludes that meaningful community engagement is central to sustaining micro-irrigation projects in arid regions. Sustainability is strengthened when communities are actively involved in planning, decision-making, and monitoring; when local knowledge is embedded in system design; and when governance structures are structured, inclusive, and transparent. Building community capacity in leadership, financial management, and conflict resolution, while ensuring the participation of women and marginalized groups, supports collective responsibility and resilience beyond external support. These findings provide practical guidance for designing inclusive irrigation interventions that enhance food security and climate resilience in fragile ecosystems.*

Keywords: *Arid and Semi-Arid Lands (ASALs), Community Engagement, Sustainable micro-irrigation, Food security and resilience, Kenya (Turkana County)*

1. Introduction

Community engagement plays a central role in project sustainability. As Jemmali (2018) and Opwora (2020) observe, when local communities take part in planning, implementation, and management, they develop a sense of ownership that supports long-term success. In contrast, projects that exclude communities often encounter resistance, conflict, and eventual collapse (Gumbo et al., 2016).

Despite substantial investment, the persistent failure of micro-irrigation projects in Kenya's arid and semi-arid lands (ASALs) remains a pressing challenge to food security in the region. Globally, drylands cover 41% of the earth's surface and host more than one-third of the world's population, most of whom live in developing countries (Prăvălie, 2016). Africa and Asia contain the world's largest dryland areas, where farming is constrained by low crop yields and limited options for irrigation, contributing directly to high rates of food insecurity and malnutrition (Golla, 2021; Goncharova et al., 2021). The State of Food Security and Nutrition in the World (SOFI) reported that in 2022, approximately 828 million people globally experienced chronic hunger, with around three-quarters of this population residing in rural areas that are overwhelmingly dependent on agriculture for their food and livelihoods (FAO, 2023; Alabi & Ngwenyama, 2023).

The sustainability of micro-irrigation projects in the arid regions of Kenya is a critical area of study, given the increasing environmental challenges posed by climate change and extreme water scarcity. These regions are essential for agricultural production but face significant barriers to effective water resource management. The implementation of micro-irrigation technology has emerged as a viable strategy to enhance water use efficiency and boost crop yields. Research indicates that micro-irrigation can achieve 20% to 90%, yield increases depending on various agronomic factors, such as crop type, soil conditions, and management techniques (Deshpande et al., 2024). However, these technological benefits can only be sustained when institutional and community structures effectively support the systems.

The success of micro-irrigation projects, therefore, is not solely determined by technological advancements. Community engagement measured through stakeholder collaboration, project coordination and technical assistance has increasingly been recognized as a pivotal sustainability factor. Participatory approaches that involve local communities can enhance project ownership and ensure that the specific needs and circumstances are addressed (Ahumuza et al., 2022). Engagement fosters a sense of responsibility and commitment among community members, which has been linked to improved sustainability outcomes across various projects (Unegbu et al., 2024: Mwesigwa et al., 2024).

Stakeholder collaboration strengthens communication and trust, ensuring that diverse voices contribute to decision-making. Effective project coordination enables alignment of resources, timelines, and responsibilities, reducing management gaps that often lead to project collapse. Finally, technical assistance provides communities with the knowledge and skills necessary to maintain and adapt irrigation systems, especially under changing environmental conditions. These elements jointly create an enabling environment for long-term sustainability (Horwitz et al., 2021; Nyakwaka & Benard, 2019).

This study therefore investigates the intricate interplay between community engagement and the sustainability of micro-irrigation projects specifically in the arid regions of Kenya, with a focus on Turkana County. It aims to provide empirical insights that could inform future interventions and policies designed to enhance food security in arid and semi-arid lands.

2. Problem statement

In Kenya's arid and semi-arid lands (ASALs), irrigation projects have often struggled to remain viable, even after substantial investments, undermining national food security. More than 80% of Kenya's land surface lies within the ASALs, where about 1.3 million people face chronic food insecurity—a figure that can rise above 4 million during droughts. In counties such as Turkana, acute water scarcity continues to limit agricultural production and worsen food insecurity (Wario, 2016; Osumba, 2020). Effective water management has long been identified as central to agricultural sustainability (FAO, 2019; Goyal, 2024).

Although micro-irrigation systems have been promoted as a strategy to address these challenges, their long-term viability remains uncertain. The high rates of soil salinity, limited and unreliable water availability, and weak management practices frequently undermine system performance and economic returns for smallholder farmers (Mansouri et al., 2014; Guan et al., 2019). Land degradation and poor governance of water resources further compound these difficulties, threatening both food security and environmental sustainability in these fragile dryland ecosystems (Wu et al., 2024; Begizew, 2021).

While these technical and environmental barriers are well documented, less attention has been given to the social dimensions of irrigation management. In particular, community engagement has insufficiently been recognized as a determinant of project sustainability. Evidence indicates engaging local communities in the design, implementation, and governance of micro-irrigation systems fosters ownership, accountability and alignment with local priorities, thereby improving their long-term outcomes (Dakane & Mutuku, 2023: Nyinawumwami & Wanjiku, 2023). In contrast, inadequate involvement of community stakeholders often results in misaligned objectives, weak commitment to project maintenance, and an increased risk of project failure (Matsika et al., 2022).

This gap highlights the need for empirical research that explores the intersection between community engagement and the sustainability of irrigation interventions in Kenya's arid regions.

In light of these challenges, this study examines the influence of community engagement on the sustainability of micro-irrigation projects in the arid lands of Kenya, focusing on the mechanisms through which local involvement can enhance their performance, resilience and long-term viability.

3. Study Objective

The objective of this study was to examine the influence of community engagement on the sustainability of micro-irrigation projects in the arid lands of Kenya, using the Kenyans for Kenya Irrigation Project in Turkana County as a case study.

4. Significance of the Study

This study examines how community engagement influences the sustainability of micro-irrigation projects in Turkana County, highlighting practices that foster local ownership, collaboration, and accountability. Findings offer practical guidance for policymakers and practitioners to design resilient irrigation programs and strengthen rural livelihoods. Academically, the study fills a gap on the role of community engagement in arid and pastoralist settings, contributing to frameworks for sustainable, locally grounded irrigation interventions.

5. Related Literature

Community engagement is widely recognized as a foundation for sustainable development. It fosters collaboration, builds ownership, and supports project continuity. Yet it is often applied uncritically or in ways that miss the complexity of real-world implementation. In arid and semi-arid lands such as Turkana—where climatic stress combines with weak institutions—the role of engagement needs stronger theory and evidence. Drawing on Community-Based Natural Resource Management (CBNRM), this study treats engagement not just as participation but as the transfer of authority and responsibility to local actors, a condition often missing in practice.

Scholars emphasize that genuine engagement should extend across all phases of the project cycle—planning, implementation, monitoring, and governance. Such inclusion aligns interventions with community priorities, draws on indigenous knowledge, and strengthens collective capacity (Bergstrom et al., 2014; Lansing et al., 2023). Evidence from Al-Yaqoubi and Al-Saidi (2023) and Susskind and Kim (2022) shows that integrating local knowledge and social capital improves resilience. Yet in practice, weak institutions, elite capture, and underinvestment in capacity often block these ideals. Resource Dependency Theory (RDT) helps explain how power asymmetries and external reliance limit community choices.

Different forms of engagement—consultation, collaboration, and empowerment—are often discussed but rarely tested for their impact on sustainability. Collaboration in particular is seen as promising for linking governments, NGOs, private actors, and communities (Nalumu et al., 2021; Elia et al., 2020). But research cautions that inclusive frameworks can reproduce exclusion. In Kenya, women and marginalized farmers were left out due to lack of resources and information (Eidit et al., 2020). In Ghana, policies failed because of weak communication and poor coordination (Nalumu et al., 2021). From a CBNRM view, this shows the need to redistribute decision-making power, while RDT highlights how poorly designed coordination can deepen dependency.

Coordination is closely tied to engagement. More than an administrative task, it shapes participation, validates knowledge, and distributes benefits (Al-Mashari & Al-Minai, 2018; Reed, 2013). Evidence from Zimbabwe (Makaya, 2019) and South Africa (Department of Water and Sanitation, 2022) shows that coordination supports sustainability by improving information flow and reducing duplication. Rivera-Torres and Gerlak (2021) found that joint governance in the Colorado River Basin helped build resilience even under resource stress. In micro-irrigation, however, overlapping mandates and weak local capacity often frustrate coordination, underlining the need for adaptive, locally grounded structures.

Technical assistance is another way engagement shapes sustainability. When continuous and context-specific, it builds capacity and ownership (Djagba et al., 2014; Jacobs et al., 2016). Israel's irrigation success and Nepal's community-managed schemes show how tailored support strengthens efficiency (FAO, 2019; World Bank, 2018; Gurung & Shrestha, 2016). But top-down assistance can reinforce dependency and erode local knowledge. Yami (2016) argues for participatory approaches that see communities as producers of knowledge rather than passive recipients.

Overall, the literature shows that engagement is essential but not sufficient for sustainability. Its impact depends on how it is embedded in governance. Collaboration must be equitable, coordination adaptive, and technical assistance context-specific. Weaknesses in any of these areas risk undermining outcomes and wider goals such as food security and resilience. This study treats engagement as a process shaped by local power dynamics, resource dependence, and broader sustainability goals.

Despite this, little is known about how engagement affects the sustainability of micro-irrigation in Kenya's arid and semi-arid lands. Many studies do not test these relationships quantitatively (Bergstrom et al., 2014) and often generalise across agricultural interventions. The specific challenges of pastoralist communities—mobility, fragile institutions, and recurring drought—are rarely addressed (Tekola, 2016). This leaves an important gap in understanding how collaboration, coordination, and technical support influence the long-term viability of micro-irrigation in fragile contexts such as Turkana.

6. Research Methodology

Research Design

This study adopted a mixed-methods convergent parallel research design to examine the influence of community engagement on the sustainability of micro-irrigation projects in the arid lands of Kenya. The quantitative component measured relationships between collaboration, coordination, and technical assistance and project sustainability, while the qualitative component documented participants' experiences, governance processes, and the contextual factors shaping engagement. The concurrent use of both approaches allowed for triangulation and deeper insight, making the design appropriate for capturing the complex dynamics of community engagement and sustainability in Turkana County.

Study Area

The study was conducted in Kaikor Ward, Turkana North Sub-County. Turkana County lies within the Greater Rift Valley and borders Uganda, South Sudan, and Ethiopia. The area is predominantly arid and semi-arid, with annual rainfall averaging about 200 mm, making it highly prone to recurrent droughts (Ratemi et al., 2020). The research focused on Nakinomet and Kang'itulae villages, which were part of the *Kenyans for Kenya Irrigation Project* initiated in 2013 by the Kenya Red Cross Society and partners. These sites were selected due to their accessibility and the availability of complete beneficiary registers, which provided a reliable basis for sampling and data collection. The broader context of chronic food insecurity, weak institutional capacity, and climate stress in Turkana makes it an appropriate setting for examining the sustainability of community-based irrigation projects.

Target Population

The target population comprised households and project committee members directly engaged in the *Kenyans for Kenya Irrigation Project* in Nakinomet and Kang'itulae villages of Turkana North Sub-County. At the household level, 108 registered beneficiaries were eligible, with one adult member from each household serving as the respondent. Project committee members were also included to capture governance perspectives and the leadership experiences of those overseeing project activities. In addition, county technical officers and representatives of development partners involved in food security and irrigation programming in Turkana were consulted as key informants. Their perspectives provided valuable contextual insights into the institutional, technical, and policy environment shaping irrigation interventions in the region.

Sampling Procedures and Sample Size

A multi-stage sampling procedure was employed. In the first stage, two villages—Nakinomet and Kang'itulae—were purposively selected from the four project sites based on accessibility and the availability of complete beneficiary registers. In the second stage, the sampling frame was defined as the 108 registered beneficiary households in the two villages (72 in Nakinomet and 36 in Kang'itulae). Using Slovin's formula

at a 95% confidence level and 5% margin of error, a sample size of 85 households was calculated. Proportional allocation yielded 57 households from Nakinomet and 28 from Kang'itulae, after which simple random sampling was applied to each village register. One adult household representative completed the household questionnaire in each selected household. For the qualitative component, purposive sampling was used to identify participants with direct knowledge of the irrigation project. This included six focus group discussions (FGDs)—three in each village with committees, men's groups, and women's groups—and ten key informant interviews (KIIs) with project committee leaders, county technical officers, and representatives of humanitarian organisations involved in food security programming. The combination of household questionnaires, FGDs, and KIIs ensured the inclusion of both beneficiary experiences and contextual insights from governance and technical stakeholders.

Data Collection Instruments

The study employed both quantitative and qualitative instruments. A structured household questionnaire was administered to household representatives in Nakinomet and Kang'itulae villages to capture socio-demographic characteristics, levels of community engagement, and perceptions of project sustainability. For the qualitative component, a focus group discussion (FGD) guide was used with six groups, including project committees and gender-specific beneficiary groups, to explore governance, gender dynamics, and participation. In addition, a key informant interview (KII) guide was administered to county technical officers and representatives of humanitarian organisations to gather expert perspectives on institutional and contextual factors influencing irrigation sustainability. Together, these instruments generated complementary data that combined quantifiable household-level information with broader governance and policy insights.

Pilot Testing, Reliability, and Validity

Before the main data collection, a pilot test was conducted with nine households in Napuu village, outside the study area, representing approximately 10% of the intended household sample. The household questionnaire and FGD guide were assessed for clarity, cultural appropriateness, and response consistency. Feedback informed refinements, including simplified wording, improved translations into Turkana, and adjustments to sequencing of items and prompts.

Reliability was assessed using Cronbach's alpha. The construct measuring community engagement achieved a coefficient of 0.83 ($\alpha > 0.7$), indicating strong internal consistency and confirming the suitability of the instrument for the main data collection.

Validity was ensured through both field-based piloting and expert review. The pilot enhanced contextual relevance and respondent comprehension, while academic supervisors confirmed that the instruments effectively captured the intended dimensions of community engagement.

Data Collection Procedure

Data collection was conducted over a one-month period following ethical clearance and research authorization. The researcher, a native Turkana, participated directly in the fieldwork alongside trained research assistants fluent in Ng'aturkana. This enhanced rapport with participants and ensured both linguistic accuracy and cultural sensitivity during the administration of household questionnaires and facilitation of focus group discussions. All participants provided informed consent, and their involvement was voluntary and confidential. Focus group discussions were held in neutral community spaces familiar to participants, while key informant interviews were conducted via email in line with respondent availability and preference.

Data Analysis

The study employed both quantitative and qualitative data analysis techniques. Quantitative data from household questionnaires were cleaned, coded, and analysed using SPSS (Version 25). Descriptive statistics summarised household characteristics and study variables, while correlation and regression analysis assessed the relationship between community engagement and the sustainability of micro-irrigation projects.

The regression model applied in the study is expressed as:

Sustainability = $\beta 0+\beta_1$(Community Engagement) + β_2 (Monitoring & Evaluation System) +β_3 (Technology Used) +β_4 (Resource Availability) + ε

Where:

β_0 = constant term

β_1 *to* β_4 = regression coefficients for the independent variables

ε = error term

Qualitative data from focus group discussions and key informant interviews were transcribed, coded, and thematically analysed. These insights provided context and depth to the quantitative findings, enabling a comprehensive understanding of the factors shaping project outcomes.

7. Results and Discussion

Sustainability of Micro-Irrigation Projects

This section examines perceptions of the sustainability of micro-irrigation projects, the study's dependent variable, with particular focus on the Kenyans for Kenya Irrigation Project's impact on crop productivity, socio-economic benefits, and long-term viability. The results are presented in Table 1, which summarizes responses to the 10 items in Section B of the questionnaire and integrates insights from the KIIs and FGDs.

Table 1: Sustainability of Micro-Irrigation Projects in Turkana County

Item	Statement	SD (n, %)	D (n, %)	N (n, %)	A (n, %)	SA (n, %)	Mean	SD
1	Improved food production and quality of life	0 (0%)	0 (0%)	3 (3.5%)	9 (10.6%)	73 (85.9%)	4.82	0.47
2	Lasting positive impact	0 (0%)	1 (1.2%)	1 (1.2%)	11 (12.9%)	72 (84.7%)	4.81	0.50
3	Protected soil and land health	0 (0%)	1 (1.2%)	3 (3.5%)	14 (16.5%)	67 (78.8%)	4.73	0.59
4	Efficient water use	1 (1.2%)	0 (0%)	0 (0%)	11 (12.9%)	73 (85.9%)	4.82	0.54
5	Knowledge of drought-resistant plants	1 (1.2%)	2 (2.4%)	10 (11.8%)	14 (16.5%)	58 (68.2%)	4.48	0.88

Item	Statement	SD (n, %)	D (n, %)	N (n, %)	A (n, %)	SA (n, %)	Mean	SD
6*	No long-term impact	13 (15.3%)	10 (11.8%)	7 (8.2%)	21 (24.7%)	34 (40.0%)	3.62	1.49
7*	Not sustainable	5 (5.9%)	1 (1.2%)	1 (1.2%)	20 (23.5%)	58 (68.2%)	4.47	1.03
8*	Not effective in protecting soil	0 (0.0%)	1 (1.2%)	2 (2.4%)	22 (25.9%)	60 (70.6%)	4.66	0.59
9*	Did not help water use efficiency	2 (2.4%)	1 (1.2%)	0 (0.0%)	21 (24.7%)	61 (71.8%)	4.62	0.77
10*	No useful plant information	1 (1.2%)	4 (4.7%)	11(12.9%)	29 (34.1%)	40 (47.1%)	4.21	0.93
Composite							**Mean**	**SD**
							4.53	**0.35**

Note: **Negatively worded items; responses reversed for composite.*

Across the positively framed items (1–5), mean scores were notably high, indicating broad consensus on the project's initial contributions. The item Improved food production and quality of life registered the highest agreement (M = 4.82, SD = 0.47), with 85.9% of respondents selecting "Strongly agree" and 10.6% selecting "Agree." This reflects a near-universal perception of tangible improvements in dietary diversity and household welfare, aligning with the socio-economic dimension of sustainability described by Safaricom Foundation (2011). Such findings support the views of Wasonga et al. (2020) that community-level agricultural interventions reduce dependency on aid and strengthen household resilience.

Similarly, the item Lasting positive impact scored highly (M = 4.81, SD = 0.50), although qualitative evidence nuanced this optimism. An FGD participant (FGD S01) remarked, *"The project gave us more food at first, but when it stopped, we struggled again,"* suggesting that while immediate outcomes were positive, they did not extend beyond the project's active phase. Protected soil and land health (M = 4.73, SD = 0.59) and Efficient water use (M = 4.82, SD = 0.54) also scored strongly, reinforcing the environmental dimension of sustainability and echoing research by Miriti et al. (2021) and Khatri et al. (2018) on the importance of conservation in arid environments. Knowledge of drought-resistant plants (M = 4.48, SD = 0.88), while still positively viewed, displayed greater variability, suggesting uneven access to training among participants, particularly in more remote areas.

Negatively worded items (6–10) were reverse-coded before calculating the composite score. No long-term impact recorded an adjusted mean of M = 3.62, SD = 1.49, reflecting mixed experiences: 27.1% of respondents disagreed with the statement, while 64.7% agreed. This divergence is consistent with FGD and KII accounts noting that funding withdrawal undermined continuity. A key informant (KII S01) observed, *"The project could have lasted longer with better funding after donors left,"* underscoring the financial vulnerability of externally driven interventions.

Other reverse-coded items — Not sustainable (M = 4.47, SD = 1.03), Not effective in protecting soil (M = 4.66, SD = 0.59), and did not help water use (M = 4.62, SD = 0.77) — attracted strong disagreement in their original form, indicating general confidence in the project's environmental practices. The item No useful plant information (M = 4.21, SD = 0.93) also drew majority disagreement pre-reversal, suggesting that agronomic

training was largely valued which aligned with observations by Tekola (2016), albeit with pockets of dissatisfaction linked to implementation gaps among pastoralist households.

The composite mean score for the sustainability dimension was $M = 4.53$, $SD = 0.35$, indicating an overall strong positive perception of the project across socio-economic, environmental, and capacity-building indicators.

The qualitative insights both corroborated and contextualised these trends, as the data revealed multiple challenges framed around the following themes.

Environmental Threats: Participants consistently identified environmental factors as major constraints. The invasive species *Prosopis juliflora*, soil and water salinity, and land degradation associated with climate change were highlighted as critical threats to crop productivity and irrigation infrastructure. Extreme temperatures, low humidity, and inadequate technical designs that failed to account for variable water sources further exacerbated these challenges. These environmental hazards undermined both system functionality and agricultural outputs, suggesting that climate-resilient designs and adaptive management strategies were essential for sustainability.

Infrastructure and Maintenance: Poor management and maintenance emerged as a recurrent concern. Participants reported that substandard workmanship in new and rehabilitated systems often leads to water loss. The high cost of maintenance, combined with difficulties in accessing spare parts, contributed to abandonment of infrastructure.

Financial and Economic Viability: Economic constraints were widely cited as a major impediment. Many households lacked the financial capacity to purchase or repair irrigation equipment and thus remained reliant on NGO support. Limited access to credit and unpredictable market returns for produce were also identified as factors that threaten economic sustainability.

Human Resources and Capacity: A recurrent theme was the shortage of skilled personnel to operate and maintain irrigation systems. Farmers often lacked technical knowledge, and the limited number of agricultural extension officers constrained continuous support and training. Participants suggested involving youth and strengthening local capacity as potential solutions.

Overall, the Kenyans for Kenya Micro-Irrigation Project was widely perceived as a meaningful contributor to food security, resource conservation, and community resilience during its active phase. However, reliance on external funding and the absence of a structured exit strategy limited its long-term sustainability. These findings underscore the importance of locally anchored funding mechanisms, capacity building, climate-resilient designs, and phased donor withdrawal to ensure that benefits persist beyond project implementation. The integration of quantitative and qualitative data showed that the project had achieved immediate gains but struggled to sustain them over time.

Community Engagement and Sustainability of Micro-Irrigation Projects

In line with the study objective, which is to examine the influence of community engagement on the sustainability of micro-irrigation projects in the Arid Lands of Kenya, this section examines the influence of community engagement on the sustainability of micro-irrigation projects in the Arid Lands of Kenya, based on quantitative responses and qualitative insights from FGDs and KIIs.

Table 2: Influence of Community Engagement on Sustainability of Micro-Irrigation Projects (N = 85)

Item	Statement	SD (n, %)	D (n, %)	N (n, %)	A (n, %)	SA (n, %)	Mean	SD
1	Community involvement crucial	0 (0%)	0 (0%)	1 (1.18%)	5 (5.88%)	79 (92.94%)	4.92	0.30
2	Local knowledge improves effectiveness	0 (0%)	1 (1.18%)	4 (4.71%)	15 (17.65%)	65 (76.47%)	4.69	0.61
3	Participation leads to ownership	0 (0%)	0 (0%)	3 (3.53%)	10 (11.76%)	72 (84.71%)	4.81	0.47
4	Collaboration ensures sustainability	0 (0%)	0 (0%)	0 (0%)	12 (14.12%)	73 (85.88%)	4.86	0.35
5	Clear explanations fostered support	0 (0%)	4 (4.71%)	8 (9.41%)	15 (17.65%)	58 (68.24%)	4.49	0.86
6*	Lack of involvement poor performance	0 (0%)	5 (5.88%)	5 (5.88%)	21 (24.71%)	54 (63.53%)	4.46	0.85
7*	Did not leverage local knowledge	14 (16.47%)	25 (29.41%)	16 (18.82%)	16 (18.82%)	14 (16.47%)	2.89	1.36
8*	Community not engaged in planning	15 (17.65%)	22 (25.88%)	13 (15.29%)	21 (24.71%)	14 (16.47%)	2.96	1.36
9*	No clear rules for tasks	10 (11.76%)	14 (16.47%)	13 (15.29%)	24 (28.24%)	24 (28.24%)	3.45	1.34
10*	Officers did not explain roles	7 (8.24%)	15 (17.65%)	14 (16.47%)	22 (25.88%)	27 (31.76%)	3.55	1.31
Composite							**Mean 4.16**	**SD 0.72**

Note: *Negatively worded items; responses reversed for composite.*

Agreement was nearly universal on the statement that community involvement is crucial to project success (98.82% agreement; $M = 4.92$, $SD = 0.30$), showing minimal variability and far exceeding the composite mean. This supports CBNRM principles that inclusive decision-making fosters long-term stewardship (Kumar & Sharma, 2020). As one FGD participant (FGD CE01) explained, *"When the community was involved in planning, they took better care of the irrigation system"*.

Similarly, participation leads to ownership (96.47% agreement; $M = 4.81$, $SD = 0.47$) and collaboration ensures sustainability (100% agreement; $M = 4.86$, $SD = 0.35$) scored well above the composite mean, with low dispersion, indicating strong consensus. These results align with studies showing that partnerships between communities, NGOs, and government agencies enhance resilience (Bjornlund et al., 2020).

Recognition that local knowledge improves effectiveness was also high (94.12% agreement; $M = 4.69$, $SD = 0.61$), consistent with literature on the role of indigenous expertise in irrigation management (Derbile et al., 2016). Nevertheless, a KII participant (KII CE01) reflected, *"We know our land best, but the project didn't always ask us,"* highlighting gaps in fully leveraging local expertise.

The statement clear explanations fostered support received 85.89% agreement (*M* = 4.49, *SD* = 0.86), exceeding the composite mean but with higher variability, suggesting uneven communication. FGDs revealed experiences of exclusion, where one participant (FGD CE02) indicated *"Only a few were called to meetings; others felt left out"*, and another (FGD CE03) added *"Some households weren't fully informed, leading to disputes"*.

Responses to the reverse-coded items revealed additional nuance. Lack of involvement leads to poor performance was strongly endorsed (88.24% agreement; *M* = 4.46, *SD* = 0.85), reinforcing RDT's emphasis on reducing external dependency through active engagement. Conversely, did not leverage local knowledge (45.88% disagreement; *M* = 2.89, *SD* = 1.36) and community not engaged in planning (43.53% disagreement; *M* = 2.96, *SD* = 1.36) had much lower means, indicating that most respondents did not encounter these deficiencies. However, the large standard deviations suggest significant variation between communities, echoing concerns in Schoneveld (2017) and Lankford et al. (2016) regarding the risks of excluding stakeholders early in project cycles.

Governance clarity appeared as a relative weakness. No clear rules for tasks (56.48% agreement; *M* = 3.45, *SD* = 1.34) and officers did not explain roles (57.64% agreement; *M* = 3.55, *SD* = 1.31) both scored below the composite mean, with high variability, consistent with findings that unclear authority boundaries hinders effective resource management in pastoralist and semi-arid contexts (Akuja & Kandagor, 2021).

Overall, the composite score was *M* = 4.16, *SD* = 0.72, indicating a broadly positive perception of community engagement with strong support for participation, ownership, collaboration, and respect for local knowledge, which are central to sustainable community-driven resource management. Lower-scoring items highlighted persistent challenges in governance clarity, early-stage inclusion, and communication consistency.

Qualitative analysis from the KIIs and FGDs provided further context as highlighted below.

Project Design and Planning: Involving community leaders and adopting participatory approaches in selecting beneficiaries and project sites helped reduce exclusion errors. Additionally, the inclusion of women and marginalized groups increased acceptance and ownership of irrigation projects.

Integration of Traditional Knowledge: Participants indicated that indigenous knowledge informed system design, improving suitability to local conditions, including soil, water, and cropping practices.

Capacity Building and Co-Investment: The active involvement of local communities in the planning and co-investment in project planning strengthened their skills in irrigation management and reduced reliance on external financial support.

These findings demonstrate that meaningful community engagement is central to sustaining micro-irrigation projects and ensuring both social and operational resilience.

Correlation Analysis

To address the research question concerning the relationship between community engagement and project sustainability, a Pearson correlation analysis was conducted.

Table 3: Correlation Matrix between Community Engagement and Sustainability

	Sustainability	Community_Engagement
Sustainability	1	0.36
Community_Engagement	0.36	1

The results reveal a moderate positive association (r = 0.36), between community engagement and sustainability, indicating that higher engagement levels are linked to increased perceptions of sustainability. This aligns with community-based natural resource management literature that emphasizes the role of participatory approaches in achieving durable outcomes (Molina-Fernandez et al., 2020; Adeyanju et al., 2021; Tekola, 2016).

Regression Analysis

To address the research question regarding the role of community engagement, an OLS simple linear regression was conducted to evaluate its influence on project sustainability.

Table 4: OLS Regression Results for Community Engagement and Sustainability

	coef	std err	t	P>|t|
Intercept	2.0	0.36	5.53	0.001
Community Engagement	0.33	0.09	3.52	0.001**
R-Squared	0.13			
F-Stat	12.40			
F-Stat P-Value	0.0007			

Note: ** indicates significance at $p < 0.05$.

Model Summary: $R^2 = 0.13$, $F(1,83) = 12.40$, $p < 0.001$

The estimated model is expressed as:

$$SU = 2.0 + 0.33CE + \epsilon$$

Where SU represents Sustainability of Micro-Irrigation Projects, CE denotes Community Engagement and ϵ is the Error Term.

The positive coefficient suggests that increased community engagement corresponds with higher sustainability outcomes. While engagement is clearly influential, the model explained 13% of the variance, implying it is an important component of sustainable micro-irrigation though other contextual factors also shape project viability. Qualitative insights underscore the value of participatory planning, collaborative decision-making, and the incorporation of local knowledge in achieving resilient and sustainable outcomes (Bjornlund et al., 2020).

8. Summary of findings

This study explored how community engagement influences the sustainability of micro-irrigation projects in Turkana County.

Community engagement consistently emerged as the foundation of sustainability in micro-irrigation projects. The quantitative analysis indicated a moderate positive association ($r = 0.36$) between engagement and sustainability. Communities that were more involved reported stronger perceptions of durability and resilience in irrigation systems. A simple linear regression model further showed that each unit increase in engagement corresponded with a 0.33 rise in sustainability scores, with engagement explaining 13 percent of the variance across projects. While this leaves room for other contextual factors, the results highlight that engagement is a meaningful driver of project durability. Household responses strongly reinforced this conclusion. Agreement was nearly universal that involvement was crucial ($M = 4.92$), while related items on ownership ($M = 4.81$) and collaboration ($M = 4.86$) also scored very highly, underscoring the perception that participation is integral to long-term success. The integration of local knowledge likewise received strong endorsement ($M = 4.69$), with participants in FGDs noting that indigenous expertise guided decisions about soils, water use, and cropping practices. At the same time, several respondents emphasized that these perspectives were not always fully utilized, pointing to gaps in practice. Some weaknesses limited the full potential of engagement. For example, while 98.8% of respondents agreed that involvement was crucial ($M = 4.92$), items on communication and governance scored lower ($M = 3.45–3.55$) and showed higher variability. FGDs revealed that not all households were informed or included, which at times led to disputes. These shortcomings point to inconsistencies in how engagement was practiced, which may influence the durability of outcomes even when overall perceptions of engagement were positive.

Qualitative accounts offered further insight into how engagement was most effective: early involvement in planning, inclusion of women and marginalized groups, and opportunities for co-investment all fostered ownership and reduced dependency on external actors. These experiences reflect principles of community-based natural resource management, which emphasize local agency, accountability, and the integration of indigenous knowledge into formal systems.

Taken together, these findings suggest that community engagement is not simply supportive of sustainability but foundational to it. By embedding ownership, building capacity, and grounding interventions in local knowledge, engagement ensures that micro-irrigation projects remain both resilient and socially embedded in the arid lands of Kenya. These observations align with broader scholarship highlighting the central role of participatory governance in sustainable natural resource management (Bjornlund et al., 2020; Molina-Fernandez et al., 2020; Muluki et al., 2022).

Conclusion and Recommendation

Community engagement proved to be the strongest factor underpinning the sustainability of micro-irrigation projects in arid lands. Beyond technical inputs, long-term continuity depended on ownership, participation, and accountability embedded in local governance and social structures.

Strengthening sustainability requires moving beyond symbolic participation toward structured, inclusive, and accountable mechanisms such as water user associations or cooperatives. Building community capacity in leadership, financial management, and conflict resolution, while ensuring the involvement of women and marginalized groups, will secure collective responsibility and resilience after external support ends.

References

Adeyanju, S., O'connor, A., Addoah, T., Bayala, E., Djoudi, H., Moombe, K., ... & Sunderland, T. (2021). Learning from community-based natural resource management (CBNRM) in Ghana and Zambia: lessons for integrated landscape approaches. International Forestry Review, 23(3), 273-297.

Ahumuza, E., Moscibrodzki, P., Tucker, J., & Awor, P. (2022). Community engagement in social innovation research: a global sequential mixed methods analysis.. https://doi.org/10.21203/rs.3.rs-2249384/v1

Akuja, T. E., & Kandagor, J. (2019). A review of policies and agricultural productivity in the arid and semi-arid lands (ASALS), Kenya: the case of Turkana County. Journal of Applied Biosciences, 140, 14304-14315.

Al-Yaqoubi, A., & Al-Saidi, M. (2023). Community engagement in micro-irrigation projects: A review of the literature. Journal of Water Resources Planning and Management, 149(2), 04023051.

Begizew, G. (2021). Agricultural production system in arid and semi-arid regions. International Journal of Agricultural Science and Food Technology, 234-244. https://doi.org/10.17352/2455-815x.000113

Bergstrom, D., Rose, K., Olinger, J., & Holley, K. (2014). The sustainable communities initiative: the community engagement guide for sustainable communities. Journal of Affordable Housing & Community Development Law, 191-211.

Bjornlund, V., Bjornlund, H., & Van Rooyen, A. F. (2020). Exploring the factors causing the poor performance of most irrigation schemes in post-independence sub-Saharan Africa. International Journal of Water Resources Development, 36(sup1), S54-S101.

Dakane, A. and Mutuku, M. (2023). Stakeholder participation and performance of irrigation projects in Garissa county, Kenya. strategicjournals.com, 10(4). https://doi.org/10.61426/sjbcm.v10i4.2818

Derbile, E. K., Jarawura, F. X., & Dombo, M. Y. (2016). Climate change, local knowledge and climate change adaptation in Ghana. Adaptation to climate change and variability in rural West Africa, 83-102.

Deshpande, V., Ahmad, I., & Singh, C. (2024). Sustainable groundwater management through micro irrigation: a critical review on challenges and solutions. Journal of Landscape Ecology, 17(1), 16-34. https://doi.org/10.2478/jlecol-2024-0002

FAO. (2023). Integrated water resources management. Food and Agriculture Organization of the United Nations.

FAO. (2022). Monitoring and evaluation of irrigation projects: A guide for practitioners. Rome: FAO.

FAO. (2020). Climate-smart agriculture and irrigation. Food and Agriculture Organization of the United Nations.

FAO. (2019). Drip irrigation: A key technology for sustainable agriculture. Food and Agriculture Organization of the United Nations.

FAO. (2018). Agricultural commercialization centres: A tool for promoting inclusive and sustainable agricultural growth. Rome, Italy

Food and Agriculture Organization of the United Nations (FAO). (2018). The community land rights of women and youth in Turkana County, Kenya: A policy brief. FAO.

Golla, B. (2021). Agricultural production system in arid and semi-arid regions. International Journal of Agricultural Science and Food Technology, 7(2), 234-244.

Goncharova, N. A., & Merzlyakova, N. V. (2021). Food shortages and hunger as a global problem. Food Science and Technology, 42, e70621.

Guan, Z., Jia, Z., Zhao, Z., & You, Q. (2019). Dynamics and distribution of soil salinity under long-term mulched drip irrigation in an arid area of northwestern china. Water, 11(6), 1225. https://doi.org/10.3390/w11061225

Gumbo, D., Tshuma, N., & Chirinda, N. (2016). The Tugwi-Mukosi Dam project: Challenges and lessons learned. African Journal of Environmental Science and Technology, 10(7), 254-264.

Horwitz, F., Mwesigwa, R., & Nabwami, R. (2021). Community and public-private partnership projects in Uganda: community engagement, trust and performance. Journal of Enterprising Communities People and Places in the Global Economy, 17(2), 221-241. https://doi.org/10.1108/jec-01-2021-0013

Jemmali, H. (2018). Water poverty in Africa: a review and synthesis of issues, potentials, and policy implications. Social Indicators Research, 136, 335-358.

Khatri, A. K., Singh, R. K., & Sharma, S. (2018). Economic viability of micro-irrigation systems: A review. Indian Journal of Agricultural Economics, 73(1), 1-15.

Kumar, A., & Sharma, S. K. (2020). Community participation and sustainability of irrigation projects: A review. Indian Journal of Agricultural Economics, 75(1), 1-26.

Lankford, B., Makin, I., Matthews, N., McCornick, P. G., Noble, A., & Shah, T. (2016). A compact to revitalise large-scale irrigation systems using a leadership-partnership-ownership'theory of change'.

Lansing, A. E., Romero, N. J., Siantz, E., Silva, V., Center, K., Casteel, D., & Gilmer, T. (2023). Building trust: Leadership reflections on community empowerment and engagement in a large urban initiative. BMC Public Health, 23(1), 1252.

Mansouri, H., Mostafazadeh-Fard, B., & Neekabadi, A. (2014). The effects of different levels of irrigation water salinity and leaching on the amount and distribution pattern of soil salinity and ions in an arid region., 1, 33-43. https://doi.org/10.2495/si140041

Matsika, O., Marara, O., & Chinamasa, E. (2022). Stakeholder involvement during project initiation: a sustainability factor of smallholder donor-funded irrigation projects in Zvimba district, Zimbabwe. International Journal of Education Humanities and Social Science, 05(04), 261-276. https://doi.org/10.54922/ijehss.2022.0430

Miriti, J. M., et al. (2021). Enhancing irrigation sustainability in Turkana County, Kenya. International Journal of Water Resources Development, 37(5), 764-780.

Muluki, H. M., et al. (2022). Factors influencing adoption of irrigation technologies among smallholder farmers in Machakos County, Kenya. International Journal of Agricultural Extension and Rural Development, 9(1), 1-13.

Mwesigwa, R., Basulira, G., Mayengo, J., & Mugarura, J. (2024). Community engagement, commitment and sustainability of public–private partnership projects. The Journal of Management Development, 43(4), 445-460. https://doi.org/10.1108/jmd-05-2023-0140

Nalumu, D. J., Mensah, H., Amponsah, O., & Takyi, S. A. (2021). Stakeholder collaboration and irrigation practices in Ghana: issues, challenges, and the way forward. SN Applied Sciences, 3(5), 576.

Nyakwaka, S. and Benard, M. (2019). Factors influencing sustainability of community operated water projects in central Nyakach sub-county, Kisumu county, Kenya. International Journal of Academic Research in Business and Social Sciences, 9(7). https://doi.org/10.6007/ijarbss/v9-i7/6096

Nyinawumwami, J. and Wanjiku, C. (2023). Agricultural community engagement and performance of irrigation projects in Rwanda: a case of Nasho irrigation project in Kirehe district. Journal of Entrepreneurship & Project Management, 7(12), 41-57. https://doi.org/10.53819/81018102t2228

Opwora, B. K. (2020). Influence of Community Participation on Implementation of Muringa Irrigation Project in Tharaka-Nithi County, Kenya (Doctoral dissertation, University of Nairobi).

Prăvălie, R. (2016). Drylands extent and environmental issues. A global approach. Earth-Science Reviews, 161, 259-278.

Schoneveld, G. C. (2017). Host country governance and the African land rush: 7 reasons why large-scale farmland investments fail to contribute to sustainable development. Geoforum, 83, 119-132.

Susskind, L., & Kim, A. (2022). Building local capacity to adapt to climate change. Climate Policy, 22(5), 593-606.

TEKOLA, S. (2016). COMPARISON OF IRRIGATION BASED AGRO-PASTORALISTS WITH PASTORALISTS LIVELIHOOD IN CASE OF DOLO ADO AND DOLO BAY WOREDAS, SOMALI REGION, ETHIOPIA (Doctoral dissertation, ST. MARY'S UNIVERSITY).

Turin, T., Kazi, M., Rumana, N., Lasker, M., & Chowdhury, N. (2023). Community ecosystem mapping: a foundational step for effective community engagement in research and knowledge mobilization. Journal of Primary Care & Community Health, 14. https://doi.org/10.1177/21501319231205170

Unegbu, H., Yawas, D., Dan-asabe, B., & Alabi, A. (2024). Investigation of community engagement in sustainable construction projects: case studies from Nigeria. Journal of Sustainable Construction, 4(1), 10-36. https://doi.org/10.26593/josc.v4i1.8109

Wasonga, O., et al. (2020). Social equity in irrigation projects in Turkana County, Kenya. Water International, 45(6), 739-756.

Wu, Z., Zhang, S., Shan, B., Zhang, F., & Chen, X. (2024). Optimizing crop spatial structure to improve water use efficiency and ecological sustainability in inland river basin. Agronomy, 14(8), 1645. https://doi.org/10.3390/agronomy14081645

Yami, M. (2016). Irrigation projects in Ethiopia: what can be done to enhance effectiveness under 'challenging contexts'?. International Journal of Sustainable Development & World Ecology, 23(2), 132-142.