Adoption of Climate Smart Agriculture Practices among Farmers in Soy Sub-County, Kenya

Frankline Yatich[1], Amon Karanja[2] & Humphreys Obulinji[1]

[1]*Department of Geography, Egerton University, Kenya*

[2]*Department of Geography, Masinde Muliro University of Science and Technology, Kenya*

**Corresponding author: yatichfrankline20@gmail.com*

https://doi.org/10.62049/jkncu.v5i1.192

Abstract

Climate variability has lowered agricultural productivity, and aggravated food insecurity, especially in Sub-Saharan Africa and Asia. Small-scale farmers are especially susceptible to the negative impacts of climate change because their livelihoods depend on rain-fed agriculture This study sought to assess the current climate-smart agricultural practices used by farmers in the Soy Sub-County and the level of adoption of these Climate Smart Agriculture (CSA) practices. The study utilized a survey method that utilized questionnaires and interviews among 196 households and seven key informants, respectively. The results revealed that the main farming system was maize farming (61%) and livestock (87%). On average, farmers owned 5-10 acres of land (32%). As part of CSA, most of the participants do fodder conservation (85%) using conventional methods. In terms of CSA, most farmers adopted improved livestock breeds that are resistant to drought and parasites and improved nutrition (94% and 82%, respectively), and changing the planting patterns (94%). The rate of CSA adoption rates varies from practice to practice depending on demographic factors. Age significantly affects the CSA adoption (p=0.029, t=-21.777, CI=0.05). On the other hand, the soil type positively influenced the farmers' adoption of CSA practices (p=0.042). Other socio-economic variables such as gender, household, experience, and education had no significant statistical effect on the adoption of CSA.

.

Keywords: Climate Smart, Small-Scale Farming, Agriculture, Variability and Subsistence

Introduction

Climate variability is the way characteristics of climate (such as precipitation and temperature) fluctuate from a normal. Climate variability threatens crop farming due to its overreliance on climatic conditions (Busolo et al., 2023). Climate change poses a severe threat to the natural and human systems. It has also affected the global economic well-being (IPCC 2018). However, the adverse impacts of changing climate are more common in developing countries due to their low adaptive capacities and poor infrastructure (Sardar et al., 2021). Temperature variation, for example, has been reported by many academic scholarships (Abegunde & Obi, 2022; Busolo et al., 2023; Sardar et al., 2021), and this climate variability has created volatility in output and reduction in productivity, worsening food poverty mainly in Sub Saharan African countries, Kenya included (Korir et al., 2023). The size and frequency of severe climatic occurrences are anticipated to rise, and small-scale farmers are especially susceptible to the negative impacts of climate change because their livelihoods depend on the weather, and they are already dealing with the negative impact of environmental degradation and socio-economic risks (Sardar et al., 2021). Therefore, small-scale farmers must adopt climate-smart practices (CSAPs) to adapt to climate change effectively.

In Uasin-Gishu County, farm produce is negatively affected due to Climate variability; maize farmers, for instance, have been adversely affected since they currently harvest 20 bags per Ha below the potential level of 40 bags per Ha (Jat et al., 2014). Agriculture supports over 80% of households in Uasin-Gishu County in terms of income and food security (Jat et al., 2014). Approximately half of the inter-annual Variability of agricultural production in Uasin-Gishu County is due to climate variability, and between 5 to 10 % of global agricultural production is lost yearly due to unfavorable weather conditions (Njehia & Wanjala, 2014).

There is a significant negative association between family food security and innovation in farming because there is a connection between a lack of innovation in agricultural operations and the number of months of food deficit. Because of this, many low-income families cannot save enough money to invest in productive avenues. With the help of CIAT, key stakeholders, including the World Bank, have started developing technical indicators to better identify and compare climate-resilient initiatives. These evaluate the potential of agricultural systems from a technical standpoint, considering their capacity to increase output while also adapting to and mitigating the effects of climate change (Jelagat, 2019). Because of the wide variety of consequences of such approaches on individuals from varied backgrounds, the indicators are weighted and measured as per regional and national contexts and may vary dramatically from one country to the other. In general, the indicators are evaluated from 1 (low potential) to 5 (high potential) in every area and measure positive gains from deploying CSA technologies.

Like in many regions, agriculture in Soy-Subcounty is susceptible to the vagaries of climatic events. Therefore, adopting new technology and productivity approaches among peasant farmers helps in risk tolerance given climate change's devastating effects, including droughts and excessive and infrequent rainfall (Abegunde& Obi, 2022). Despite the growing recognition of the importance of CSAPs in addressing the challenges posed by climate change, there is a notable gap in understanding the specific factors that influence the level of adoption of these practices among small-scale farmers in Soy sub-county, Uasin Gishu County (Jat et al., 2014). Existing studies on CSAP adoption in agriculture have focused on Arid and Semi-Arid (ASAL) with limited studies on the selected areas where farmers face unique constraints (Abegunde & Obi, 2022). This paper soughtto fill this knowledge gap by providing context-specific insights into the level of farmers' adoption of climate-smart agriculture (CSA) and the factors influencing the farmer's adoption of CASPs in Soy Sub-County, Kenya.

Methodology

Study Area

The study was conducted in the Soy sub-county in Uasin-Gishu County, Kenya. The sub-county lies between longitude 35° 8′ and 35° 19′ East and Latitudes 0° 45′ and 0° 56′ North (Figure 3.1). The area borders the Turbo sub-county to the Southwest, the Moiben Sub- County to the east, the Kapseret Sub-county to the southeast, and the Kesses Sub-county to the southeast.

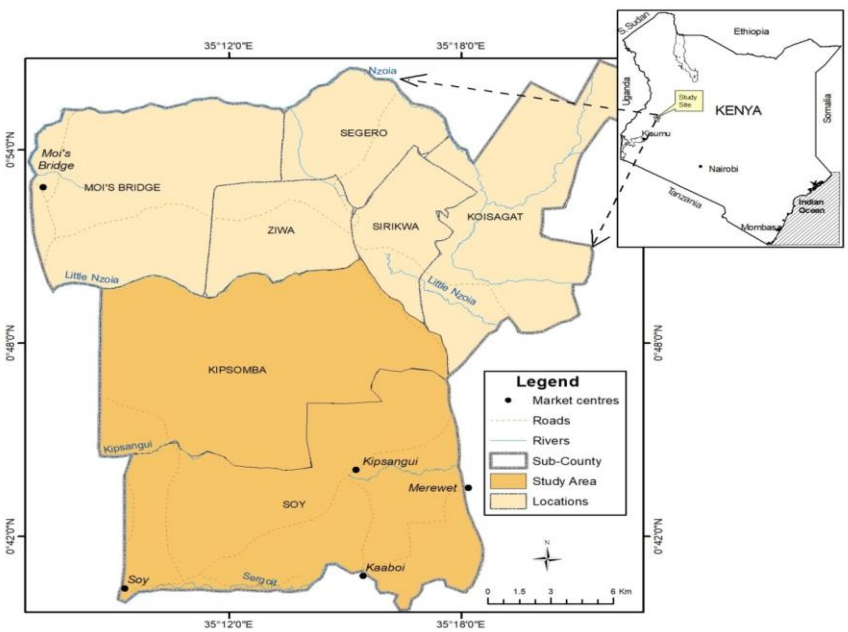


Figure 1: Map of the study area

Research Design

The study utilized a survey research design to collect data on the level of adoption of Climatic-Smart Agriculture by farmers within the Soy sub-county in managing climate variability. The data was collected using a survey questionnaire tailored to understand farmers’ acceptance of CSA and the determinants of adoption and acceptance of CSA in the Soy sub-county. The quantitative data collected during the questionnaire survey were supplemented with quantitative data collected from key informants. The key informants’ interviews were held with administrators and agricultural officers drawn from Soy Sub-County within Uasin-Gishu County. The study targeted all the farming households in the Soy sub-county. In the previous national census 2019, the Soy sub-county had about 88,956 households distributed in Kipsomba Ward 5343and Soy Ward3560 (Kenya National Bureau of Statistics, 2019).

Sample Size and Sampling Procedure

A multi-stage sampling method was used to obtain the study area and the study units in two selected wards of Soy and Kipsomba. Households to participate in the study were sampled using simple random protocol. The sample size was derived using Kothari formula (Kothari, 2004).

n= $z^2.p.q.N/\,e^2(N-1)+\,z^2.P.Q$... (1)
Where: N = the population size,
n = sample size,
p = the sample proportion (q = 1-p), (p=0.5)
Z is the standard variant at a given significance level at α=0.05, Z=1.96,
e = acceptable error (precision).
p=0.5 and an acceptable error of 7 % (e).
q= the weighting variable and is computed as 1-P.
The sample was determined as follows.
n= (1.96^2x 0.5 x 0.5 x 88,956) / (0.07^2 x 88,955) + (1.96^2 x 0.5^2) ≈ 196

Data Analysis Procedure

The survey questionnaire was pre-tested using approximately 20 respondents from the neighboring Moiben sub-county, which has similar agroecological characteristics to the study area, to test its reliability, which was the primary tool. The piloted survey was then subjected to the Cronbach alpha (α) test, which produced coefficients of 0.853. According to Mugenda & Mugenda (2003), this is highly reliable.

Results and Discussion

Demographic Characteristics of the Respondents

Table 1: Age of the household head in soy sub-county

Characteristics	Category	Percent
Age	18-25	20
	26-35	31
	36-50	22
	Above 50	27
	Total	100
Years of farm Experience	1 -5	15
	6-10	21
	11-15	12
	15-20	15
	Above 20	37
	Total	100
Occupation of the respondent	Farming	48
	Formal employment	13
	Casual employment	39
	Total	100

Source: Research Data, 2019

Most of the respondents were between 36-50 (22), 26-35 (31%) and above 50 years (27%. These results resonate with Busolo et al. (2023), who posit that the average age of a farm household's heads in Uasin Gishu was above 25 years. Farming was the main occupation among the heads of households (48%), and the survey revealed that 37 percent of respondents had been actively engaged in farming for 20 years or more, 21 percent have been practicing farming for 5 to 10 years (Table 1). In terms of employment, the resultsshow that 13 percent of the participants were formally employed, 39 percent worked in the informal economy, and 48 percent were farmers. These occupation types indicate that farming is the primary means of subsistence for the studied households. The larger percentage of families in Soy Sub County whose major source of income is farming demonstrates the significance of farming and CSA to the local economy.Regarding the respondents' level of education, 47 percent had completed secondary school, 35 percent completed primary school, 18 percentattained tertiary levels, and only 10 percent had no formal education. These findings suggest that most farmers had attained formal education. This high level of education underscores the ability of most farmers to adopt the education on CSAPs.

Household Farming Practices and Average Land Sizes

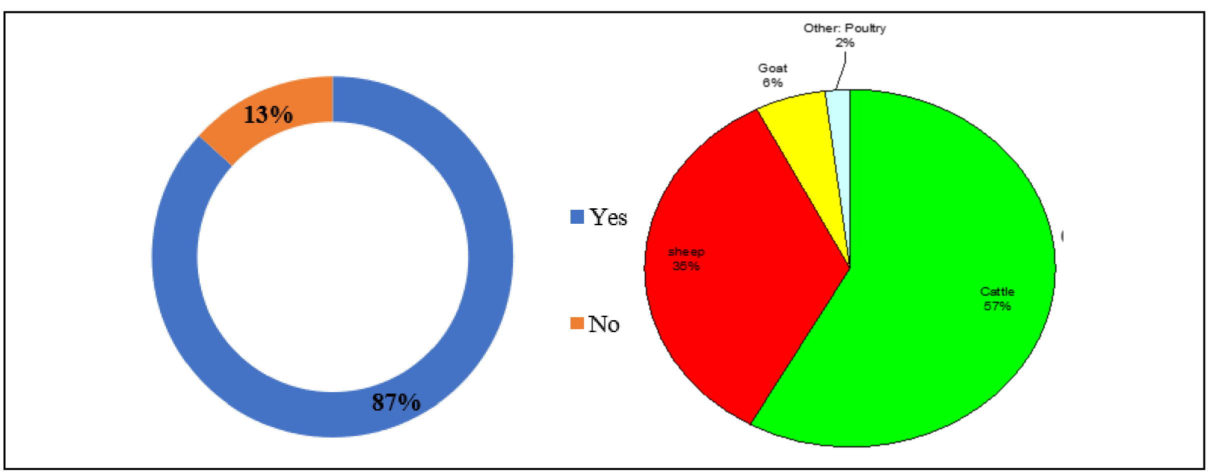
Table 2 shows the main cropping types. Most participants, 61 percent, grow maize as their primary food crop, whereas 30 percent grow beans and 9 percent grow sorghum. Most farmers do crop diversification, albeit in a rotational system, to lower the risk of one crop failure.

Table 2: Shows household major cropping types

Crop type	Percentage (%)
Maize	61
Beans	30
Sorghum	9
Total	100

Most farmers keep livestock (86.7%), thus providing diversity and a cushion in situations of crop failure and other catastrophes. The livestock distribution is as follows: 57% kept cattle, 35% kept sheep, 6% kept goats, and 2% kept poultry.

Table 3: Respondents practicing livestock



On average, farmers farm on 5-10 acres of land (31.63%) and 15-20 acres (25.51%). A significant proportion of 12.75 percent owned less than five acres; the last category was above 20 acres (8.18%). Larger tracts of land allow for more output, but most respondents in the area had less than 10 acres.

Table 4: Land Size under Cultivation

Land Size Under Cultivation	**Number Of Respondents (%)**
1 -5	13
5-10	32
10-15	22
15-20	25
Above 20	8.
Total	100

Source: Research Data, 2019

Climate Smart Agriculture Practices

As part of conservation agriculture, most of the participants in the study do fodder conservation (84.7%) using conventional methods, while only 1.5% of respondents feed their animals on irrigated fodder and pastures. This practice implies that most farmers prefer to graze their animals on preserved feeds than on broad rangelands despite the larger average acreage sizes owned by the farmers (15-20 acres). This practice is attributed to most of the land being used for crop farming, leaving little room for grazing animals. Conversely, Adewumi and Olafadehan (2010) reported that ranchers with access to extensive rangeland rarely supplemented their stock and relied solely on range pasture.

Table 5: Mode of Feeding Livestock

Feeding mode	Conserved fodder (%)	Conserved forage (%)	Irrigated pastures (%)	Irrigated fodder (%)
Yes	84.7	64.8	1.5	1.5
No	16.3	35.2	98.5	100.0
Total	100.0	100.0	100.0	100.0

Source: Research Data, 2019

In terms of CSA practices, most participants have adopted improved livestock breeds that are resistant to drought and parasites and improved their nutrition (94% and 82%, respectively), changed the planting patterns (94%), crop rotation (59%). The least adopted CSA practices were agroforestry (53%) and minimum tillage to conserve soil (51%), soil conservation through terracing (44%), and mulching (28%). Change in planning dates entails either early planting (EP) at rainfall onset or late planting (LP) two weeks after onset rains.

Table 6: The CSA practices in the study area

CSA Practices	**Percentage**
Minimum Tillage	51
Crop Rotation	59
Terracing	44
Agro-forestry	53

Change in planting patterns	94
Mulching	28
Improved livestock breeds	94
Improved livestock nutrition	82
Totals	100

Source: Research Data, 2019

Regarding the duration of time practicing the above CSAs practices, most farmers have been practicing climate-smart agriculture for more than 6 years (49%), as shown in Table 7. Others have adopted for four to six years (17%) and four years (16%), while 4% have never adopted CSA practices (Table 7).

Table 7: Years of experience practicing CSA

Length of time	**Percentage**
Not adopted	4
1-2 yrs	14
2-4 yrs	16
4-6 yrs	17
Above 6 yrs	49
Total	100

Source: Research Data, 2019

The Level of Adoption of Climate Smart Agriculture Practices

Adoption rates vary from practice to practice depending on demographic factors such as gender, age, land area, and household income.Non-CSA farmers have mentioned in FDGs that they need more proof of how innovations may be effectively implemented into agricultural systems, illustrating the non-adoption of CSA practices. These findings corroborate Amwata et al. (2015), who reported that although CSA procedures are popular in most agroecological zones in Kenya, their adoption rate remains low. Nyang'au et al. (2021) link these low levels of adoption of CSA with a need for more relevant infrastructure support, institutional support, capacity building, and finances.

We identified six socio-economic characteristics of farmers (independent variables) that had the potential to influence the adoption of climate-smart agriculture in the study area (Table 8). The results revealed that most of these variables negatively influenced the rate of adoption of CSA except slope and soil type, which positively influenced its adoption.As most farmers advanced in age, they were less likely to adopt the CSA practice and vice versa (p=0.029, t=-21.777, CI=0.05). These results support the findings of Tesfaw (2013), who concluded that farmers' age was detrimental to market participation— as the head of the household ages, he/sheis less likely to adopt the best farming practices even if not capital and labor-intensive. These findings illustrate older farmers' declining preference and adoption of CSA practices.

On the other hand, the soil type positively influenced the farmers' adoption of CSA practices (p=0.042, t=0.530, CI=0.05). The soil type in the study area positively influences the adoption rate of CSA by farmers in those areas, the physical and chemical properties of soil in Soy Sub-County necessitate farmers to embrace CSA practices as an alternative approach to other practices that rely on adequate rainfall. Moreover, the land topography in the area positively influenced the adoption of CSA, although it was not significant at a 95% confidence interval (p=0.056, t=0.045, CI=95%). Thus, the general low land elevation (slope percent) in the study area was relatively favorable to CSA practices such as minimum tillage, drought-resistant crops, and crop rotation.

Other socio-economic variables such as gender of the head of household, experience, and education had no significant statistical effect on the adoption of CSA (p>0.05). These findings corroborate findings by Apata et al. (2009). While Apata et al. (2003) identified that several socio-economic characteristics such as gender, age of household head, farming experience, occupation, and source of livelihood influenced the level of understanding and implementation of agricultural technologies, gender of the household head had no significant relationship with adaption strategies while the other factors significantly motivated farmers to adopt the CSA practices.

Table 8: Social Economic Factors Influencing Adoption of CSAP

Model		Unstandardized Coefficients		Standardized Coefficients		Sig.
		B	Std. Error	BetaT		
	(Constant)	-1.722	.941		-1.829	.319
	Experience	-.115	.012	-.705	-9.241	.069
	Age	-.192	.009	-1.209	-21.777	.029
	Gender	-.009	.001	-.296	-6.162	.102
	Education	-.007	.002	-.102	-3.130	.197
	Slope	.045	.004	.958	11.317	.056
	Soil type	.530	.035	.413	15.155	.042

Source: Research Data, 2019

Conclusion

Farmers in the study area have used various CSA techniques to adapt to climate variability. Farmers posit that changes in rainfall over the last several years prove that the region is experiencing climatic unpredictability. The research also demonstrated that farmers' cropping methods, grazing patterns, productivity, and adaption tactics to climatic Variability are all affected by the unreliability and unpredictability of the rains.Most farmers in the study area rely on rain-fed agriculture, which is affected adversely by delayed and unpredictable rainfall patterns occasioned by the vagaries of climate change. This reliance on rain-fed practices consequently leads to decreased crop yields, negatively impacting household income and food security. The challenges associated with unpredictable weather patterns highlight the significant potential of CSA in the area. However, the adoption of CSA practices depends on many other factors, such as farmers' education level, age, land's physical and chemical properties, and experience level in farming.

References

Adeola, A. O., Apata, T. G., & Samuel, K. D. (2009). *Analysis of Climate Change Perception and Adaptation among Arable Food Crop Farmers in Southwestern Nigeria.*

Abegunde, V. O., & Obi, A. (2022). The role and perspective of climate-smart agriculture in Africa: A scientific review. *Sustainability*, *14*(4), 2317.

Adewumi, M. K., & Olafadehan, O. A. (2010). Livestock Management and Production System of Agropastoralists in the Derived Savanna of South-West Nigeria. *Tropical and Subtropical Agroecosystems*, *12*(3), 685–691.

Amwata, D., Campbell, B. M., Cofie, O. O., Frid-Nielsen, S., Girvetz, E. H., Kinyangi, J., Mapfumo, P., Mul, M. L., Nyasimi, M., Partey, S. T., Rosenstock, T. S., Speranza, C. I., Wamukoya, G., Williams, T. O., &Zougmoré, R. B. (2015, November 17). *Climate Smart Agriculture in the African Context*.

Azizipour, M., Cahn, M., DeVincentis, A. J., Garza-Díaz, L. E., Kisekka, I., Mahlknecht, J., Medellín-Azuara, J., Sandoval-Solis, S., & Zaccaria, D. (2019). Land-use optimization for sustainable agricultural water management in Pajaro Valley, California. *Journal of Water Resources Planning and Management*, *145*(12), 05019018–05019018.

Busolo, T. A., Koech, M. K., & Wemali, E. (2023). Climate Variability Adaptation Strategies Used by Small-Scale Maize Farmers in Uasin Gishu County, Kenya. *African Journal of Climate Change and Resource Sustainability*, *2*(1), 153-170.

Beyene, F., & Muche, M. (2010). Determinants of food security among rural households of Central Ethiopia: An empirical analysis. *Quarterly Journal of International Agriculture*, *49*(892-2016–65219), 299–318.

Higgins, L., & Ishdorj, A. (2015). Children’s Food Security and Participation in the National School Lunch Program. *Applied Economics and Finance*, *2*(1), 119–128.

Jama, B. A., Okalebo, J. R., Opala, P. A., & Othieno, C. O. (2007). Effect of phosphate fertilizer application methods and nitrogen sources on maize in western Kenya: An agronomic and economic evaluation. *Experimental Agriculture, 43*(4), 477–487.

Korir, D., Ouma, C., & Okech, T. (2023). Human Resource Training and Development and Adoption of Solar Photovoltaics in Climate Smart Agriculture in Uasin Gishu County, Kenya. *The University Journal*. https://doi.org/10.59952/tuj.v5i3.273.

Jelagat, J. (2019). *Effects Of Climate-Smart Agricultural Awareness on Food Security Among Smallholder Farmers* (Doctoral dissertation, University of Nairobi).

Jat, R. K., Sapkota, T. B., Singh, R. G., Jat, M. L., Kumar, M., & Gupta, R. K. (2014). Seven years of conservation agriculture in a rice-wheat rotation of Eastern Gangetic Plains of South Asia: yield trends and economic profitability. *Field Crops Research, 164*, 199-210.

Kang'ara, J. N., Ngoroi, E. H., Muturi, J. M., Amboga, S. A., Ngugi, F. K., & Mwangi, I. (2001). *The role of livestock in soil N fertility, biodiversity, land use, cultural and welfare change in Nduuri Embu, Kenya*.

Kassie, M., Ndiritu, S. W., & Shiferaw, B. (2011). *Adoption of agricultural technologies in Kenya: How does gender matter?*

Kenya National Bureau of Statistics. (2019). *2019 Kenya population and housing census*. Kenya National Bureau of Statistics.

Kothari, C. R. (2004). *Research Methodology*. https://books.google.com/books/about/Research_Methodology.html?id=hZ9wSHysQDYC

Mugenda, A. G., & Mugenda, O. M. (2003). *Research methods: Quantitative and qualitative approaches*. African Centre for Technology Studies.

Najafi, B. (2003). An overview of current land utilization systems and their contribution to agricultural productivity. *APO Seminar on Impacts of Land Utilization Systems on Agricultural Productivity Held in the Islamic Republic of Iran, 4-9 November 2000*, 49–54.

Nyang'au, J., Mohamed, J., Mango, N., Makate, C., & Wangeci, A. (2021). Smallholder farmers' perception of climate change and adoption of climate-smart agriculture practices in Masaba South Sub-county, Kisii, Kenya. *Heliyon*, 7. https://doi.org/10.1016/j.heliyon.2021.e06789.

Sardar, A., Kiani, A. K., &Kuslu, Y. (2021). Does adopting climate-smart agriculture (CSA) practices improve farmers' crop income? Assessing the determinants and their impacts in Punjab province, Pakistan. *Environment, Development and Sustainability, 23*, 10119-10140.

Tesfaw, A. (2013). Benefit-Cost Analysis Of Growing Pepper: A Trial At West Gojjam, Near The Source Of Blue Nile. *International Journal of Agriculture and Crop Sciences*, *6*, 1203–1214.