Review Article

EFFECTS OF CLIMATE SMART AGRICULTURE PRACTICES ON HOUSEHOLD LIVELIHOODS IN SOY SUB-COUNTY KENYA

ABSTRACT

Agriculture is considered to be "climate-smart" when farmers are in a position to adapt and sustainably mitigate climate risk and contribute to increasing food security. Climate variability poses serious economic challenges including low yields and high post-harvest losses leading to low income among farmers. Although there have been technological and policy efforts in Kenya by both national and county governments through county integrated development plans to assist farmers to cope with the challenge of climate variability, the effects are yet to be fully realized at the household level. This study sought to analyze the effects of adoption of Climate Smart Agriculture practices on farmers' livelihoods in Soy sub County Kenya. The study adopted a cross-sectional descriptive survey research design. The study utilized household survey where 196 respondents were selected to participate in the study. Descriptive statistics was used to analyze the effects of adoption of Climate Smart Agriculture practices in Soy sub County. The study found that 88.7% of the farming households that had adopted CSA practices led to increased yields, 73.46 % of farming households felt that the adoption led to increased income, 7.65 % felt that it has led to employment creation, 4.08 % felt that the adoption led to control of pest and 0.06 % felt that it led to control of weeds. The study concludes that the adoption of Climate Smart Agriculture practices positively and negatively influences the livelihoods of farming households in Soy sub- County. The study recommend that farmers be engaged in the planning of the adoption of Climate Smart Agriculture practices and to be encouraged to work jointly with technical specialist and extension officers to identify CSA practices that are suitable to local conditions.

Keywords: Climate Smart, Household Survey, climate variability, food security, livelihoods

1.0 Introduction

Climate variability has caused instability in production and decline in productivity exacerbating food insecurity particularly in Sub Saharan Africa including Kenya and some parts of Asia. The magnitude and frequency of extreme climatic events is projected to increase. The effects of climatic changes is more pronounced among small scale farmers whose farming activities are weather dependent and vulnerable to climate change, and already affected by environmental degradation and socio-economic risks. Effective adaptation to climate change among small scale farmers is therefore critical and is dependent on adoption of climate smart practices.

Agriculture is vulnerable to climate events. New technologies and production strategies among peasant farmers may be beyond their risk tolerance, given that failure may be catastrophic (FAO, 2012). According to Kristjanson *et al.* (2012), there is a strong negative relationship in farming between household food security and innovation since there is a correlation between lack of innovation in farming practices and the number of food deficit months. This makes many poor households unable to save sufficiently to invest in high-return strategies. Stakeholders such as the World Bank, in collaboration with CIAT, have begun to establish technical indicators in order to identify diverse strategies and compare them in terms of climate smartness (Castells-Quintana *et al.,* 2018). These assess the technical potential of various agricultural techniques in terms of their ability to boost productivity, adapt, and mitigate climate change. Because of the wide range of effects of such tactics on people from various backgrounds, the indicators are weighted and quantified according to national and regional contexts, and may differ significantly from one country to the other. In general, the indicators are scored from 1 (low potential) to 5 (high potential) in each area and assess positive improvements resulting from the application of CSA technologies:

The adoption of CSA contributes to climate variability adaptation and mitigation of greenhouse gases (GHGs), approaches such as agro forestry, zero tillage, and use of cover crops increase the amount of carbon sequestered in the soil (Comoé, 2013). The adoption of CSA can have long-term household benefits in terms of increased yields and make farming systems more resilient to variation in climate. The approaches generate positive benefits locally in terms of household and community level, as well as the public in reducing atmospheric carbon. However, adoption of CSA practices has been slow, particularly in food insecure and vulnerable regions in sub-Saharan Africa, however, the regions which have adopted the approaches have witnessed increased productivity as a result of improved soil characteristics and water retention (Giller *et al.,* 2009). A case in point is agro forestry which generates adaptation benefits through its impacts on reducing soil and water erosion, reducing yields variation, and improving water management. Agro forestry also contributes to carbon sequestration above ground and below ground, thereby contributing to GHG mitigation (Mital, 2012). Agro forestry has been practiced and succeeded in Indonesia, and Colombia, whereas in Kenya it involves the planting of *the Grevillea* Agro forestry system and *shelterbelts* in Togo (Adenle *et al.*, 2019).

Reduced or Zero tillage leads to minimized soil disturbance, increases water retention and improves soil structure and aeration, also reduces yield variability due to extreme weather events (Blanco & Lal 2009). Thus Zero tillage practice increases farm system resilience and improves the capacity of farmers to adapt to climate variability, moreover, such practices may reduce carbon losses that occur with ploughing and also sequester carbon through residue incorporation and reduced erosion (Campbell *et al.*, 2012). However, in many circumstances, farmers who adopt Zero tillage still periodically plough the land improving yields without compromising the gains in terms of resilience and adaptability, releasing stored carbon (Puig-Sirera *et al.*, 2022). Zero/ minimum tillage has been practiced and succeeded in the following countries; wheat and Barley farming in Morocco, minimum tillage and direct planting in Ghana, and small-scale conservation tillage in Kenya (Kassam *et al*., 2019).

A cover crop can alleviate potential weed problems where herbicides are not available or accessible to smallholder farmers. Cover crops such as leaving residues on the field or improved fallows ensure that soil is not left bare after harvest and decomposes easily replenishing soil fertility (Matata *et al*., 2010). Continuous cover crops are significant to farmers since it helps in weed suppression and pest control. In terms of adaptation, the practices reduce erosion and enhance water retention and resilience to drought. Population pressure and the need for continuous cultivation increases the rate of adoption of cover crops, however, due to the high rate of poverty in other regions high population pressure have instead led to the abandonment of cover crops and severe land degradation and where weeds and pests problems are greater (Showers, 2005).

CSA helps to improve food security for the poor and marginalized groups through proper land management practices that build the resilience in agriculture and adaptive capacity of farmers' households to climate variability, while also reducing food waste (Azadi *et al*., 2021). CSA also improves the relationship between agriculture and poverty since agriculture is the main source of food, employment, and income for many people living in developing countries. Crop rotation, mulching, and minimum/ zero tillage are the components of conservation agriculture since they are approaches that aim at minimizing soil disturbances and minimizing bare and uncovered soil (Blanco & Lal 2008).

The implementations of CSA technologies individually or in combination have substantial potential to reduce climate variability impacts on agriculture. A meta-analysis of crop simulation under several climate situations found that farm-level adaptations can increase crop yields by an average of 7–15% when compared to without adaptation (Porter *et al*., 2014). Various studies show that the benefits of adaptation differ from one method to the other and with temperature and rainfall changes (Easterlingn *et al*., 2007). Similarly, several farm-level studies suggest that adoption of CSA technologies can improve crop yields, increase input use effectiveness, increase net income and decrease GHG emissions (Khatri-Chhetri *et al*., 2016).

The CSA is faced with challenges during the adoption; mulching is done in semi-arid regions where termites are abundant, surface mulch will be eaten by the termites limiting the benefits of CSA (Sanginga & Woomer 2009). Zero/minimum tillage is affected by animals that graze in post-harvested lands, since animals remove the residue in the land leaving too little residue to adequately cover the field. Moreover grazing is too heavy to compact the soil, making planting with zero-tillage more difficult (Bot & Benites 2005). The CSA practices require greater management skills than the traditional system, hence farmers require new approaches and more sophisticated systems, and farmers perceive the risk of adopting CSA as a key constraint to adoption in the African context (Mizik, 2021). Security of tenure may also influence the adoption of such practices to the extent that greater security increases incentives to invest for the long-run increase in yields and greater yield stability (Rashid, 2021).

The adoption of Climate-Smart Agriculture (CSA) plays a key role in promoting resilience to climate variability, improvement of household income, and increase in agricultural productivity. Study analyzes both negative and positive effects of CSA on farmers' livelihoods and environmental sustainability.

2. Study Area and Research Methodology

The study area was Soy sub County Uasin Gishu County. The sub-County lies between longitude 35° 8′ and 35° 19′ East and Latitudes 0° 45′ and 0° 56′ North and area of 768.0 square kilometer (Figure 1). The sub County is situated on a plateau falling gently from 2700 meters to about 1,500 meters above sea level. Soy sub County has seven administrative wards namely; Ziwa, Segero Barsombe, Kipsomba, Soy, Kuinet Kapsuswa, Kapkures and Mois’bridge.

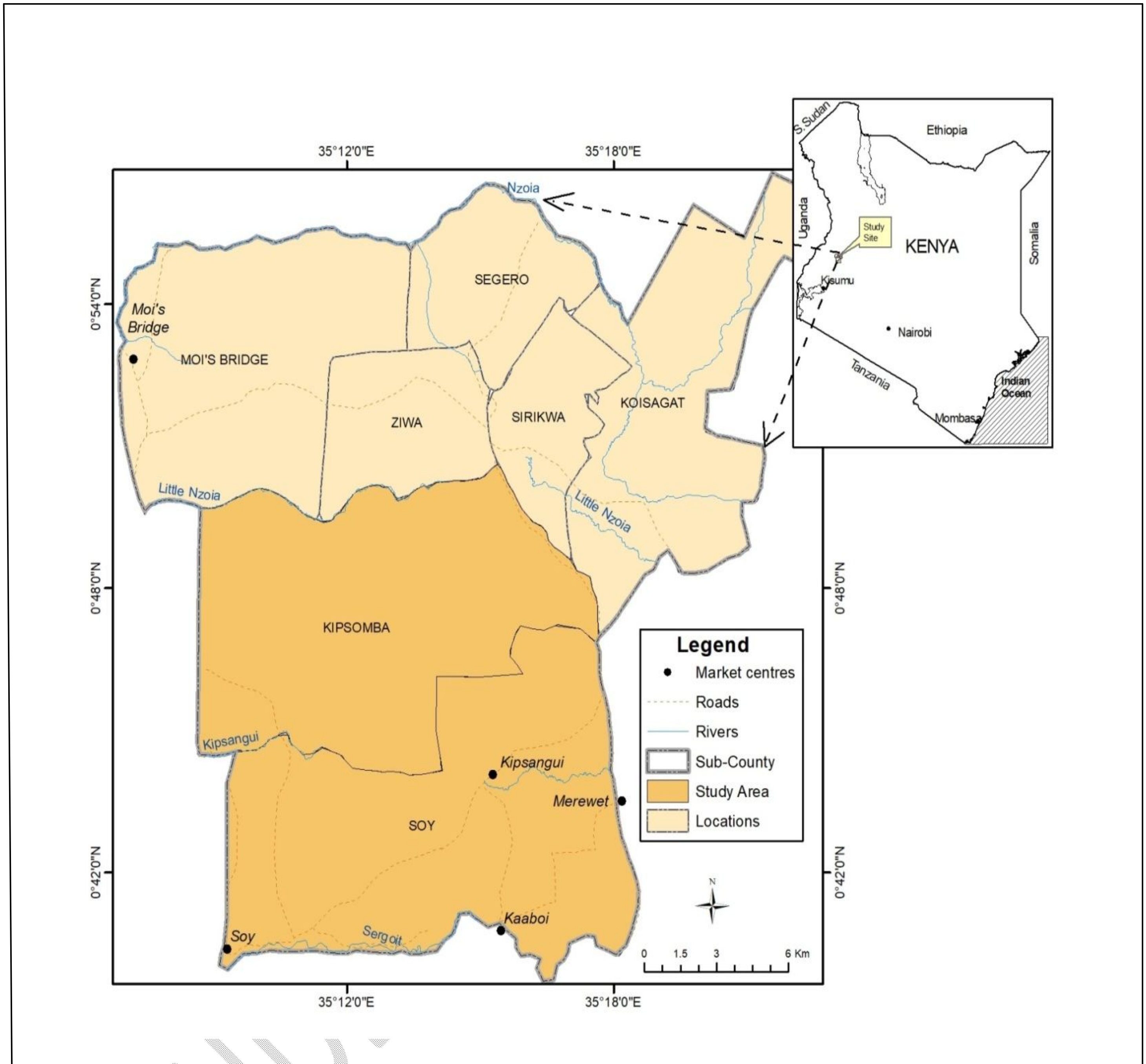

Figure1.0 A map of Soy sub-County showing the sampled sites

2.1 Climate and Agro-Ecological Zones

Soy sub-County enjoys two rainy seasons with an annual rainfall ranging between 900 to 1200mm. The sub-county has a cool and temperate climate, with annual temperatures ranging - between 8.4 °C and 27 °C. The wet seasons in the region are experienced in March April May and October-November-December while the dry season is between January and February. Approximately 218 km^2 of land in Soy is underwater, swamps, and rocks.

2.2 Sampling Procedures and Sample size

Sample size was determined by use of proportionate sampling methodology as specified by Kothari (2004) formula for finite population;

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),

Z= the standard variant at a given significance level (α = 0.05) and

e= acceptable error (precision).

Using p=0.5 as the proportion of farmers with off-farm investments ("n" will be the most conservative sample and will give the desired precision).

Z=1.96,

p=0.5 and an acceptable error of 7 % (e).

q= the weighting variable and is computed as 1-P.

The sample will be determined as;

n= $(1.96^2 \times 0.5 \times 0.5 \times 88{,}956) / (0.07^2 \times 88{,}955) + (1.96^2 \times 0.5^2) \approx 196$

Therefore, from the equation, the desired sample size was 196 respondents. These were obtained as 5443/ 8903 x 19 = 119.22 ≈ 119 for Kipsomba ward and 196-119= 77 for Soy ward. The Key informants involved; two crop officers, two National Cereal Board Officers, two Meteorologists, and one Environmental Officer and documentation of the adopted approaches to provide rich qualitative information to support primary data from interviews.

2.3 Data Collection

Primary data was collected using questionnaires and Key Informant Interview. Household questionnaires were administered to selected households targeting household heads. The questionnaires helped to gather data on effects of CSA on agricultural production and climate variability information. Besides the questionnaires, Key Informant Interviews were also conducted, with the six Key Informants who were chosen purposely to give insight information on adaptive approaches, agricultural production, rainfall amount, and distribution.

Secondary data was used to complement the survey data. The data included the interventions of the national and county government to improve farmers' livelihoods, rainfall data and information on climate variation.

3.1 Results and Discussion

3.2 Effects of Adoption of climate smart agricultural practices in Soy sub County

In order to analyze the effects of CSA on farming households in Soy sub –County descriptive statistics was used to analyze the data collected using farming household survey and the results presented in Table 1 . The result shown show that, 88.7% of the respondents indicated that with adoption of CSA practices there were positive effects as evidenced by the increased yields. Seventy-three percent (73%) of the farming households indicated that adoption of CSA leads to increased income, 96 % of the farming households opined that the adoption of CSA can control pest in farms, 99.93% also that the adoption of CSA control weeds in the farms. This result indicates that CSA can be an effective approach for improving food security and alleviating poverty in rural areas. The results concurs with the study by Mujeyi *et al.*(2021), who concluded that the factors such as the home head's education, labor size, and the implementation of CSA all had a substantial impact on household income.

Table 1: Data collected using farming household survey

Benefits of CSA	**Number of respondents (%)**
Increased yields	88.77
Increased income	73.46
Employment creation	7.65
Able to control pests	4.08
Able to control weeds	0.06
Totals	100

According to the study findings the soil management practices for CSA include; minimum tillage, agro-forestry practices, and crop rotation through compost, crop residues, and green manure. The practices also prevent the leaching of nutrients by erosion and better retention of soil moisture. Agro forestry leads to reduced soil and water erosion, increased yields of food, fodder, and fuel; however adoption of agro forestry worries farmers in that the introduction of some trees on farms can affect the growth of crops.

The study established that the main benefits of the adoption of CSA practices are, increased yields raised farm income, and increased food availability. It also indicates that farming households can be an effective part of the response to climate variability. This is an indication that CSA can be a useful approach for mitigating climate variability, building more resilient livelihoods, improving food security, and alleviating poverty. According to the key informants, most important achievement of the adoption of CSA is the integrated soil fertility through the increase of the soil organic matter status of the soil.

4.1 Conclusions and Recommendations

The adoption of CSA practices positively and negatively influence the livelihoods of farming households in Soy sub-County, the main achievements of the adoption of CSA is the increase of farm yields, yield stability due to the soil being well-drained, and having raised farm income due to reduced farming activity, for instance, minimum tillage where farmers can avoid the normal ploughing of land and just go for direct planting or plant after harrowing their land. However, the adoption of some CSA practices such as agro forestry had a negative effect where the planting of trees affect some of the growth of crops on the farm. Farmers need to advance in ways in which will lead them to strengthen the flexibility of farming communities and their livelihoods bring about this development through the introduction of useful climate-resilient and low carbon emission agricultural practices in farmer's land and adopting an extensive vision of agricultural growth that directly link farmers with policies and programs which will enable them to have suitable incentives to adopt new practices. Kenya has quite a lot of potential for CSA, but it needs to be explored extensively. CSA practices promotion requires concerted action from multiple actors to allow for context-specific approaches to be designed and implemented. Although the country has traditional agricultural practices as well as research-based programs and techniques that have CSA qualities, CSA practices promotion requires concerted action from multiple actors to allow for context-specific approaches to be designed and implemented.

The study recommends the Ministry Of Agriculture in consultation with County government to conduct a comprehensive analysis of Climate Smart Agriculture policies, programs, and institutional arrangements in the areas through generation of CSA research based evidences and uptake and up scaling CSA practices as best practices in Soy sub County Uasin Gishu County, Kenya.

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