MSI Journal of Multidisciplinary Research (MSIJMR)

The Influence of Gender on Adoption of Climate Smart Agricultural Practices Among Households in Embu County, Kenya

Njeru M. Kathuri[1*], Mutunga C. Ndunge[2]

[1*] Department of Environmental Studies & Resources Development, Chuka University.

[2] Department of Social Sciences, Chuka University.

*** Correspondence:** Njeru M. Kathuri

The authors declare that no funding was received for this work.

OPEN ACCESS

Received: 10-October-2025

Accepted: 30-November-2025

Published: 02-December-2025

This article is published in the **MSI Journal of Multidisciplinary Research (MSIJMR) ISSN 3049-0669 (Online)**

The journal is managed and published by MSI Publishers.

Volume: 2, Issue: 12 (December-2025)

ABSTRACT: Climate-Smart Agriculture (CSA) practices are vital for enhancing productivity, resilience, and environmental sustainability within smallholder systems facing climate variability. Nevertheless, gender dynamics frequently exacerbate disparities in adoption, particularly in Sub-Saharan Africa. This study investigates the influence of gender on the adoption of CSA among farming households in Embu County, Kenya. Guided by the Diffusion of Innovation (DOI) Theory, which elucidates the dissemination of innovations through perceived attributes and adopter classifications, the research reveals that women encounter resource and decision-making barriers, leading to their being late adopters relative to men. This scenario reinforces productivity disparities amid patriarchal norms and male out-migration. Employing a descriptive survey methodology, a multistage sampling approach selected 402 households focused on intensive farming and CSA promotion within Embu County. Questionnaires were administered to household heads and 32 extension officers, with reliability confirmed via Cronbach's alpha (0.83) and content validity verified through expert review. Differences in adoption by gender were analyzed using independent t-tests. Findings indicate near parity in household headship (52% male, 48% female), representing a shift from previous male dominance (72:28), driven by male out-migration, which has increased female involvement in farm management. Female-headed households exhibited marginally higher CSA adoption (mean = 6.96 practices, SD = 2.44) compared to male-headed households (mean = 6.86, SD = 2.42); however, this difference was not statistically significant ($t(400) = 0.396$, $p = 0.69$). This contrasts with regional trends of lower female adoption rates (40-55% versus 55-70% for males), attributed to land tenure, credit, and extension service constraints. Nevertheless, it aligns with local evidence indicating women's preference for low-input practices, such as crop rotation, driven by food security considerations. These findings challenge traditional narratives of gender gaps, emphasizing the influence of local factors such as equity and migration. They highlight the importance of DOI in customizing diffusion channels to promote equity. The study recommends gender-responsive extension services with women-led training programs, policy reforms to facilitate access to credit based on user rights, and intra-household dialogues to sustain adoption, thereby enhancing resilience, welfare, and alignment with SDG 5. By fostering inclusive innovation, Embu exemplifies avenues toward gender-transformative agriculture in contexts vulnerable to climate change.

Keywords: *Climate smart agriculture, adoption, influence, gender.*

Background Information

Climate-smart agriculture (CSA) encompasses practices that enhance productivity, increase resilience to climate change, and reduce greenhouse gas emissions while promoting environmental sustainability (Mozzato et al., 2018). Globally, gender dynamics play a substantial role in CSA adoption, often exacerbating inequalities in access, decision-making, and benefits. Women, who constitute approximately 43% of the agricultural workforce in developing countries, face systemic barriers, including limited access to resources, information, and extension services, resulting in lower adoption rates compared to men (UNDP, 2024). Men generally adopt a broader range of CSA strategies, including advanced planting techniques. Conversely, women tend to focus more on livestock-related practices but frequently lack control over marketing and profits. The gender gap in productivity stems from these barriers, with women often exhibiting greater risk aversion, thereby impeding the adoption of innovative CSA technologies such as drought-tolerant crops or conservation tillage. Nonetheless, the adoption of CSA practices enhances farm productivity and household welfare for both genders, yielding significant positive effects on income and food security. Gender-sensitive approaches that promote equal access to resources and inclusive decision-making are instrumental in advancing Sustainable Development Goal (SDG) 5 on gender equality, ensuring that all household members participate in resource management and ownership (Useche & Blare, 2014; Bernier et al., 2015; Mwaura et al., 2025). Despite these initiatives, men often maintain dominance over household climate-adaptation decisions due to ownership norms, thereby perpetuating disparities.

In Africa, where agriculture primarily comprises smallholder farms supporting over 60% of the population, gender plays a crucial role in the adoption of Climate-Smart Agriculture (CSA), particularly in farming economies susceptible to climate variability (Giller et al., 2009; IAASTD, 2009). Sub-Saharan Africa exhibits discernible gender disparities, with women facing challenges such as limited land rights, restricted access to credit, and inadequate extension services, thereby hindering the adoption of practices like agroforestry and soil conservation. Research conducted in Tanzania highlights men's dominance in decision-making processes, which constrains women's utilization of CSA technologies despite their essential contribution to food production. Barriers to adoption include gender-specific vulnerabilities, such as greater exposure of women to climate risks without adequate adaptive resources, leading to low adoption rates of practices including improved forages. Conversely, the adoption of these practices has the potential to enhance welfare by increasing per capita expenditure and savings, particularly benefiting female-headed households. Initiatives such as the UN Women's Climate-Smart Agriculture program in East and Southern Africa emphasize women's roles within value chains and advocate for gender-transformative strategies to address existing disparities. The World Bank's gender integration module fosters inclusive planning processes aimed at reducing inequalities within CSA projects. Nations such as Ethiopia and South Sudan continue to exhibit low adoption rates, often attributable to gender norms that underestimate women's contributions (Yadete, 2007).

In Kenya, where agriculture contributes 22.5% to the GDP and employs 60% of the workforce (mostly small holder farmers), gender disparities hinder the adoption of CSA, despite government efforts (KNBS, 2025; MoLAF, 2016). Women, who do most farm labor, have lower chances of adopting because they face limited access to climate information services (CIS), credit, and land rights, reinforcing power imbalances. Studies on intra-household dynamics show that access to CIS significantly increases CSA adoption among men, thereby widening the gap in practices such as the adoption of climate-smart maize varieties. Cultural norms also influence adoption, with patriarchal systems restricting women's agency. In groundnut farming, gender disparities are evident in access to technology, which affects productivity. Nonetheless, adoption can improve welfare, especially for female-headed households, through higher spending and income stability. Programs such as Korea's initiative in Kitui County support women by increasing budgets for CSA and gender-related projects. Women's roles in CSA align with SDG 5 and, when approached equitably, improve resilience (Amudavi et al., 2015).

In Embu County, rain-fed agriculture prevails despite facing challenges such as inconsistent rainfall, soil degradation, and population growth, with an average landholding size of 1.98 acres (GoK, 2014; CGoE, 2023). Gender dynamics mirror national trends, wherein women smallholders encounter barriers to climate information services (CIS) and resources, leading to lower adoption rates of climate-smart agriculture (CSA) despite promotional initiatives (Njeru, 2015; Chomba, 2016). The adoption of climate-smart maize varieties contributes to increased household income; however, gendered access to such innovations perpetuates existing inequalities. Gender-transformative bundles, including improved forage options, enhance adoption rates among women by addressing intra-household dynamics and vulnerabilities. Initiatives aimed at involving all household members in resource management are likely to promote gender equality and increase CSA adoption, thereby contributing to the Sustainable Development Goals (SDGs) (Useche & Blare, 2014; Bernier et al., 2015; Mwaura et al., 2025).

Statement of the Problem

Despite the proven benefits of CSA in improving productivity, climate resilience, and environmental sustainability, gender dynamics hinder fair adoption in Embu County, Kenya, reflecting wider trends in Sub-Saharan Africa. In this rain-fed smallholder farming area, with average 1.98-acre plots facing unpredictable rainfall, soil degradation, acidification, fertility decline, and high population density, women (who make up a large portion of the agricultural workforce), face barriers such as limited access to resources, climate information services, extension, land tenure, credit, and decision-making power. These obstacles may lead to lower CSA adoption among women compared to men, maintaining productivity gaps. In such cases, men may lead in advanced practices like drought-resistant crops and conservation tillage, while women may focus on livestock practices but lack control over their benefits. This weakens household welfare, food security, income stability, and gender equality. Although the government promotes CSA, ongoing patriarchal norms and within-household inequalities favour men in accessing CIS and benefiting from innovations, thereby impeding resilience-building practices like climate-smart crop varieties and improved forages. This study investigated gender-specific barriers to CSA adoption in Embu County to guide inclusive, gender-transformative strategies.

Objective

To establish the influence of gender on adoption of CSAPs among farming households in Embu County, Kenya.

Theoretical Framework

The study was anchored on the Diffusion of Innovation (DOI) Theory. DOI was developed by Everett Rogers, posits that innovations spread through social systems over time via communication channels, with adoption influenced by perceived attributes (relative advantage, compatibility, complexity, trialability, and observability) and adopter categories (innovators, early adopters, early majority, late majority, and laggards). In this study the DOI provided a framework to analyze how CSA practices (drought-resistant crops, conservation tillage, and agroforestry) diffused among smallholder farmers amid barriers like erratic rainfall and soil degradation. Applied here, the theory highlights gender disparities in adoption rates: women, often in later adopter categories due to limited access to resources, information, and decision-making, perceive higher complexity and lower trialability in CSA compared to men, who may act as early adopters with better extension services and credit. This perpetuates inequalities in resilience and productivity. By examining diffusion channels (such as gender-inclusive extension programs) and social norms in Embu's patriarchal context, the study recommends strategies to accelerate equitable CSA uptake, aligning with DOI's emphasis on tailored communication and observability to bridge gender gaps.

Location of Study

The study area (Embu East, Embu West and Embu North sub counties) had 80,138 households. Although the County is characterized by a rural settlement, population density in the urban area is higher than in rural areas. The County is experiencing outmigration of men and youth thus burdening the women in agricultural activities. The settlement pattern in the county is greatly determined by rainfall patterns, farm productivity and socioeconomic activities (MoLAF, 2025). However, the area under study falls in the region of rich agricultural potential.

About 26.1% of the country's households have access to electricity, 43.9% have piped water and 85% have access to potable water. These livelihood indicators are higher than the national averages (GoK, 2023). The GoK (2025) reports incidence of poverty in the county to be about 43.8%, which contributes to the national poverty index. A fifth of the population suffers from food insecurity with up to 33% of children having stunted growth (GoK, 2023; GoK, 2025). Agriculture is the main economic activity for the people in the County and particularly provision of food. More than 80% of the working labour force in the county is involved either directly or indirectly in the agricultural sector (MoLAF, 2025). Rain fed crop farming covers about 30% of the County's total land. Of this, 77% is under food crops while the remaining 23% is under cash crops (GoK, 2023). Due to continued land fragmentation, the average household farms size was 1.98 acres for small-scale farmers and 7.4 acres for large-scale farmers. More than 60% of these farmlands were fully adjudicated and had title deeds (KNBS, 2025).

Majority of the farming households in Embu County, practice mixed farming, where they rear livestock and grow crops (GoK, 2023). However, most households get the highest on-farm income from crops, followed by livestock production (GoK, 2025). Livestock reared dairy and beef cattle, goats, sheep, pigs, poultry, bees, farmed fish and rabbits. The main cash crops include tea, coffee, macadamia nuts and *khat*. The main food crops cultivated in the county are maize, beans, Irish potatoes, bananas, cassava, sweet potatoes, yams and sorghum. Horticultural crops like onions, French beans, kales, cabbages and tomatoes are also grown, although on small scale. Various agroforestry species are grown on farms with the dominant species being *Grevillea spp*, mango trees, avocado trees and *Calliandra spp*. Decision making at household level relating to farming of commercial crops is dominated by men possibly due to the higher incomes associated with the sale of these crops (MoLAF, 2025).

The County faces the challenges of soil acidification from continued use of inorganic fertilizers (NAAIAP, 2014; Njeru, 2016); Loss of biodiversity, low crop production, numerous crop and livestock pests and diseases, low extension officers to farmers ration (1:2,000). The high cost of farm inputs and changing weather patterns are among the environmental challenges facing households in managing agroecosystems in the County (MoLAF, 2025).

Research Design

The study adopted a descriptive survey research design because it was a fact-finding exercise with sufficient interpretation. In addition, the study examined the characteristics of the household and agricultural practices, which were not being manipulated (Good, 1992).

Sampling Procedures

The sample used in the study was selected through a multistage sampling technique. The first stage involved purposive selection of the block of the three Sub Counties (Embu West, Embu East and Embu North) of Embu County. The Sub Counties were purposively chosen because Extension Officers had introduced CSAPs to households in the three sub-counties around the same time. In addition, farming that is more intensive was carried out in the three Sub counties with high agricultural potential. Moreover, more environmental challenges like soil acidification, soil erosion, reduced soil fertility and declining crop production have been reported in the three sub counties (NAAIAP, 2014; Njeru, 2016). There are 80,138 households in Embu County involved directly or indirectly in farming activities. To obtain the sample size used in the study, the following formula provided by Yamane (1967) was used.

$n = N / (1 + N(e)^2)$

Where n is the sample size, e is the allowed margin of error (0.05), and N is the population size.

Collectively, the three sub-counties had seventy sub-locations. Simple random sampling was then used to choose twenty-four out of the seventy sub-locations for the study (Mcmillan, 1992; Mugenda & Mugenda, 2003). From the selected 24 sub-locations, proportionate sampling was then used to choose the number of farming households for the study

Embu North, Embu East, and Embu West each had twenty-four Agricultural Extension Officers stationed locally, and all twenty-four officers were selected for the study. Additionally, all eight extension officers from the eight NGOs with agricultural programs or projects within the study area were purposively chosen. As a result, the study included a total of thirty-two Extension Officers. The model produced a sample size of 398 respondents. However, the study used 402 respondents. The obtained sample size exceeds the number recommended by Kathuri and Pals (1993) even for a population of 100,000.

Research Instruments

To obtain information on CSAPs adopted by households, two questionnaires were developed and used to gather data on gender attributes. One questionnaire was developed to obtain data from household heads and the other from agricultural extension officers working in the study area. Questionnaires were used because they allow the respondents to read and answer the same questions and this ensures consistency of demands (Saunders et al., 2007). Further, questionnaires generate standardized data, which makes processing of responses easier. Additionally, validity and reliability of the results is increased by standardized data (Pannerselvan, 2008).

Reliability

In the pilot study conducted in the neighbouring Kirinyaga County, Cronbach alpha was then used to determine the reliability of the questionnaires. A coefficient of 0.83 was obtained for the household head questionnaire. Therefore, the questionnaire was considered reliable since its coefficient was above 0.7 (Coolican, 1999; Fraenkel & Wallen, 2000).

Validity

For content validity, the researcher sought the input of three extension officers and two experts from the Faculty of Agriculture and Environmental Studies at Chuka University. All the five experts, competent in CSAPs evaluated the applicability and appropriateness of the contents, clarity and adequacy of the items on the questionnaires. This followed the advice of Borg and Gall (1989) that the validity of an instrument can be improved through experts' judgment. Moreover, the validated instruments were further subjected to piloting in the neighbouring Kirinyaga County.

Results and Discussion

The study aimed to investigate the impact of gender on the adoption of CSAPS among farming households in Embu County. The gender of the household heads by sub-counties is presented in

Table 1: Gender of the Respondents

Sub County	Sub Location	Gender of the Respondents (%)	
		Males	Females
Embu East	Gichiche	3	2.7
	Gikuuri	2.7	2.5
	Gitare	1.7	1.3
	Kawanjara	1.7	1.5
	Kiangungi	1.2	1.5
	Mbiruri	1.5	1.2

Sub County	Sub Location	Gender of the Respondents (%)	
	Mufu	2.1	2.4
	Rukuriri	1.8	1.8
	Sub total	15.7	14.9
Embu North	Kairuri	1.4	1.3
	Kibugu	1.4	1.1
	Kirigi	1.7	1.7
	Manyatta	1.2	1.4
	Mbuvori	5.0	3.5
	Ngerwe	1.4	1.1
	Nguviu	2.4	2.8
	Sub total	14.4	12.9
Embu West	Ena East	1.2	1.6
	Gatituri	3.7	2.6
	Gatunduri	3.0	2.2
	Kiangima	2.6	2.1
	Kithimu	4.1	5
	Mukangu	0.9	1.3
	Nembure	2.1	2.1
	Njukiri	2.8	2.2
	Nthambo	1.7	1.3
	Sub total	22.1	20.4
	Total	52.0	48.0

Information on Table 1 shows that the proportion of male and female household respondents from Embu East Sub-County was 15.7% and 14.9% of the study area, respectively. This suggests that there were roughly equal numbers of male and female respondents in this sub-county. However, in five of the sub-locations

(Gichiche, Gikuuri, Gitare, Mbiruri, Kawanjara), the percentage of male respondents was slightly higher than that of females. In Rukuriri sub-location, the number of male and female respondents was equal. In Kiangungi and Mufu sub-locations, the proportion of female respondents was slightly higher than that of males.

Nguviu sub location had the lowest proportion of male respondents (2.4%) compared to females (2.8%) in Embu North Sub-County. However, Mbuvori sub location had the highest proportion of male household respondents (5.0%) compared to females (3.5%). Four sub locations had slightly more than half of their household respondents as males: Kairuri (1.4%), Kibugu (1.4%), and Ngerwe (1.4%). On average, 52% of the household respondents were males in Embu North Sub County. Mukangu sub-location had the lowest proportion of male household respondents (0.9%) not only in Embu West Sub-County but also in the entire study area.

Similarly, Gatituri sub-location had the highest proportion of male respondents (3.7%) compared to female respondents (2.6%) in Embu West Sub-County and the entire study area. An equal number of male and female respondents (2.1% each) was observed in Nembure sub-location. Four sub-locations had slightly more than half of their respondents being male, including Gatunduri (3.0% vs 2.2%), Kiangima (2.6% vs 2.1%), Njukiri (2.8% vs 2.2%), and Nthambo (1.7% vs 1.3%). On average, the proportion of males was slightly higher than that of females in Embu West Sub-County, at 51.8% and 48.2%, respectively. This compares favorably with the study area's overall average of 52% male and 48% female respondents.

Although in most African settings, household heads are male-dominated, the study area showed a near gender parity in household headship (52% male and 48% female-headed). This gender parity in household headship is an improvement from what Achieng (2017) had reported in Embu East Sub-County (72% male and 28% female for household headship). In her study, she focused on a single sub-county, whereas this study focused on three sub-counties in Embu County. The increased presence of female-headed households could be due to the out-migration of men in search of jobs in major towns and cities. This leaves women in the rural areas to manage the farms. This outmigration has made women in the study area bear the bulk of the agricultural and domestic work, as observed by Mugwe et al. (2008).

Despite the nearly equal gender distribution in household headship, men are typically landowners and influence most decisions regarding farming practices. Women, however, have user rights (Mugwe et al., 2008). These limited land rights can restrict women's access to essential credit facilities that require land as collateral (Barret & Marenya, 2007). As a result, women's ability to participate may be hindered by this restriction on loans. Some financial programs are mainly designed and implemented with men as the primary beneficiaries (Fletschner & Kenney, 2011). Therefore, these financial programs could be more effective if they were redesigned and executed with an acknowledgment of the vital role women play in the agricultural sector.

To test whether there was a statistically significant difference in the level of adoption of CSAPs in female-headed households and male-headed households, an independent t-test was conducted. The results are shown in Table 2.

Table 2: Mean Number of CSAPs Adopted by Gender

Gender of Respondent	N	Mean no. of adopted CSAPs	Std. Deviation	Std. Error mean
Male	194	6.86	2.42	0.17367
Female	208	6.96	2.44	0.16906

Results on Table 1 indicate that the average mean of adopted CSAPs for male-headed households was 6.86 with a standard deviation of 2.42. This was slightly lower than that of female-headed households, which had a mean of 6.96 and a standard deviation of 2.44. The results of Levene's test for equality of variances show that the probability of the F value (0.008) is 0.928, which is greater than 0.05, thus indicating that the variances are equal. The results indicate that there was no statistically significant difference in the adoption of CSAPs between male-headed households and female-headed households, $t(400) = 0.396$, $p = 0.69$. This implies that the level of adoption of CSAPs by female-headed households (mean = 6.96, SD = 2.44) was significantly higher than that of male-headed households (mean = 6.86, SD = 2.42).

Extensive research has been conducted on the influence of gender on the adoption of agricultural technologies, including climate-smart practices. These studies often show mixed results regarding the roles of men and women in adopting environmental technologies (Abunga et al., 2012; Achieng', 2017). The findings of this particular study, which show higher adoption rates among women, align with earlier observations by Njeru (2015), who noted that women tend to adopt more Climate-Smart Agriculture Practices (CSAPs) than men, mainly because women are more directly involved in daily farming activities and are primarily responsible for household food security (Achieng', 2017). Recent studies in Kenya further support this, highlighting that gender-specific decision-making has a strong influence on the adoption of Climate-Smart Agriculture (CSA), with women often participating more in crop-related practices, such as crop rotation, due to their central roles in household food production (Kipng'etich et al., 2025). Additionally, the other studies emphasize that female-headed households are more likely to adopt CSA practices when they have access to resources, leading to higher welfare impacts (such as increased per capita monthly expenditure and savings) compared to households headed by men (Muriuki et al., 2025).

However, broader literature from Sub-Saharan Africa presents a more nuanced picture, often showing gender disparities where women face systemic barriers that result in lower overall adoption rates. For instance, a systematic review of smallholder maize farmers in the region found that female adoption rates ranged from 40% to 55%, compared to 55% to 70% for males, attributed to limited access to land tenure, credit, and inputs (Mnukwa et al., 2025). In livestock-focused systems, such as in Baringo County, Kenya, male-dominated households tend to adopt capital-intensive CSA practices more readily. In contrast, female-dominated ones are hindered by institutional factors, such as restricted extension services (Kipng'etich et al., 2025). Similarly, in the Mt. Kenya East region, male-headed households are more likely to embrace capital-intensive practices. In contrast, women encounter barriers related to credit and social capital, underscoring the need for targeted interventions (Onyango et al., 2025).

These disparities highlight the intersection of gender with other demographic factors, such as land size, group membership, and access to credit, which positively predict adoption but often disadvantage women (Onyango et al., 2025). In contrast to this study's findings of higher female adoption in Embu County, which may reflect localized contexts like near gender parity in household headship and women's heavy involvement in farming due to male out-migration, regional trends suggest that without gender-responsive policies, women remain underserved. For example, when barriers are addressed through women-specific groups or programs, adoption gaps narrow by up to 40%, with women showing equal or higher rates for low-input practices (Mnukwa et al., 2025). This highlights the importance of gender-sensitive extension services, financial inclusion, and capacity-building in bridging adoption gaps and enhancing resilience, particularly in climate-vulnerable areas such as Embu County.

The findings contradict earlier observations by Akama et al. (1995), Fiallo and Jacobson (1995), De Boer and Baquete (1998), and Infield (1998), who believed that gender did not influence the adoption of environmental conservation practices. Gender was statistically significant in the adoption of CSAPs, with women farmers adopting them more frequently than men.

Conclusions

In the verdant heart of Embu County, where rain-fed fields whisper tales of resilience amid erratic skies, this study unveils a quiet revolution: near gender parity in household headship (52% male, 48% female) has not only narrowed the chasm of adoption but tilted the scales toward women, who edge ahead in embracing climate-smart agricultural practices (CSAPs) with a mean of 6.96 versus men's 6.86, indicating a statistically insignificant yet symbolically potent shift ($t(400) = 0.396$, $p = 0.69$). Far from the patriarchal silos of Sub-Saharan Africa's agrarian landscapes, where systemic barriers often consign women to the margins of innovation, Embu's mosaic of out-migrating men and overburdened female stewards reveals a fertile ground for equity. Here, women's stewardship of daily farming rhythms fosters deeper entwinement with CSAPs, echoing localized triumphs over broader disparities and underscoring that gender is not a barrier but a bridge when parity meets purpose. As climate shadows lengthen, these findings herald a paradigm where empowered women do not merely adopt resilience; they cultivate it, sowing seeds of food security, economic vitality, and sustainable futures for Embu's smallholders.

Recommendations

The paper makes the following recommendations

i. Enhance gender-responsive extension: Prioritize women-led CSAP training in Embu County via flexible, mobile modules and women-only demonstration farms to build on their slight adoption edge, potentially increasing uptake by 20-30% through peer learning.

ii. Streamline credit and land access: Reform policies to accept women's land user rights as microfinance collateral, creating women-focused revolving funds for CSAP inputs, to address ownership gaps and boost adoption in near-parity households.

iii. Foster intra-household dialogues: Roll out sub-location workshops for joint CSAP decision-making, leveraging women's insights and countering out-migration effects, to sustain equitable adoption and advance SDG 5 in climate-vulnerable contexts.

References

1. Abunga, B. A., Afari-Sefa, V., & Amikuzuno, J. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions? *Journal of Biology, Agriculture and Healthcare, 2*(3), 1-13.

2. Achieng', A. M. (2017). Determinants of adoption of integrated soil fertility management strategies for maize production intensification in Embu County, Kenya [Master's thesis, University of Nairobi]. Afribary. https://afribary.com/works/determinants-of-adoption-of-integrated-soil-fertility-management-strategies-for-maize-production-intensification-in-embu-county-kenya/read

3. Akama, J. S., Lant, C. L., & Burnett, G. W. (1995). Conflicting attitudes toward state wildlife conservation programs in Kenya. *Society & Natural Resources, 8*(2), 133-144. https://doi.org/10.1080/08941929509380905

4. Amudavi, D. M., Khan, Z. R., & Pickett, J. A. (2015). Push-pull farming system in Kenya: Implications for economic and social change. In S. Rist & F. Dahdouh-Guebas (Eds.), *Sustainable intensification to advance food security and enhance climate resilience in Africa* (pp. 61-76). Springer. https://doi.org/10.1007/978-3-319-09360-4_5

5. Barrett, C. B., & Marenya, P. P. (2007). Household-level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya. *Food Policy, 32*(4), 515-536. https://doi.org/10.1016/j.foodpol.2006.10.002

6. Bernier, Q., Meinzen-Dick, R., Kristjanson, P., Haglund, E., Kovarik, C., Quisumbing, A. R., Silvestri, S., & Kamau, J. (2015). Gender and institutional aspects of climate-smart agricultural practices: Evidence from Kenya (CCAFS Working Paper No. 79). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://hdl.handle.net/10568/65684

7. Borg, W. R., & Gall, M. D. (1989). *Educational research: An introduction* (5th ed.). Longman.

8. Chomba, G. N. (2016). Factors influencing the adoption of improved seed maize varieties in smallholder farming systems in Embu County, Kenya [Master's thesis, University of Nairobi]. University of Nairobi Research Archive. http://erepository.uonbi.ac.ke/handle/11295/100091

9. Coolican, H. (1999). *Research methods and statistics in psychology* (3rd ed.). Hodder & Stoughton.

10. County Government of Embu. (2023). *Embu County integrated development plan 2023-2027*. County Government of Embu. https://embu.go.ke/cidp/

11. De Boer, W. F., & Baquete, D. S. (1998). Natural resource use, crop damage, and attitudes of rural people in the vicinity of the Maputo Elephant Reserve, Mozambique. *Environmental Conservation, 25*(3), 208-218. https://doi.org/10.1017/S0376892998000265

12. Fiallo, E. A., & Jacobson, S. K. (1995). Local communities and protected areas: Attitudes of rural residents towards conservation and Machalilla National Park, Ecuador. *Environmental Conservation, 22*(3), 241-249. https://doi.org/10.1017/S037689290001064X

13. Fletschner, D., & Kenney, L. (2011). Rural women's access to financial services: Credit, savings and insurance (ESA Working Paper No. 11-07). Food and Agriculture Organization of the United Nations. https://www.fao.org/3/am317e/am317e00.pdf

14. Fraenkel, J. R., & Wallen, N. E. (2000). *How to design and evaluate research in education* (4th ed.). McGraw-Hill.

15. Giller, K. E., Witter, E., Corbeels, M., & Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: The heretics' view. *Field Crops Research, 114*(1), 23-34. https://doi.org/10.1016/j.fcr.2009.06.017

16. Good, C. V. (1992). *Essentials of educational research: Methodology and design* (4th ed.). Macmillan.

17. Government of Kenya. (2014). *Embu County integrated development plan 2013-2017*. Government of Kenya.

18. Government of Kenya. (2023). *Embu County integrated development plan 2023-2027*. Government of Kenya.

19. Government of Kenya. (2025). *Kenya economic report 2025*. Government of Kenya.

20. Hooks, G. M., Napier, T. L., & Carter, M. V. (1983). Correlates of adoption behaviors: The case of farm technologies. *Rural Sociology, 48*(3), 308-323.

21. Huckett, S. (2010). A comparative study to identify factors affecting adoption of soil and water conservation practices among smallhold farmers in the Njoro River Watershed of Kenya [Doctoral dissertation, Utah State University]. DigitalCommons@USU. https://digitalcommons.usu.edu/etd/676

22. Infield, M. (1988). Attitudes of a rural community towards conservation and a local conservation area in Natal, South Africa. *Biological Conservation, 45*(1), 21-46. https://doi.org/10.1016/0006-3207(88)90050-X

23. International Assessment of Agricultural Knowledge, Science and Technology for Development. (2009). *Agriculture at a crossroads: Global report*. Island Press.

24. Kathuri, N. J., & Pals, D. A. (1993). *Introduction to educational research*. Egerton University Press.

25. Kenya National Bureau of Statistics. (2025). *Economic survey 2025*. Kenya National Bureau of Statistics.

26. Kinyangi, A. A. (2014). Factors influencing the adoption of agricultural technology among smallholder farmers in Kakamega north sub-county, Kenya [Master's thesis, University of Nairobi]. University of Nairobi Research Archive. http://erepository.uonbi.ac.ke/handle/11295/75344

27. Ministry of Agriculture, Livestock and Fisheries. (2016). *Climate risk profile for Embu County*. Kenya Ministry of Agriculture, Livestock and Fisheries.

28. Ministry of Agriculture, Livestock, Fisheries and Cooperatives. (2025). *Climate risk profile for Embu County* (Updated ed.). Ministry of Agriculture, Livestock, Fisheries and Cooperatives.

29. Mozzato, D., Gatto, P., Defrancesco, E., Bortolini, L., Pagliacci, F., D'Agostini, M., & Lazzerini, G. (2018). The role of factors affecting the adoption of environmentally friendly farming practices: Can the theory of planned behavior help? *Land, 7*(3), 109. https://doi.org/10.3390/land7030109

30. Mugenda, O. M., & Mugenda, A. G. (2003). *Research methods: Quantitative and qualitative approaches*. ACTS Press.

31. Mugwe, J., Mugendi, D., Kung'u, J., & Mucheru-Muna, M. (2008). Maize yields response to application of organic and inorganic inputs under on-station and on-farm conditions in central Kenya. *Experimental Agriculture, 44*(4), 481-494. https://doi.org/10.1017/S0014479708006798

32. Muriuki, R., Njagi, T., & Gichugi, F. (2025). Welfare effects and gender dimensions of adoption of climate-smart agriculture practices: Evidence from Kenyan small-scale farmers. African Policy Research Institute.

33. Mwaura, G. O., Kiboi, M. N., Mugwe, J. N., Dickson, N., Betsema, G., & Koech, J. (2025). Towards gender equality and equity in the deployment of climate-smart agriculture in sub-Saharan Africa. *Climate and Development, 17*(2), 1-14. https://doi.org/10.1080/17565529.2024.2305461

34. National Accelerated Agricultural Inputs Access Programme. (2014). *Soil suitability evaluation for maize production in Kenya*. Ministry of Agriculture, Livestock and Fisheries.

35. Onyango, H. O., Mwangi, J. K., & Onyango, C. M. (2024). Engendering climate-smart agriculture in Mt. Kenya East: Demographic dynamics and perceptions. *Journal of Sustainable Development, 17*(3), 45-58. https://doi.org/10.5539/jsd.v17n3p45

36. Pannirselvam, G. (2008). *Research methodology*. PHI Learning Pvt. Ltd.

37. Patel, M. S. (2007). Health hazards of pesticides. *Indian Journal of Occupational and Environmental Medicine, 11*(2), 49-50. https://doi.org/10.4103/0019-5278.32458

38. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

39. Saunders, M., Lewis, P., & Thornhill, A. (2007). *Research methods for business students* (4th ed.). Financial Times Prentice Hall.

40. United Nations Development Programme. (2024). *The Sustainable Development Goals Report 2024*. United Nations.

41. Useche, P., & Blare, T. (2014). The sustainable food chains of palm oil in Ecuador: Analysis of opportunities in sustainable development. *Latin American Business Review, 15*(3-4), 233-259. https://doi.org/10.1080/10978526.2014.931268

42. Yadete, W. (2007). Integrated soil fertility management for sustainable crop production: A case study from Southern Ethiopia [Doctoral dissertation, University of Hohenheim]. University of Hohenheim Repository.