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ROLE OF WOMEN IN PROMOTING SUSTAINABLE AGRICULTURE PRACTICES IN AHERO IRRIGATION SCHEME, KISUMU COUNTY KENYA

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ABSTRACT

This study examined the role of women in promoting sustainable agricultural practices within the Ahero Irrigation Scheme in Kisumu County, Kenya. Despite being central to agricultural production, women in Ahero continue to face significant socio-economic and institutional barriers that hinder their full participation in sustainability-oriented farming. The research was guided by two specific objectives: to assess the influence of access to agricultural resources and analyze how group participation shapes the adoption of sustainable practices among women farmers. A descriptive research design was employed, targeting a population of 130 women farmers, from which 113 respondents (86.9%) provided valid responses. Data were collected through structured questionnaires and analyzed using SPSS, incorporating descriptive statistics, Pearson correlation, and multiple regression analysis. The reliability and validity of the research instrument were confirmed through Cronbach's Alpha (all above 0.8) and factor analysis (KMO > 0.7), indicating strong internal consistency and construct validity. Findings revealed that women in Ahero generally have moderate access to land, water, farm inputs, and extension services, but limited access to credit and green finance—critical enablers for sustainable agriculture. Most respondents reported high awareness and application of climate-smart agricultural techniques, though digital access to farming information remained limited. Cultural norms were found to moderately restrict women's autonomy in land use decisions and group leadership, with male relatives still playing dominant roles in farm-level decisions. Notably, membership in farmer groups emerged as a significant facilitator, enhancing access to training, input support, and collective marketing. Correlation analysis showed strong, statistically significant relationships between the independent variables and the adoption of sustainable agricultural practices, with group participation ($r = 0.818$) and access to resources ($r = 0.805$) showing the strongest associations. The regression model confirmed that Group participation ($\beta = 0.294$) and access to resources ($\beta = 0.291$) were the most influential predictors. The study concludes that women are pivotal actors in driving sustainability within irrigation-based systems, but systemic barriers—including inadequate credit and limited institutional support—must be addressed. It recommends strengthening women's land rights, expanding access to climate-smart training, investing in digital inclusion, and promoting gender-equitable leadership in farmer groups.

Key Words: Sustainability-Oriented Farming, Access to Agricultural Resources, Group Participation, Adoption, Sustainable Practices

Background of the Study

Sustainable agriculture has emerged as a global priority in addressing food security, environmental conservation, and climate change challenges. It promotes farming methods that protect ecosystems while meeting present and future food needs (Soltani et al., 2025). However, sustainable agriculture cannot be fully achieved without recognizing the integral role of women in agricultural production and environmental stewardship.

Globally, women contribute nearly 43% of the agricultural labor force, performing essential tasks such as planting, weeding, harvesting, and post-harvest processing (Sannou et al., 2025). Despite this, they remain marginalized in access to critical agricultural resources, including land, credit, inputs, and technology, which limits their influence on decision-making and sustainable farming transitions (Zecca & Saima, 2025). Evidence shows that women possess deep indigenous knowledge and practice eco-friendly farming techniques such as organic fertilizer use, agroforestry, and conservation tillage—practices critical for sustainability (Rosero-Añazco et al., 2025). Their roles in biodiversity conservation, soil fertility management, and water resource preservation have been well documented, positioning them as natural custodians of sustainable agricultural systems (Manta, 2025).

Despite their contributions, social and cultural norms, coupled with weak land rights, limit women's capacity to fully engage in sustainable agriculture (Prasad et al., 2025). For instance, many women operate as unpaid family laborers, excluded from accessing extension services and formal agricultural markets (Ravsandjani, 2025). This exclusion perpetuates gender inequality and reduces the uptake of sustainable agricultural innovations. Women's participation in cooperatives and farmer groups has proven transformative in enhancing their agency and promoting sustainable agriculture (Sannou et al., 2025). Through such platforms, women gain access to training, credit facilities, and market opportunities, which in turn empower them to adopt climate-smart farming practices (Oyedokun & William, 2025).

However, studies reveal that most agricultural policies and programs still lack gender sensitivity, failing to create enabling environments for women's participation in sustainability transitions (Zecca & Saima, 2025). This oversight hampers efforts to scale up successful women-led agricultural sustainability models (Soltani et al., 2025).

While global research highlights these gendered dynamics, there is limited localized research focusing on women's roles within specific agricultural systems, such as irrigation schemes (Ravsandjani, 2025). Irrigation farming presents unique challenges and opportunities where water management, market access, and resource distribution intersect with gender (Rosero-Añazco et al., 2025). The Ahero Irrigation Scheme in Kisumu County, Kenya, is a prime example of an ecosystem where women play critical yet understudied roles in promoting sustainable agricultural practices (Prasad et al., 2025). With its rice-based production and diversified cropping systems, Ahero offers a fertile ground to examine how women navigate resource constraints, cultural norms, and group dynamics to influence sustainability outcomes (Dewandini & Religia, 2025). Therefore, this study sought to explore the role of women in promoting sustainable agricultural practices in the Ahero Irrigation Scheme, providing evidence that can inform gender-responsive policies and community-driven sustainability strategies.

Statement of the Problem

Women remain central to Kenya's agricultural sector, providing nearly 75% of labor in smallholder farming systems where they dominate crop production, weeding, harvesting, and post-harvest processing (Wamalwa et al., 2024). Despite this critical contribution, their role in promoting sustainable agricultural practices continues to be undermined by persistent gendered barriers. Nationally, less than 2% of land titles are registered under women's names (FAO,

2022), severely restricting their ability to make land-use decisions, access credit, or invest in long-term sustainable farming technologies. This disparity in land ownership not only limits women's capacity to implement conservation agriculture but also prevents them from fully benefiting from climate-smart agriculture programs and green finance initiatives.

In Kisumu County, where women produce over 60% of the region's food, they remain largely excluded from climate-resilient knowledge systems, agricultural financing, and leadership positions within cooperatives (FSD Kenya, 2024). Their participation in green finance—an essential driver of sustainable agriculture—is less than 20%, constrained by factors such as lack of collateral, limited financial literacy, and poor digital access (FSD Kenya, 2024). Within the Ahero Irrigation Scheme, which serves as a major rice production zone, women shoulder most of the labor-intensive activities. However, only 18% of them access agricultural extension services that offer knowledge on sustainable practices like water conservation, agroforestry, and organic farming (Omondi, 2023). This limited access significantly weakens their ability to adopt and promote sustainable agricultural methods.

Existing studies further reveal that socio-cultural norms, limited capital access, and weak infrastructure structurally exclude rural women from entrepreneurial and agricultural spaces. Sindani (2022), in a study of Kisumu and Vihiga counties, noted that these barriers hinder women's economic empowerment and their capacity to engage meaningfully in sustainable agriculture. Similarly, Onyango (2024) found that women along Kisumu's food corridors face regulatory hurdles and limited market access, further restricting their ability to integrate environmentally sustainable practices into their farming enterprises.

The problem is exacerbated by weak institutional support and policy implementation gaps. While Kenya has made progress in developing gender-responsive agricultural policies, women's representation in key decision-making structures—such as cooperative leadership and water resource management boards—remains below 30%, particularly in Kisumu County (Ooro, 2020). This underrepresentation curtails women's influence over sustainability-focused decisions, undermining community-level environmental resilience and slowing the scaling up of sustainable agricultural practices.

Several critical gaps persist. Women in Ahero and Kisumu generally have limited access to climate-smart agriculture knowledge and extension services, with only 18% benefiting from these vital resources (Omondi, 2023). Economically, women's access to credit, green finance, and sustainable agricultural inputs remains critically low, as demonstrated by their less than 20% participation in green finance programs and only 2% land ownership nationally (FAO, 2022; FSD Kenya, 2024). Compounding this is the weak enforcement of gender equity policies, which leaves women with minimal representation in leadership and resource governance structures, limiting their influence over sustainability decisions (Ooro, 2020). If these barriers remain unaddressed, they continued to undermine Kenya's efforts to achieve Sustainable Development Goals (SDGs) 2 and 5, which focus on zero hunger and gender equality. The continued marginalization of women's potential threatens not only agricultural productivity but also environmental sustainability and climate resilience, particularly in critical ecosystems like the Ahero Irrigation Scheme. This study, therefore, sought to examine the socio-economic, institutional, and cultural factors influencing women's role in promoting sustainable agriculture within Ahero, with the aim of offering evidence-based solutions to bridge these gaps and enhance women's contributions to sustainability.

Objectives of the Study

General Objective

To examine the role of women in promoting sustainable agricultural practices in Ahero Irrigation Scheme in Kisumu County, Kenya.

The study was guided by the following specific objectives;

1. To assess how women's access to resources affects adoption of sustainable agricultural practices in Ahero Irrigation Scheme in Kisumu County, Kenya.
2. To analyze the effect of group participation on the adoption of sustainable agricultural practices in Ahero Irrigation Scheme in Kisumu County, Kenya.

LITERATURE REVIEW

Theoretical Review

Resource-Based Theory

Penrose (1959) initially introduced the Resource-Based Theory (RBT), later expanded by Barney (1991), which posits that access to valuable, rare, and inimitable resources is a primary driver of competitive advantage and long-term success. Within agriculture, this theory emphasizes that control over resources such as land, water, credit, farm inputs, and technology determines a farmer's ability to innovate, invest, and implement sustainable agricultural practices. The theory assumes that those with better resource access are strategically positioned to adopt new technologies, diversify production, and build resilience against environmental and economic shocks.

Wernerfelt (1984) further argues that resources form the foundation of capabilities necessary for sustainable productivity. Applied to the agricultural sector, this means that ownership or control over land—viewed as a core productive asset—directly affects a farmer's ability to engage in sustainable practices like soil conservation, agroforestry, and water management. Similarly, access to financial resources enhances farmers' capacity to invest in long-term sustainability measures, such as irrigation systems or organic fertilizers.

However, Barney (1991) acknowledges that while the theory accounts for tangible assets, it often underestimates the role of intangible resources like social capital, gender dynamics, and cultural norms. This is a significant limitation when applying RBT to gendered agricultural systems, particularly in rural and patriarchal societies. Kozlenkova et al. (2014) critique RBT for focusing predominantly on individual ownership and control, which does not align with communal land tenure systems common in many African rural settings. In these contexts, resources like land and water are owned and controlled by families, clans, or community groups, complicating the simplistic resource-user relationship RBT assumes.

Additionally, Grant (1991) points out that RBT tends to treat resources as static and inherently valuable, disregarding how environmental changes, seasonal variations, and socio-political dynamics affect resource utility over time. For example, water—though essential for agriculture—may fluctuate in availability due to climate change, making it an unstable resource. This dynamic nature of agricultural resources is inadequately captured within the classic RBT framework.

Moreover, Hart (1995) argues that RBT's focus on competitive advantage is rooted in corporate strategy and may not fully translate into agricultural systems where collective action, cooperation, and shared resource management dominate. In rural communities, especially among women farmers, the reliance on farmer groups, cooperatives, and communal labor illustrates that sustainable agricultural success is not purely individualistic but deeply social. This cooperative nature of agricultural production is overlooked by RBT's individual-centric model.

In conclusion, while RBT offers valuable insights into how access to and control over resources shape agricultural outcomes, it remains limited in addressing the gendered and communal realities of rural farming. To effectively apply RBT in studying women's role in sustainable

agriculture, it must be complemented by theories that account for social structures, and collective resource management. Nonetheless, RBT lays the groundwork for understanding why women's limited access to land, credit, and technology undermines their capacity to promote sustainable agricultural practices..

Social Capital Theory

Putnam (1995) popularized Social Capital Theory (SCT) by defining social capital as the networks, norms, and trust that facilitate coordination and cooperation for mutual benefit within a society. Unlike theories focused on individual capabilities or resources, SCT emphasizes the collective value derived from social networks, relationships, and community engagement. It argues that individuals embedded in strong social networks are better positioned to access information, resources, and support systems that enhance their well-being and economic productivity.

In agriculture, Social Capital Theory provides a powerful framework for understanding how group participation, farmer cooperatives, and community organizations influence women's ability to engage in sustainable agricultural practices. Membership in farmer groups enables women to pool resources, share knowledge, access training, and collectively market their produce—benefits that may be unattainable at the individual level. Through such networks, women also gain bargaining power, access to microfinance, and visibility in decision-making platforms, which are essential for promoting sustainability.

Woolcock and Narayan (2000) argue that social capital plays a critical role in rural development by bridging the gap between marginalized groups and formal institutions. For women in agriculture, particularly in resource-constrained environments, social networks serve as alternative pathways to access knowledge, credit, and technology. Group participation also creates platforms for women to influence local governance, advocate for their rights, and drive the adoption of eco-friendly farming techniques such as organic agriculture, water conservation, and agroforestry.

However, Social Capital Theory faces several critiques, especially regarding its application in gendered rural contexts. Bourdieu (1986) critiques SCT for being overly optimistic about the benefits of social networks, arguing that social capital is not equally distributed and often reflects existing power structures. In patriarchal societies, men dominate influential networks, while women's groups may have limited resources, weaker political influence, and reduced access to external markets. This unequal distribution means that while group participation can be empowering, it does not automatically translate into increased sustainability or gender equity.

Furthermore, Portes (1998) warns that social capital can have "dark sides" when it reinforces exclusionary practices or creates bonding within homogeneous groups that resist change. In agricultural settings, traditional women's groups may uphold cultural norms that discourage innovation or perpetuate unsustainable practices. Additionally, some women may face barriers to joining powerful groups due to class, ethnicity, or marital status, limiting SCT's assumption that social networks are universally accessible.

Another critique is that SCT often overlooks structural and institutional barriers that limit the effectiveness of social networks. Fine (2001) argues that the theory is too focused on micro-level interactions, ignoring macro-level issues such as discriminatory policies, weak institutions, or market failures that affect rural women's participation in agriculture. Merely belonging to a group does not resolve challenges like lack of land rights, access to extension services, or credit constraints—systemic issues that require more than social capital to address.

Despite these limitations, Social Capital Theory remains relevant in understanding how group participation can facilitate women's engagement in sustainable agriculture. It highlights the

importance of strengthening women's cooperatives, enhancing leadership roles, and building trust-based networks that enable collective action toward sustainability. When designed inclusively, such networks can empower women, improve access to resources, and enhance resilience to environmental and economic shocks.

In conclusion, while Social Capital Theory provides valuable insights into the role of social networks in rural development, its practical application must consider existing gender dynamics, power relations, and structural barriers. For women in agricultural schemes like Ahero, group participation is a potential pathway to overcome resource constraints and promote sustainable practices—but only if these groups are well-integrated into broader institutional frameworks that support gender equity and sustainability.

Conceptual Framework

A conceptual framework guides this study by illustrating the relationship between the independent variables and the dependent variable—women's promotion of sustainable agricultural practices. It is anchored in theories that explain how access to resources, knowledge, socio-cultural dynamics, and social networks influence behavior and decision-making in agriculture. According to Miles and Huberman (1994), a conceptual framework serves as a visual and narrative model that links concepts, provides clarity on what the study examines, and highlights expected relationships among variables. In this study, the framework posits that women's ability to promote sustainable agriculture is influenced by their access to productive resources, agricultural knowledge and skills, the socio-cultural environment, and participation in farmer groups or cooperatives.

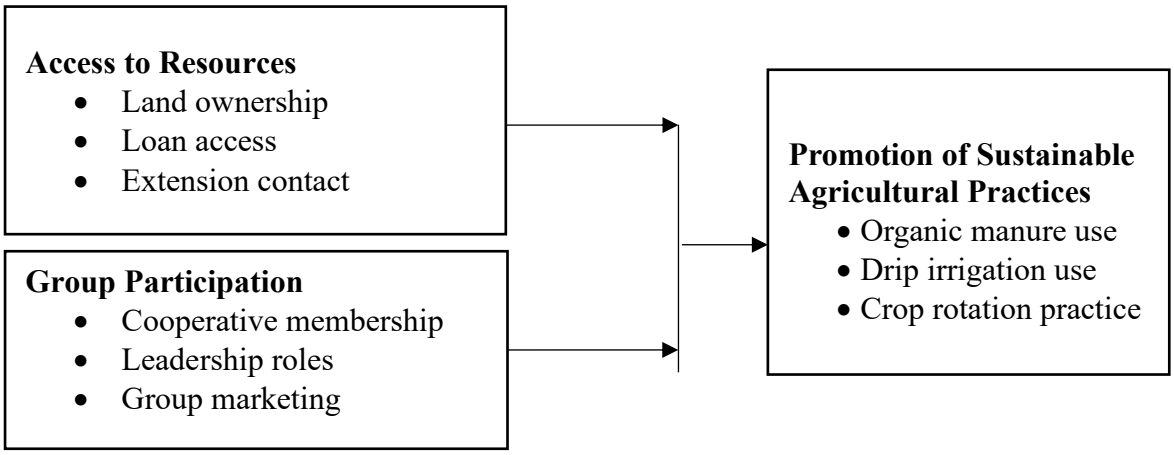

Figure 2. 1: Conceptual Framework

Access to Resources

Access to resources and services refers to the ability of individuals, particularly women, to obtain, control, and benefit from the productive assets and services required to engage meaningfully in agriculture. It includes land, water, credit, farm inputs, extension services, market access, and technological innovations. Wanjala et al. (2024) define women's access to agricultural resources as not only their physical ability to utilize resources but also their legal, social, and economic rights to control and benefit from them. They argue that meaningful access must encompass the empowerment of women to make autonomous decisions over these resources to improve both their livelihoods and environmental outcomes. Olutende and Wamalwa (2024) add that access to resources also entails women's ability to leverage market information, policy incentives, and sustainable technologies, which are often mediated by their position in social hierarchies.

The Food and Agriculture Organization (FAO, 2022) expands this definition by emphasizing that access is fundamentally about ownership rights and decision-making power. FAO states that land, as a foundational resource, often determines access to other productive assets like credit, inputs, and government subsidies, especially in agriculture-based economies. Without land ownership or secure tenure, women face systemic exclusion from agricultural programs aimed at improving sustainability. Similarly, Kipchumba et al. (2025) emphasize that true resource access is achieved when women have equal rights and opportunities to own and manage land, water, and financial services, which are critical for practicing sustainable, climate-resilient agriculture.

Further deepening the conversation, Maseno and Chitando (2024) argue that access is not merely physical but also ideological, requiring the dismantling of patriarchal norms that prevent women from fully benefiting from agricultural services. They highlight that gendered cultural and religious beliefs, especially in African rural contexts, continue to subordinate women by assigning them labor-intensive roles while excluding them from resource ownership and leadership. Complementing this, Osabohien (2024) posits that institutional and policy frameworks must proactively enforce women's rights to resources to ensure their active involvement in sustainability initiatives. He warns that without legal reforms, women remained stuck in subsistence farming, unable to transition to climate-smart, sustainable agriculture.

In modern agricultural discourse, access to resources now includes the digital and informational dimensions. Wambu (2024) explains that women's inclusion in agricultural cooperatives improves their chances of accessing pooled resources, markets, and training, yet these opportunities remain skewed due to male dominance in cooperative leadership. He emphasizes that collective action is increasingly necessary for smallholder women farmers to access sustainability-enhancing inputs. Jumanne (2024) adds that digital tools—mobile money, e-extension platforms, and market information apps—are emerging as critical agricultural resources. Unfortunately, women are frequently excluded from digital spaces due to low digital literacy, limited phone ownership, and cultural barriers, widening the existing gender gap in resource access.

Overall, contemporary literature frames women's access to agricultural resources and services as multidimensional and deeply gendered. It is not simply about the physical presence of resources but about the agency and capacity of women to control and make decisions regarding those resources. Barriers such as discriminatory land tenure systems, lack of collateral for credit, exclusion from extension services, and limited participation in cooperatives systematically disempower women. This disempowerment ultimately curtails their potential to drive sustainable agricultural practices, particularly in ecosystems like irrigation schemes where resources like water are heavily contested. Closing these gaps is critical for enhancing women's contribution to climate-smart agriculture, food security, and rural development.

Group Participation

Group participation is increasingly recognized as a critical factor influencing women's engagement in sustainable agriculture. Defined as the active involvement of women in organized farmer groups, cooperatives, self-help groups, and community-based organizations, group participation enhances collective bargaining power, knowledge sharing, and access to resources. According to Nyamolo et al. (2024), group settings serve as innovation hubs where women learn new farming techniques, share experiences, and access joint inputs and markets, contributing directly to sustainable agricultural outcomes. Group participation reduces isolation and enables women to overcome barriers they face as individual farmers.

Women's participation in groups is particularly impactful in facilitating access to agricultural knowledge, financial services, and sustainable technologies. Kranthi et al. (2024) highlight that group-based projects involving biochar and composting practices among African women

farmers enhanced soil fertility and supported long-term environmental sustainability. Through platforms such as WhatsApp groups, women were able to share real-time feedback and project updates, demonstrating that digital group interactions now complement physical farmer groups in knowledge dissemination and sustainability planning.

However, structural barriers and gendered power dynamics continue to limit women's influence in group settings. Wamalwa and Njoroge (2024) observe that, while women participate in farmer groups, leadership positions remain male-dominated, thus affecting women's ability to shape group decisions, particularly those related to the adoption of sustainable agricultural practices. This is compounded by cultural norms that assign women reproductive and unpaid care roles, leaving them less time for active engagement in cooperatives or training sessions. Yet, studies show that when women assume leadership roles, group performance improves, especially in promoting climate-smart agriculture and accessing markets.

Recent initiatives focusing on socio-technical innovation bundling demonstrate the potential of women-led groups in scaling sustainability. Nyamolo et al. (2024) reflect on scaling impacts in Kenya through group-based socio-technical innovations where collective action among women farmers enhanced the adoption of climate-resilient technologies and practices. Such bundles—combining seed varieties, irrigation techniques, and market access—worked better when women's groups were empowered to implement and manage the innovations, proving that participation goes beyond membership to active leadership and decision-making.

In conclusion, women's group participation is a powerful enabler of sustainable agriculture when designed to be inclusive and gender-sensitive. Key indicators of this variable include membership in cooperatives, participation in farmer groups, and involvement in collective marketing or training initiatives. Strengthening women's voices and leadership within these groups is essential for achieving sustainable agricultural development, particularly in resource-constrained settings like Ahero Irrigation Scheme.

Promotion of Sustainable Agricultural Practices

Promotion of sustainable agricultural practices (SAPs) refers to women's active role in adopting, practicing, and championing environmentally friendly, economically viable, and socially responsible farming methods. Sustainable agriculture includes practices like organic farming, soil and water conservation, agroforestry, crop diversification, and climate-smart agriculture, all aimed at preserving resources for future generations. Maseno and Chitando (2024) argue that women, due to their close interaction with land and natural resources, are uniquely positioned to drive sustainability agendas in agriculture, especially in rural African settings.

Recent evidence highlights the growing role of women in promoting SAPs across Kenya and Africa. Ambaw et al. (2024) in their CGIAR study note that gender-responsive climate-smart agricultural interventions, including community-based breeding programs and adaptive livestock innovations, significantly enhance women's participation in sustainable agriculture. They emphasize that women's involvement in such initiatives leads to improved resilience, environmental conservation, and food security. Similarly, Gondwe et al. (2024) find that women's active engagement in low-emissions livestock systems strengthens adaptive capacities and promotes sustainable practices in Eastern and Southern Africa.

Empirical studies further show that when women are empowered, their promotion of sustainable agriculture extends to influencing household and community-level decisions. Wamalwa and Njoroge (2024) highlight that women in Western Kenya, when actively participating in farmer groups, take on leadership roles that enable them to advocate for conservation agriculture and sustainable soil management. These actions not only improve

productivity but also enhance collective environmental stewardship, signaling the importance of women's agency in sustainability.

However, challenges persist. Mekuriaw et al. (2024) point out that while women show high interest in sustainable interventions, structural barriers such as limited access to resources, cultural restrictions, and insufficient technical support hinder their full participation. Addressing these challenges requires targeted programs that equip women with the knowledge, resources, and platforms necessary to effectively promote sustainable agriculture.

Key indicators for this variable include adoption of organic farming, practice of crop diversification, engagement in water and soil conservation, and participation in agroforestry. Together, these indicators capture women's contributions towards sustainable food systems, environmental conservation, and climate resilience.

Empirical Review

Access to Resources

Empirical studies reveal persistent gender disparities in women's access to agricultural resources, limiting their role in sustainable agriculture. Hailemariam et al. (2024) conducted a multi-country empirical analysis in Kenya, Uganda, and Senegal to assess gender gaps in adopting climate-smart agriculture (CSA) practices. Using household survey data from over 3,500 farming households and applying multivariate regression models, the study found that women consistently faced barriers in accessing land, credit, and extension services—factors that significantly reduced their likelihood of adopting CSA techniques. The researchers emphasized that equalizing access to these resources would narrow the gender gap in sustainable agriculture adoption.

In Kenya, Wanjala, Olutende, and Wamalwa (2024) carried out a comprehensive household survey in the Maasai Mau Forest region, targeting 350 households. Their mixed-method approach combined structured questionnaires, focus group discussions, and key informant interviews. Results showed that while women contributed significantly to agricultural production, they had limited access to land ownership, water rights, and market information—critical resources for sustainable agriculture. The study uniquely highlighted the intersection of environmental degradation and gendered resource access, arguing that women's limited resource control exacerbates environmental vulnerabilities. Their findings recommended integrating women into water management and land-use decision-making structures.

Further, Mekonnen et al. (2023) employed a comparative case study approach in Ethiopia and Kenya, involving 260 women farmers to examine access to land and financial services. Using in-depth interviews and econometric analysis, they discovered that cultural and institutional barriers restricted women's access to formal credit, preventing investments in sustainable farming methods. The study concluded that land tenure security and gender-responsive financial services were essential for empowering women in climate-smart agriculture.

Similarly, Ajuang et al. (2021) focused on western Kenya's sugarcane farming belt and used panel data analysis on 480 smallholder farmers to assess access to land, extension, and inputs. They reported that men controlled over 75% of sugarcane contracts and farm inputs, while women performed most labor tasks but had minimal decision-making power. The lack of access to contracts and inputs significantly limited women's capacity to adopt sustainable land management practices, reinforcing the cycle of gendered resource exclusion.

Owuor et al. (2022) utilized propensity score matching (PSM) on cross-sectional data from 400 households in Kisumu County to examine the impact of credit access on women's adoption of agroecological farming. The study revealed that women's access to microcredit positively influenced the uptake of organic fertilizers, intercropping, and soil conservation. However,

women were 60% less likely than men to secure agricultural loans due to lack of collateral and restrictive lending conditions, ultimately limiting their contribution to sustainable agriculture.

Collectively, these empirical studies underscore that women's limited access to land, credit, water, and extension services remains a significant barrier to their participation in sustainable agriculture. Methodologically, most studies combined quantitative models such as regressions, PSM, and panel data with qualitative interviews, offering robust insights into gendered resource inequalities. However, several studies recommended deeper institutional reforms and targeted gender-responsive policies to address these disparities.

Group Participation

Empirical studies consistently affirm that women's participation in farmer groups, cooperatives, and collective action significantly enhances their engagement in sustainable agriculture. Wamalwa and Njoroge (2024) employed a qualitative case study design involving focus group discussions and key informant interviews with women in Western Kenya's farmer groups. Grounded in African feminist theory, the study revealed that while women dominated labor contributions, their influence over group decisions, especially concerning sustainable agriculture adoption, remained limited due to patriarchal leadership structures. The authors recommended that empowering women in leadership positions within groups could boost their role in promoting sustainability practices like soil conservation and agroforestry.

Similarly, Cacchiarelli et al. (2024) conducted a cross-country econometric analysis focusing on women's participation in climate-smart agriculture (CSA) across Sub-Saharan Africa. Using household survey data and multi-level modeling, the study found that group participation enhanced women's knowledge sharing and access to sustainable agricultural technologies. Importantly, the study highlighted that women's involvement in cooperatives significantly increased the adoption of CSA, yet gender norms still limited women's decision-making capacity in some groups.

Mwangi (2024) explored the impact of group participation on women's agricultural practices in Kakuma Refugee Camp through a case study approach combining semi-structured interviews and participant observation. The research showed that women's involvement in refugee-based agricultural groups enhanced their knowledge and practice of permaculture, organic farming, and composting. However, the study noted that fragile group cohesion and limited resources in the refugee setting constrained long-term sustainability impact.

Further, Oduol et al. (2017) examined women's participation in high-value agricultural commodity chains in Kenya's avocado sector using mixed methods—focus group discussions, key informant interviews, and market chain analysis. Their findings revealed that organized group participation was critical for women to access lucrative markets and sustainability knowledge. However, women faced cultural and financial barriers limiting their engagement in decision-making within the groups, thereby restricting their full benefits from sustainable agricultural practices.

Lastly, Muriithi et al. (2018) used quantitative impact evaluation to assess the adoption of sustainable agricultural practices like push-pull pest management in Western Kenya. The study surveyed 600 households and applied regression models to determine the influence of village group participation on technology adoption. Results showed that women in groups were more likely to adopt sustainable practices than non-members due to better access to extension services, collective input purchases, and peer learning. However, the study noted the need for gender-responsive group dynamics to ensure equal participation.

RESEARCH METHODOLOGY

This study adopted a descriptive research design. According to Kothari (2004), a descriptive design systematically describes the characteristics of a population or phenomenon, providing a clear picture of the existing conditions without manipulating variables. The target population comprises registered women farmers in Ahero Irrigation Scheme, Kisumu County, estimated at approximately 192 individuals (National Irrigation Authority, 2023). This study adopted simple random sampling to select respondents from the target population of women farmers within the Ahero Irrigation Scheme. Simple random sampling is a probability sampling technique where every member of the population has an equal chance of being selected (Kothari, 2004). The sample size was determined using Yamane's (1967) formula for calculating sample sizes Thus, the sample size was 130 women farmers, which is both statistically sufficient and logistically manageable for field data collection. This size allows for adequate representation of the population and meaningful statistical analysis while considering time and resource constraints.

This study utilized questionnaires in primary data collection. According to Connelly (2008), 10% of the total sample size is generally recommended for pilot studies in survey research, as it provides sufficient feedback on the instruments while conserving resources. In this study, 13 respondents (10% of 130) was selected from the target population for pilot testing. These respondents were excluded from the final data collection to avoid bias and duplication. Pilot testing ensures both the content and structure of the tools are refined to enhance data quality.

Quantitative data from the structured questionnaires were analyzed using Statistical Package for Social Sciences (SPSS) version 28. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were computed to summarize demographic characteristics and food safety practices of the vendors. Additionally, correlation analysis was performed to examine the relationships between variables such as knowledge levels and hygiene practices, while regression analysis was employed to identify predictors of safe food handling behaviors among the vendors.

RESEARCH FINDINGS AND DISCUSSIONS

The study targeted 130 women farmers within the Ahero Irrigation Scheme. Out of these, 113 respondents successfully completed and returned the questionnaires, yielding a response rate of 86.9%. This is considered a highly acceptable rate in social science research. According to Mugenda and Mugenda (2003), a response rate of 50% is adequate, 60% is good, and above 70% is very good for analysis and reporting. Therefore, the 86.9% response rate achieved in this study is statistically robust, reducing the likelihood of non-response bias and enhancing the reliability of the findings.

Descriptive Analysis

This section presents the descriptive statistics for each variable investigated in the study, based on the responses of 113 women farmers. The study used a five-point Likert scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. The goal is to assess how respondents rated various statements related to their access to resources, group participation, and actual engagement in sustainable agricultural practices. In this study, 1–2.6 denoted disagreement, 2.7–3.4 represented neutral, and 3.5–5 showed agreement. A standard deviation of two or higher indicated significant diversity in replies. A mean greater than the overall average indicates that the statement has a positive influence on the variable, and the opposite is true.

Access to Resources and Services

The first objective of the study was to assess how women's access to resources affects adoption of sustainable agricultural practices in Ahero Irrigation Scheme in Kisumu County, Kenya. This section assessed how access to land, water, credit, agricultural inputs, extension services, market information, and green financing influence women's ability to promote sustainable agricultural practices. Table 1 presents summary of findings obtained.

Table 1: Descriptive Statistics for Access to Resources

Statement	Mean Score	Std. Dev.
I access water resources for irrigation when needed.	4.088	0.957
I have reliable access to quality farm inputs.	3.805	0.993
I have full control over the land I farm.	3.672	1.021
Agricultural extension officers visit my farm regularly.	3.504	1.045
I receive timely information on market prices.	3.381	1.078
I can access credit or loans for farming.	2.928	1.112
I benefit from environmental or green financing programs.	2.796	1.203
Aggregate Score	**3.453**	**1.058**

Among the resources evaluated, access to water for irrigation received the highest level of agreement (mean = 4.088, SD = 0.957), suggesting that most women benefit from a functioning irrigation infrastructure. This aligns with the operational goals of the Ahero Irrigation Scheme, where irrigation is central to crop productivity. The second-highest score was for access to quality farm inputs (mean = 3.805, SD = 0.993), indicating that while access exists, it may not be equitable or consistently affordable. Land control was next (mean = 3.672, SD = 1.021), reflecting that many women operate land they use, though this may be through informal or family-based arrangements rather than legal ownership.

Moderate agreement was reported on the availability of agricultural extension services (mean = 3.504, SD = 1.045) and market price information (mean = 3.381, SD = 1.078). These results suggest that while women occasionally receive support, they do not benefit from regular, systematic visits or timely updates, which can limit their decision-making on production and marketing. Access to financial services was notably low. Credit access scored a mean of 2.928 (SD = 1.112), and participation in environmental or green financing scored the lowest (mean = 2.796, SD = 1.203). These high standard deviations reflect inconsistent experiences—some women may access such support through group affiliations or donor programs, while many are entirely excluded.

These findings reinforce observations in the study that, despite basic resource availability like water and inputs, structural and institutional support remains weak. This is consistent with Owuor et al. (2022), who found that while women may work the land, lack of land titles significantly reduces their eligibility for credit. Similarly, Wanjala et al. (2024) noted that extension agents often overlook women due to cultural biases, while Michura and Michura (2023) argue that although women contribute heavily to food production, their access to resources remains restricted by social and financial barriers.

Moreover, the low access to green financing reflects what Gondwe et al. (2024) describe as policy neglect, where environmental financing mechanisms fail to reach rural women unless through targeted programs. The aggregate mean of 3.453 and standard deviation of 1.058 indicate that while core physical resources are moderately accessible, financial and institutional services are uneven and insufficient, which limits women's ability to fully engage in sustainable agricultural practices.

Group Participation

The second objective of the study was to analyze the effect of group participation on the adoption of sustainable agricultural practices in Ahero Irrigation Scheme in Kisumu County, Kenya. This construct assessed women's involvement in farmer groups and how that participation supports sustainability. Table 2 presents summary of the findings obtained.

Table 2: Descriptive Statistics for Group Participation

Statement	Mean	Std. Dev.
I am an active member of a farmer group/cooperative.	4.336	0.768
Group participation helps me market my farm produce.	4.115	0.794
Group meetings increase my knowledge of climate-smart agriculture.	4.088	0.861
My group provides training on sustainable farming.	4.017	0.869
My group helps me access farming inputs.	3.920	0.841
I participate in group decision-making on farming activities.	3.805	0.908
My group promotes soil and water conservation.	3.699	0.915
Aggregate Score	**4.026**	**0.851**

This section assessed the role of farmer group membership in supporting women's access to sustainable agriculture information, resources, and decision-making spaces. The item with the highest agreement was active membership in a farmer group or cooperative (mean = 4.336, SD = 0.768), showing that most respondents belong to and engage with agricultural groups. This is followed by the belief that group participation helps in marketing farm produce (mean = 4.115, SD = 0.794) and that group meetings enhance knowledge of climate-smart agriculture (mean = 4.088, SD = 0.861), suggesting that groups serve both as economic and informational platforms for women farmers.

Respondents also agreed that groups provide training on sustainable farming (mean = 4.017, SD = 0.869) and help members access farm inputs (mean = 3.920, SD = 0.841), confirming that collective membership enhances access to otherwise scarce resources. Participation in group-level decision-making scored slightly lower (mean = 3.805, SD = 0.908), indicating that while women are involved in groups, they may not always be fully included in leadership or decision-making roles. The item with the lowest mean in this category was group promotion of soil and water conservation (mean = 3.699, SD = 0.915), though still positive overall.

The aggregate mean score was 4.026, with a standard deviation of 0.851, making this the highest-performing construct across the study and also one of the most consistent in terms of responses. This highlights that group membership is not only prevalent but also uniformly beneficial among women participants in the scheme. These findings align with the literature on social capital and its impact on sustainable agriculture. Several studies have emphasized the role of collective action in enhancing women's access to training, input subsidies, and market linkages. For instance, Cacchiarelli et al. (2024) and Nyamolo et al. (2023) found that group-based learning and cooperative engagement are among the most effective strategies for delivering sustainability-focused education to rural women. Similarly, Ambaw et al. (2023) observed that participation in agricultural collectives significantly increases the likelihood of adopting climate-resilient practices, especially in irrigation-based systems.

The consistency in responses also supports the notion that groups act as equalizers—providing women with shared platforms to access knowledge, participate in dialogues, and exert agency in farming systems where individual access to institutional support is often constrained. The study itself confirms that 71% of respondents were members of at least one group and reported benefiting from training, credit linkages, and marketing services. However, the slightly lower score for group-based decision-making and conservation promotion indicates potential gaps in leadership inclusion and the thematic scope of group activities. While groups are evidently

instrumental in empowering women economically and technically, scholars such as Wamalwa and Njoroge (2024) caution that group dynamics can still reflect broader societal inequalities—particularly when leadership roles remain male-dominated or more educated women dominate influence. Therefore, it is essential to ensure that such groups are not only inclusive in membership but also equitable in governance and agenda-setting.

In summary, the results demonstrate that farmer groups are one of the most effective and accessible vehicles for promoting sustainable agriculture among women in the Ahero scheme. Strengthening these groups with capacity-building in leadership, sustainability themes, and financial management could further enhance their transformative potential.

Promotion of Sustainable Agricultural Practices

The main objective of the study was to examine the role of women in promoting sustainable agricultural practices in Ahero Irrigation Scheme in Kisumu County, Kenya. This section therefore assessed the extent to which women actively engage in the implementation of sustainable agricultural practices (SAPs). Table 3 presents summary of the findings obtained.

Table 3: Descriptive Statistics for Sustainable Agriculture Practices

Statement	Mean	Std. Dev.
I practice crop diversification to improve soil health.	4.221	0.792
I practice water harvesting and soil conservation.	4.088	0.817
I adopt climate-smart agricultural techniques.	4.044	0.801
I engage in organic farming practices.	3.893	0.854
I practice agroforestry or tree planting.	3.699	0.838
I train other farmers on sustainable agriculture techniques.	3.690	0.911
I participate in environmental conservation initiatives.	3.602	0.926
Aggregate Score	**3.891**	**0.848**

The highest-rated item was practicing crop diversification to improve soil health (mean = 4.221, SD = 0.792), indicating that this technique is widely adopted among women farmers. This is followed closely by water harvesting and soil conservation (mean = 4.088, SD = 0.817) and adoption of climate-smart agricultural techniques (mean = 4.044, SD = 0.801), showing a strong inclination toward environmentally resilient practices. Further, respondents reported positively on engagement in organic farming practices (mean = 3.893, SD = 0.854) and agroforestry or tree planting (mean = 3.699, SD = 0.838), implying active integration of ecological farming techniques, albeit to a slightly lesser extent. Items related to peer capacity-building — specifically, training other farmers on sustainable techniques (mean = 3.690, SD = 0.911) and participation in environmental conservation initiatives (mean = 3.602, SD = 0.926) — had the lowest agreement levels in this category. While most women are adopting sustainable practices for their own farms, fewer are involved in leading community-based training or environmental campaigns.

The aggregate mean for this construct was 3.891, with a standard deviation of 0.848, reflecting high but slightly varied levels of adoption. These findings confirm that sustainable practices are well-established at the household level, but leadership and outreach roles among women require more encouragement and support. These findings are consistent with previous sections, where women demonstrated high knowledge and access to training on sustainability. Their strong agreement with the adoption of practices like crop diversification, soil conservation, and climate-smart techniques reflects effective knowledge translation into action. This supports studies such as Ambaw et al. (2023) and Gondwe et al. (2024), which report that women, particularly in irrigated agricultural settings, are increasingly leading in adopting resilience-focused farming approaches due to their central role in managing food security.

However, the relatively lower scores for training others and participating in broader conservation efforts suggest a gap in empowerment for community leadership. Mekuriaw et al. (2024) and Cacchiarelli et al. (2024) argue that while women are frontline adopters of sustainable practices, they are often underrepresented in formal agricultural training roles or public-facing environmental initiatives. This may be due to societal norms, time constraints, or lack of institutional recognition.

This interpretation aligns with the study's internal findings, which showed that although women practiced sustainability at the household level, fewer had roles in training programs or policy-related conservation groups. This reflects a structural issue in program design — women are often included as beneficiaries, but less frequently positioned as leaders or knowledge multipliers. From a development perspective, the strong uptake of core practices provides a solid foundation. However, enabling women to scale these efforts — through platforms for peer mentorship, inclusion in farmer field schools as trainers, or targeted leadership training — will be critical to achieving transformative, community-wide sustainability outcomes.

Correlation Analysis

Correlation analysis was conducted to evaluate the strength and direction of the relationships between the independent variables — Access to Resources and Group Participation — and the dependent variable, Promotion of Sustainable Agricultural Practices. The analysis used the Pearson correlation coefficient (r), with values near +1 indicating strong positive correlations. All results were significant at the 0.05 level.

Table 4: Correlation Analysis Results

		Sustainable Agriculture	**Access to Resources**	**Group Participation**
Sustainable Agriculture	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	113		
Access to Resources	Pearson Correlation	0.805**	1	
	Sig. (2-tailed)	0.000		
	N	113	113	
Group Participation	Pearson Correlation	0.818**	0.215	1
	Sig. (2-tailed)	0.000	0.062	
	N	113	113	113

Correlation is significant at the 0.05 level (2-tailed).

Access to Resources and Sustainable Agriculture ($r = 0.805$, $p < 0.05$). There is a very strong positive correlation between access to resources and women's promotion of sustainable agricultural practices. This suggests that when women have better access to land, irrigation, credit, and inputs, they are significantly more likely to engage in sustainable practices. This is consistent with empirical studies that show secure access to productive resources enables women to invest in long-term ecological strategies. Studies like FAO (2022) and Owuor et al. (2022) affirm that land tenure, irrigation, and financial access are foundational to women's agricultural innovation.

Group Participation and Sustainable Agriculture ($r = 0.818$, $p < 0.05$). Group participation had the strongest correlation with sustainable agriculture, showing that involvement in farmer groups greatly boosts women's sustainability outcomes. These results are in line with the findings of Cacchiarelli et al. (2024), who noted that groups enhance access to shared learning, inputs, and cooperative marketing. Participation in collective structures offers social support, access to innovations, and a platform for voice and agency.

Multiple Regression Analysis

The regression coefficients are summarized in the table below:

Table 5: Regression Coefficients of Study Variables

Variable	Unstandardized Coef (B)	Std. Error	Standardized Beta	t	Sig.
Constant	0.445	0.215		2.070	0.041
Access to Resources	0.291	0.058	0.312	5.017	0.000
Group Participation	0.294	0.063	0.277	4.667	0.000

Access to Resources (B = 0.291, p = 0.000). This was a strong and significant predictor. A unit increase in access to resources (such as land, irrigation, inputs, and credit) leads to a 0.291 unit increase in the promotion of sustainable agricultural practices. This confirms that resource availability is foundational for sustainable agriculture, aligning with findings by Owuor et al. (2022) who emphasized that women's empowerment in agriculture depends heavily on equitable access to productive assets.

Group Participation (B = 0.294, p = 0.000). Group participation was the most influential variable. A one-unit increase in group participation increases sustainable practices by 0.294 units. Groups enhance social learning, cooperative access to inputs, and collective problem-solving, echoing insights by Cacchiarelli et al. (2024) who found that farmer groups are critical enablers of climate-smart agriculture adoption among rural women.

The regression model predicting the promotion of sustainable agriculture (PSA) is:

Promotion of Sustainable Agricultural Practices = 0.445 + 0.291 (Access to Resources) + 0.294 (Group Participation)

Conclusions

The study concludes that women's access to agricultural resources significantly influences their ability to adopt sustainable agricultural practices. Access to water for irrigation, quality inputs, and control over farming land were positively associated with sustainability adoption. However, inadequate access to credit and environmental financing continues to limit women's ability to invest in long-term sustainable technologies. These findings highlight the importance of strengthening both physical and institutional resource access.

The study concludes that group participation is the most impactful factor in promoting sustainable agricultural practices among women. Farmer groups provide access to shared learning, marketing opportunities, and input support. Active participation in these groups significantly boosts sustainability adoption. However, women's roles in group leadership and decision-making need to be strengthened to ensure equitable benefits.

Recommendations

Access to Resources

To enhance women's ability to implement sustainable agricultural practices, the study recommends strengthening women's access to productive resources, particularly land, irrigation, quality inputs, and credit facilities. There is a need for policy interventions that promote formal land ownership and land use rights for women, as informal arrangements limit access to credit and long-term planning. Local governments and agricultural institutions should streamline access to irrigation infrastructure and subsidized inputs, ensuring that resource distribution is gender-sensitive and transparent. Moreover, financial institutions and NGOs must develop tailored credit products and green financing schemes specifically targeting

women farmers, with simplified application processes, flexible collateral requirements, and financial literacy support. Strengthening linkages between women farmers and agricultural extension officers through regular, targeted visits can also bridge gaps in input usage, pest management, and resource conservation. This multi-level approach will empower women with both the physical and financial capital needed for sustainable agriculture.

Group Participation

Recognizing the pivotal role of farmer groups, the study recommends supporting the formation, strengthening, and professionalization of women-led agricultural groups. Local authorities and agricultural NGOs should provide technical support in group governance, financial management, and sustainability planning. To ensure inclusivity, emphasis must be placed on equitable participation in group leadership, with efforts made to promote the active involvement of younger, less educated, or marginalized women. Training group leaders on participatory decision-making and conflict resolution can help democratize internal processes. Additionally, linking farmer groups with cooperatives, input suppliers, and buyers can enhance market access and income generation, making sustainability economically viable. Groups should also be encouraged to engage in community-wide sustainability initiatives such as soil conservation, agroforestry campaigns, and environmental advocacy. Lastly, government grants and revolving loan funds can be channeled through registered farmer groups to scale their sustainability interventions and build collective resilience.

Suggestions for Further Studies

While this study accounted for 82.3% of the variance in women's promotion of sustainable agricultural practices through the variables of access to resources, knowledge and training and group participation, 17.7% remains unexplained. Future research could explore additional factors such as market dynamics, household income levels, technological adoption, climate variability, and policy enforcement which may also influence sustainability practices. Longitudinal studies are recommended to assess how women's roles evolve over time, especially in relation to emerging climate risks and technological shifts. Moreover, qualitative studies could provide deeper insights into the personal, cultural, and psychological dimensions of women's empowerment in agriculture, complementing quantitative findings with lived experiences. Finally, comparative studies across other irrigation schemes or counties would enhance generalizability and inform broader policy frameworks.

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