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Effect of Women's Participation in Climate Smart Agriculture on Sustainable Household Food Security in Baringo County, Kenya

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Abstract: *Women play a critical role in agricultural activities, yet their contributions to household food security are often undervalued and under-supported. Despite their central involvement in food production, women are frequently excluded from key decision-making processes related to agriculture and food security. This study investigated the effect of women's participation in agriculture on sustainable household food security in Baringo County. The research aimed to explore how women's involvement in agricultural activities impacts food security outcomes at the household level. The study adopted a cross-sectional research design with a mixed methods approach, utilizing both qualitative and quantitative data. A sample of 316 registered members of SMART Agriculture and 6 field officers were selected through random and purposive sampling. Data was collected using structured questionnaires and interviews. The findings revealed that a majority of respondents felt women were not sufficiently involved in decision-making regarding household food security, and there was a noticeable gender disparity in contributions to food production. Despite this, many respondents acknowledged the growing role of women in agricultural activities and their positive impact on household food security. The study's results indicate a strong positive correlation between women's participation in agriculture and sustainable food security, as demonstrated by a Pearson correlation coefficient of 0.684 (p = 0.000). The study concludes that increasing women's involvement in agriculture significantly enhances food security outcomes, emphasizing the need for policies that promote gender inclusion in agricultural decision-making and community support for women.*

Keywords: *Women's participation, Agriculture, Sustainable food security, Household, Baringo County, Gender equality, Food production, Community support, Empowerment*

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1. Introduction

Women's participation in climate-smart agriculture (CSA) plays a crucial role in enhancing sustainable household food security, especially in regions vulnerable to climate change. According to Chikozho et al. (2022), empowering women with the knowledge and tools to adopt CSA practices can lead to improved agricultural productivity and food security. This is particularly important in communities where women are primary caregivers and contribute significantly to food production yet often face barriers to accessing resources and decision-making processes (FAO, 2021). In focusing on climate-resilient

practices, women can better manage local agricultural systems, thus ensuring the availability and stability of food for their households (Bardhan et al., 2020). Moreover, studies by Doss et al. (2021) suggest that gender-sensitive agricultural policies that integrate women's roles in climate change adaptation are critical for improving food security outcomes.

In developed countries, such as the United States, Canada, Australia, and the Netherlands, women's involvement in CSA has been linked to advancements in sustainable agricultural practices. For example, in the U.S., women farmers are increasingly adopting conservation techniques that enhance soil health and reduce water usage, contributing to long-term food security (Gillespie et al., 2021). In Canada, women-led farming cooperatives promote CSA practices that increase agricultural productivity while addressing environmental challenges (Baker et al., 2022). Similarly, Australian women are pivotal in implementing drought-resistant crop management strategies, thereby enhancing food security in rural communities (Miller et al., 2020). The Netherlands has seen significant involvement of women in agricultural innovation, particularly in technologies that improve resource efficiency and reduce the carbon footprint of farming (Veldkamp et al., 2020).

In developing countries, the role of women in CSA is especially significant, as they are often at the forefront of managing household food security while grappling with climate change impacts. In Ethiopia, women's participation in climate-smart practices, such as water harvesting and drought-tolerant crop cultivation, has led to improved food security and resilience to climate shocks (Mulugetta et al., 2020). In Uganda, women are key players in agroforestry and sustainable land management, which has enhanced both household food security and environmental sustainability (Bamwenda et al., 2021). Likewise, in Malawi, women's involvement in CSA interventions, including sustainable farming techniques and community-based climate adaptation programs, has strengthened local food systems (Lungu et al., 2021). In Tanzania, women's roles in food production, particularly in the adoption of climate-resilient technologies, have contributed to more stable food availability despite increasing climate variability (Rwebangira et al., 2021). In Kenya, women's empowerment through CSA initiatives has the potential to significantly reduce food insecurity by improving crop yields, diversifying income sources, and promoting sustainable farming practices (Kairu et al., 2022).

In Baringo County, women play a crucial role in climate-smart agriculture (CSA), contributing significantly to household food security amidst climate variability and change. Their involvement in adopting drought-resistant crops, water conservation techniques, and sustainable land management practices has been shown to improve agricultural productivity and resilience (Kairu et al., 2022). Women in the region, often responsible for household food production, have embraced CSA strategies that not only increase food availability but also enhance their economic stability and overall well-being (Kairu et al., 2022). Empowering these women with training, resources, and decision-making opportunities is key to promoting sustainable food security and adapting to the impacts of climate change, as it directly impacts their livelihoods and the food security of their communities (Bardhan et al., 2020). Therefore, the study seeks to examine the effect of Women's Participation in Climate Smart Agriculture on Sustainable Household Food Security in Baringo County.

1.1 Objective of the study

To examine the effect of Women's Participation in Climate Smart Agriculture on Sustainable Household Food Security in Baringo County.

1.2 Research hypothesis

$H0_1$: There is no statistically significant relationship between women's participation in agriculture and sustainable household food security in Baringo County**.**

2. Literature review

A growing body of literature has explored the role of climate-smart agriculture (CSA) in enhancing food security, particularly in regions vulnerable to the effects of climate change. Many studies have highlighted the positive impact of women's involvement in CSA practices, emphasizing the ways in which it contributes to sustainable agricultural systems. Globally, CSA has emerged as a key approach to addressing climate challenges, with diverse findings across various regions. Researchers have examined how CSA helps build resilience against climate change, improve crop yields, and secure food sources for vulnerable populations. In countries such as the United States, Finland, Germany, the Netherlands, India, Egypt, Nigeria, Zimbabwe, Rwanda, and Uganda, CSA has been implemented in various forms, yielding mixed results that shed light on the effectiveness of these practices in different socio-economic and environmental contexts.

In the United States, studies have shown that CSA practices, such as conservation tillage, crop rotation, and agroforestry, have contributed to improved soil health and water management, leading to enhanced agricultural

productivity and long-term food security (Gillespie et al., 2021). Women farmers, in particular, have been found to adopt these practices at increasing rates, highlighting the gendered dimension of agricultural innovation (Baker et al., 2022). A study by Green and Sills (2020) examined the role of women in implementing CSA practices and found that women's leadership in sustainable farming initiatives has not only improved food security but also empowered rural communities by increasing income generation through more diverse agricultural products.

In Finland, the adoption of CSA has been focused on reducing carbon emissions while improving the resilience of agricultural systems. The Finnish government has promoted agroecological practices, which have had positive impacts on biodiversity and food security (Mikkonen et al., 2020). Studies have shown that CSA initiatives in Finland have improved the ability of smallholder farmers to adapt to changing climatic conditions, although challenges remain in ensuring widespread adoption, particularly in rural areas where access to technology and training is limited (Kouadio et al., 2021). Women have played an instrumental role in this process by incorporating CSA techniques in home gardens and small-scale farming enterprises, contributing to household food security and economic stability (Lehtonen et al., 2022).

In Germany, the integration of CSA into agricultural policy has been a significant focus, particularly in the context of sustainable farming practices that mitigate the impacts of climate change. A report by Jänicke and Weidner (2020) found that CSA adoption has helped German farmers increase the sustainability of their practices, especially in terms of water conservation and soil fertility management. However, despite the clear benefits, gender disparities in the adoption of CSA practices were noted, with women often receiving less access to resources and decision-making power than their male counterparts. Gender-sensitive interventions are needed to empower women farmers, who have been found to be more likely to adopt CSA practices when given proper support and resources (Schröder et al., 2021).

In the Netherlands, CSA has been increasingly promoted as a means to ensure food security while reducing the environmental footprint of agriculture. Women in the Netherlands have been involved in CSA through community-based farming initiatives, which have focused on local food production, biodiversity conservation, and resource efficiency (Veldkamp et al., 2020). CSA practices such as precision farming and organic agriculture have been linked to improved yields and reduced dependency on chemical inputs. A study by Brouwer et al. (2021) found that women's involvement in such practices has not only contributed to sustainable food systems but also enhanced their socio-economic empowerment by providing them with opportunities to engage in agricultural entrepreneurship.

In India, CSA has gained traction as a response to climate-induced challenges such as droughts and erratic rainfall patterns. The Indian government has supported various initiatives aimed at promoting CSA, particularly in rural areas where smallholder farmers are most vulnerable. According to Sharma et al. (2021), CSA practices such as water harvesting, soil fertility management, and integrated pest management have led to improved agricultural yields and food security in drought-prone regions. Women's participation in these initiatives has been instrumental in their success, as women are often the primary managers of household food production. However, studies have also noted that women face significant barriers to accessing CSA technologies and resources, suggesting the need for gender-sensitive policies and programs (Saxena et al., 2021).

In Egypt, CSA has been increasingly recognized as an important strategy to combat desertification and water scarcity, two major challenges in the country's agriculture sector. A study by El-Basyuni et al. (2020) found that CSA practices such as water-saving irrigation techniques and agroforestry have contributed to the improvement of agricultural productivity in arid regions. Women have played a central role in these initiatives, particularly in rural areas where they are responsible for managing water resources and food production (El-Kholy et al., 2021). However, challenges such as limited access to finance and training opportunities have hindered the broader adoption of CSA practices among women farmers (Khamis et al., 2021).

In Nigeria, CSA has been promoted as a means to enhance food security and resilience in the face of climate change. A study by Olayide et al. (2021) found that CSA practices such as improved seed varieties, crop diversification, and soil management have been effective in improving yields and reducing the vulnerability of smallholder farmers to climate risks. Women in Nigeria have been increasingly involved in CSA through community-based agricultural extension programs. However, the study also highlighted that women face gender-based challenges in accessing land, credit, and training, which has limited their full participation in CSA programs (Oladele et al., 2020).

In Zimbabwe, CSA has been adopted as a response to climate variability, particularly in the context of recurrent droughts. According to Mupangwa et al. (2020), CSA practices such as conservation farming and agroforestry have helped smallholder farmers adapt to climate change

and improve food security. Women have played a key role in the adoption of these practices, as they are often the primary managers of household food production. However, gender inequalities in access to resources and decision-making power remain a significant barrier to the full participation of women in CSA programs (Chikozho et al., 2021).

In Rwanda, CSA has been integrated into national agricultural policies as part of efforts to promote food security and climate resilience. A study by Niyonsaba et al. (2020) found that CSA practices such as improved soil management, water conservation, and agroecology have been effective in enhancing agricultural productivity and food security in rural communities. Women have been involved in these initiatives, particularly in the context of household food production and nutrition. However, the study also found that women often lack the necessary resources and training to fully benefit from CSA practices, suggesting the need for targeted interventions to support women farmers (Ndayisenga et al., 2021).

In Uganda, CSA has been increasingly recognized as a key strategy to enhance food security and resilience in the face of climate change. A study by Bamwenda et al. (2021) found that CSA practices such as agroforestry, rainwater harvesting, and drought-tolerant crops have helped improve food security in Uganda. Women have been key participants in these programs, as they are responsible for most of the food production in rural areas. However, the study also found that women face significant barriers to accessing CSA technologies, training, and financial support, which limits their ability to fully benefit from these practices (Bamwenda et al., 2020).

The findings from these global studies highlight the significant role of women in climate-smart agriculture and the positive impact of CSA practices on food security. However, they also emphasize the need for gender-sensitive policies and interventions that address the barriers women face in accessing resources, training, and decision-making opportunities. These studies underscore the importance of empowering women in the context of CSA to enhance their resilience to climate change and improve food security at the household and community levels.

In Kenya, climate-smart agriculture (CSA) has become an important approach to improving food security amidst increasing climate variability. Studies indicate that CSA practices, such as agroforestry, drought-resistant crops, and water-efficient irrigation, have significantly contributed to enhancing resilience and food security in rural areas (Kariuki et al., 2020). Women's participation in these practices has been central to the success of CSA programs, as women in Kenya are often responsible for household food production and play a key role in managing water and other agricultural resources (Mogoi et al., 2021). For instance, a study by Gikonyo et al. (2021) highlighted those women who adopted CSA practices experienced improved crop yields, which led to better food security and income stability for their families. However, gender inequalities persist, particularly in access to land, credit, and extension services, which continue to limit women's full participation in CSA (Gichuki et al., 2020).

The Kenyan government, alongside non-governmental organizations, has implemented various initiatives aimed at promoting CSA among women farmers. These initiatives include providing training on sustainable agricultural practices, facilitating access to climate-resilient seeds, and supporting community-based resource management programs (Njiru et al., 2020). Research by Njeru et al. (2021) demonstrated that women's involvement in CSA not only improved food security at the household level but also empowered women by increasing their participation in decision-making processes within their communities. Nevertheless, despite these positive impacts, women continue to face challenges such as limited access to financial resources and a lack of adequate land rights, which hinder their ability to fully engage with CSA practices (Mutai et al., 2021). Therefore, the literature underscores the need for targeted interventions to address these gendered barriers and promote more inclusive approaches to CSA in Kenya.

The potential for CSA to improve food security in Kenya is significant, but its success relies heavily on addressing these barriers. Studies have shown that when women are empowered through access to resources and support, they are more likely to adopt CSA practices, leading to enhanced agricultural productivity and better food security outcomes (Mbugua et al., 2021). However, the intersection of gender, land ownership, and access to climate-smart technologies remains a challenge, and policy interventions aimed at removing these barriers are crucial for scaling up the impact of CSA in Kenya (Njeru et al., 2021). The role of women in CSA is not only essential for food security but also contributes to building community resilience against the impacts of climate change, making it a key area of focus for sustainable development in Kenya.

3. Methodology

The study adopted a cross-sectional research design utilizing mixed methods, incorporating both qualitative and quantitative data collection and analysis. The target population comprised 1,783 members registered with SMART Agriculture and six field officers covering the wards of Tenges, Kapropita, Emmining, Mogotio, Lembus, and Koibatek. The sample size of 316 registered members

was determined using the Krejcie and Morgan (1970) formula and selected through proportionate and simple random sampling techniques, while the six field officers were chosen purposively. Data collection involved the use of questionnaires and interviews. Reliability was assessed using Cronbach's Alpha, and validity was ensured by consulting supervisors from Kisii University, who provided feedback to refine the data collection tools. Quantitative data was analyzed through frequencies, percentages, Pearson correlation, and linear regression to establish the relationship between the independent and dependent variables. Qualitative data was thematically organized and presented in narratives and quotations based on the research objectives.

4. Results and Discussion

This section presents the findings and discussions from the study. The first section presents descriptive statistics the second section provides inferential statistics while the third section presents qualitative findings from interviews

4.1 The effect of women's participation in agriculture on sustainable household food security

The purpose of the study was to explore the effect of women's participation in agriculture on sustainable household food security in Baringo County. In order to achieve this objective, the respondents were requested to rate on a five-point Likert scale items in the questionnaire on literacy empowerment programs on sustainable household food security. The items in the questionnaire were rated as 1=strongly disagree (SD), 2=disagree (D), 3= Undecided (U), 4=Agree (A) and 5=Strongly Agree (SA). The responses from the participants were tabulated and the results are presented in Table 1.

Table 1: Women's Participation in agriculture and household food security

Statement	SD		D		U		A		SA	
	F	%	F	%	F	%	F	%	F	%
Women are actively involved in decision-making regarding household food security.	53	17.26%	141	45.92%	9	2.93%	67	21.82%	37	12.06%
Women participation in agricultural activities has increased over the past year.	59	19.22%	57	18.57%	11	3.58%	149	48.53%	31	10.10%
Women contribute equally to household food production compared to male family members.	137	44.62%	63	20.52%	4	1.30%	33	10.75%	70	22.80%
Women’s involvement in agriculture is supported by my community.	51	16.61%	143	46.58%	7	2.28%	39	12.70%	67	21.82%
I believe women have a significant role in ensuring food security.	25	8.14%	59	19.22%	13	4.23%	139	45.28%	71	23.13%
My participation in local agricultural groups has increased my knowledge.	35	11.40%	55	17.92%	5	1.63%	147	47.88%	65	21.17%
Women feel empowered to share their views on food security issues in my community.	29	9.45%	61	19.87%	11	3.58%	133	43.32%	73	23.77%
Women’s participation in agriculture leads to better food outcomes for households.	27	8.79%	65	21.17%	4	1.30%	151	49.19%	59	19.22%

Source: Field Data 2024

The findings showed that a majority of respondents, 141 (45.92%), disagreed with the statement that women are actively involved in decision-making regarding household food security, 67 (21.82%) agreed, 53 (17.26%) strongly disagreed, 37 (12.06%) strongly agreed, while 9 (2.93%) were undecided. This suggests that 63.18% of respondents feel that women are not sufficiently involved in household decision-making about food security. This finding concurs with Brown et al. (2021) who found that despite women’s essential roles in food systems, their involvement in decision-making is often limited, highlighting the need for policies that encourage gender inclusion in food security governance.

Similarly, a majority of respondents, 149 (48.53%), agreed that women's participation in agricultural activities has increased over the past year, while 59 (19.22%) strongly disagreed, 57 (18.57%) disagreed, 31 (10.10%) strongly agreed, and 11 (3.58%) were undecided. This indicates that 58.63% of respondents observed a rise in women's involvement in agriculture, which aligns with findings from Patel and Singh (2020), who noted a growing trend of female engagement in agriculture, driven by awareness campaigns and community empowerment programs.

Furthermore, 137 (44.62%) of the respondents strongly disagreed that women contribute equally to household food production compared to male family members, 63 (20.52%) disagreed, 70 (22.80%) strongly agreed, 33 (10.75%) agreed, while 4 (1.30%) were undecided. This suggests that 65.14% of respondents perceive a gender disparity in food production contributions within households. In the same vein, Adeyemi et al. (2019) emphasized the need for gender equality in food production activities, as equal participation can significantly improve food security outcomes.

Moreover, the findings showed that a majority of respondents, 143 (46.58%), disagreed with the statement that women's involvement in agriculture is supported by their community, 67 (21.82%) strongly agreed, 51 (16.61%) strongly disagreed, 39 (12.70%) agreed, and 7 (2.28%) were undecided. This implies that 63.19% of respondents feel that women do not receive adequate community support for their agricultural roles. This finding is consistent with those of Lopez and Garcia (2018), who argued that cultural and societal barriers often limit women's participation in agricultural activities despite their potential to contribute significantly to food production.

Similarly, 139 (45.28%) of the respondents agreed that they believe women have a significant role in ensuring food security, 71 (23.13%) strongly agreed, 59 (19.22%) disagreed, 25 (8.14%) strongly disagreed, while 13 (4.23%) were undecided. This indicates that 68.41% of respondents acknowledge the vital role of women in food security, a sentiment supported by research from Khan and Foster (2020), who found that empowering women in food security initiatives leads to more resilient households and communities.

Further, a majority of respondents, 147 (47.88%), agreed that their participation in local agricultural groups has increased their knowledge, 65 (21.17%) strongly agreed, 55 (17.92%) disagreed, 35 (11.40%) strongly disagreed, while 5 (1.63%) were undecided. This implies that 69.05% of respondents have benefited from agricultural group participation, which has enhanced their knowledge. This finding is in line with research by Taylor et al. (2019), who highlighted the importance of agricultural groups in disseminating knowledge and best practices that improve food security.

Moreover, 133 (43.32%) of the respondents agreed that women feel empowered to share their views on food security issues in their community, 73 (23.77%) strongly agreed, 61 (19.87%) disagreed, 29 (9.45%) strongly disagreed, while 11 (3.58%) were undecided. This suggests that 67.09% of respondents believe that women are empowered to voice their opinions on food security, supporting findings by Adomako and Mensah (2021), who emphasized the need for community platforms where women can contribute to discussions on food security matters.

Finally, the findings indicated that a majority of respondents, 151 (49.19%), agreed that women's participation in agriculture leads to better food outcomes for households, 59 (19.22%) strongly agreed, 65 (21.17%) disagreed, 27 (8.79%) strongly disagreed, while 4 (1.30%) were undecided. This implies that 68.41% of respondents recognize the positive impact of women's participation in agriculture on household food security. Similarly, Chirwa and Kamanga (2022) found that increasing women's involvement in agriculture correlates with improved household nutrition and food availability.

4.2 Relationship between women's participation in agriculture and sustainable household food security in Baringo County

The hypothesis of this research stated that:

$H0_1$: There is no statistically significant relationship between women's participation in agriculture and sustainable household food security in Baringo County.

This hypothesis was further tested using Pearson correlation Analysis and the results are presented in Table 2.

Table 2: Correlation Coefficient between women's participation in agriculture and sustainable household food security in Baringo County

		Sustainable food security
Women's participation	Pearson Correlation	.684**
	Sig. (2-tailed)	.000
	N	307

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

From table 2, Pearson correlation coefficient (r) between women's participation in agriculture and sustainable household food security is 0.684, indicating a strong positive relationship between the two variables. The significance value (p = 0.000) is less than 0.05, showing that this correlation is statistically significant. Therefore, this study rejected the null hypothesis ($H0_2$) and concluded that there is a statistically significant relationship between women's participation in agriculture and sustainable household food security in Baringo County. This suggests that higher involvement of women in agriculture contributes significantly to improving household food security, likely through their active role in food production and management practices.

On interview with the field officers, one of the participants FO4 hinted that:

> *"I perceive women's participation in agricultural activities as a critical factor impacting food security in the households I work with. Women play a vital role in food production, often responsible for cultivating crops, managing livestock, and ensuring the nutritional needs of their families are met. When women are actively involved in agriculture, they bring unique insights and skills that enhance productivity and sustainability. Their participation not only increases the quantity of food produced but also contributes to the diversity of crops grown, which is essential for a balanced diet.*
>
> *Moreover, women's involvement in agricultural decision-making significantly influences household food security. Research shows that when women have a say in agricultural practices and resource management, it leads to better food management and distribution within the household. They tend to prioritize the nutritional needs of their family members, which can improve overall health outcomes. Additionally, when women are empowered through education and access to resources, they are more likely to adopt innovative practices that increase resilience to climate change and market fluctuations, further securing food availability"*

The sentiment emphasizes the fundamental role of women in agricultural activities and their significant impact on food security within households. Women's involvement in food production goes beyond merely increasing the quantity of food available; it also enhances the diversity of crops cultivated, which is essential for providing a balanced diet. Studies have shown that women contribute to agricultural systems by growing a variety of crops, including fruits, vegetables, and staples, which directly affects dietary diversity and nutrition (FAO, 2011). This diversification is critical in promoting food security, as it not only ensures availability but also enhances the resilience of household food supplies against climatic shocks and market fluctuations.

Furthermore, the response highlights the influence of women's decision-making power in agricultural practices and resource management. When women are empowered to participate in decision-making, research indicates that households experience improved food management and distribution, which positively affects nutrition outcomes (Quisumbing & Pandolfelli, 2010). Women's focus on the nutritional needs of family members often leads to better health outcomes, as they prioritize the cultivation of nutrient-rich crops and the appropriate allocation of food resources within the household. The evidence suggests that women's agency in agriculture is linked to better food security, as they are more likely to invest in the health and nutrition of their children, thereby contributing to long-term human capital development (World Bank, 2012).

5. Conclusion and Recommendations

5.1 Conclusion

In conclusion, the findings of the study reveal that while women's participation in agriculture is acknowledged as essential for improving household food security, significant barriers remain that hinder their full involvement in decision-making and agricultural activities.

A majority of respondents highlighted gender disparities in contributions to food production, a lack of community support for women's agricultural roles, and limited empowerment in food security discussions. However, the study also demonstrates that increased participation in agricultural groups and recognition of women's vital role in food security positively impacts knowledge and food outcomes.

5.2 Recommendations

Based on the findings, the study made the following recommendations:

1. There is a need to enhance gender inclusivity in decision-making processes related to household food security by implementing policies that encourage the active involvement of women in leadership and governance at both community and household levels.
2. There is a need to provide more targeted training and literacy empowerment programs for women to improve their agricultural knowledge and skills, which will further strengthen their capacity to contribute to sustainable food security at the household level.
3. There is a need to address cultural and societal barriers that limit women's participation in agriculture by fostering community awareness campaigns and encouraging local leaders to support women's roles in agricultural activities.
4. There is a need to establish more platforms and local agricultural groups where women can share their views, gain support, and exchange knowledge on food security, ensuring their active participation in discussions that shape food security strategies in their communities**.**

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