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SOIL CONSERVATION TECHNOLOGIES FOR SUSTAINABLE CROP PRODUCTION IN KIPKELION, KERICHO COUNTY, KENYA

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Abstract:
Kenya depends on agriculture to feed its entire population, with maize as its staple food. However, this has been affected by increased climate change, evidenced by erratic rainfall, which has a direct effect on soil sustainability. This paper investigates soil conservation technologies for sustainable crop production in Kipkelion Constituency, Kericho County, Kenya. A cross-sectional research design using a descriptive approach was used in addressing the research question. The study targeted 394 respondents who included farmers, agricultural extension officers, and county officials, from whom data was collected through questionnaires, observation, and focus group interviews. Out of 394 questionnaires, 350 were returned for analysis. Data was processed using the Statistical Package for Social Science (SPSS), with descriptive and inferential statistics used to interpret results. From the study findings, the most commonly adopted soil conservation technique was strip cropping, with 56.6% of farmers showing a likelihood to practice it, while the least used method was no-tillage, with 64% of farmers indicating an unlikelihood to adopt this practice. Other techniques included improved tillage, conservation agriculture, and terracing. Legislative structures had a significant positive impact on the adoption of these technologies, as shown by a multiple regression analysis ($F = 78.745$, $p = 0.000$). The study noted a challenge of high investment costs and lack of technical support that necessitates greater involvement of agricultural extension officers to help farmers adopt soil conservation methods effectively. The study emphasizes the need for increased governmental and institutional support in promoting soil conservation practices, particularly by providing financial and technical assistance to farmers.

Keywords: soil conservation, technologies, sustainable agriculture, productivity, small-scale farmers, Kipkelion sub-county

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1. Introduction

Agricultural productivity in Sub-Saharan Africa remains low, largely attributed to traditional farming practices and limited innovation. Despite the region's growing population, food insecurity persists, exacerbated by the slow adoption of modern agricultural technologies. The African Green Revolution, proposed by Kofi Annan in 2004, aimed to enhance productivity using Africa's wide array of proven technologies but failed due to a lack of proper execution (Pawlak & Kołodziejczak, 2020). This has led scholars to argue for the need to modernize farming techniques, including adopting mechanization, improved seeds, and chemical fertilizers, and revising land tenure systems (Heumesser & Kray, 2019).

One of the challenges in Sub-Saharan Africa is the resistance to change among small-scale farmers. Traditional methods are deeply ingrained, with low use of fertilizers and mechanized techniques, leading to limited adoption of advanced technologies (Yengoh *et al.*, 2010). Additionally, soil erosion, land degradation, and climate change are significant contributors to food insecurity and rural poverty in the region (FAO, 2020). Thus, promoting sustainable agricultural practices is crucial to increasing productivity and protecting the environment.

About 4.4 million of Kenya's population is facing high levels of acute food insecurity, of which 17.5% percent are in the IPC AFI Phase 4 (Emergency) (Knowledge4Policy, 2023). This suggests a significant drop in the country's food production, affecting its population adversely. Kericho County is known for tea, maize, wheat, pineapples, and pyrethrum production, supplemented by dairy farming. However, according to the Kericho Annual Development Plan (2015), heavy rains in the region are a major challenge, causing soil degradation in areas with hilly landscapes like Sigowet in Belgut Sub County, Chilchila in Kipkelion Sub County and Ainamoi Sub County. It is for this reason that this paper addresses the urgency in the area-specific soil conservation measures. In this, the paper focuses on investigating the conservation technologies for sustainable crop production in the Kipkelion Constituency, Kericho County, Kenya.

2. Literature Review

Soil conservation is a set of practices aimed at preventing land degradation and improving soil quality over time (Olsson *et al.*, 2019). It enhances soil fertility, improves water retention, and reduces the need for chemical fertilizers. Technologies such as minimum tillage, crop rotation, contour farming, and agroforestry have been widely recognized for their ability to mitigate soil erosion, reduce pollution, and enhance biodiversity (Kust *et al.*, 2017). While these modern practices, according to Abbasian *et al.* (2017), are more enhanced to promote efficiency and effectiveness, the techniques have not been widely adopted in Sub-Saharan Africa due to socio-economic, institutional, and environmental factors (Kamara *et al.*, 2019).

Most agricultural lands in Africa are less than 5 acres and are often managed by rural small-scale farmers who rely on agriculture for their economic sustenance. The primary challenge facing most small-scale farmers is a lack of adequate funds that would help them improve their agricultural productivity, ensure food security, and boost their income (Kamara *et al.*, 2019). Despite these difficulties, the small-scale farmers make a substantial contribution to the rural economy and therefore actively contribute to conserving natural resources. Consequently, small-scale farmers are a crucial demographic to consider when striving to alleviate poverty, a fact that is well demonstrated in Kamara *et al.*'s (2019) work. They examined the significance of small-scale farming in Africa's developmental agenda, focusing on the challenges and prospects they encounter and their adoption of practices aligned with ecological and climate-smart agriculture, even in the absence of substantial public investment in this domain (Kamara *et al.*, 2019). Their findings indicated that agricultural activities of small-scale farmers can catalyze economic growth and overall development in Africa. Kamara *et al.* (2019) further recommend the need to direct adequate investments towards addressing the obstacles faced by these small-scale farmers. Thus, we cannot ignore the fact that the involvement of small-scale farmers when producing legislations on soil conservation initiatives determines its success.

Initially, according to Walie and Fisseha (2015), there were three ways in which soil conservation can be adopted and they included personal initiative, enrolling in a scheme or program, and compliance with set rules and regulations on soil conservation. However, despite the availability of many programs in agricultural technology, only a few end up being adopted, while others fail for lack of involvement of all stakeholders at the inception stage. For instance, farmers may perceive an innovative technology as imposing, especially when they lack understanding of the technology, hence increasing chances of resistance to adoption.

Most countries, especially in sub-Saharan Africa, have experienced little or no adoption of conservation technologies despite elevated levels of soil degradation and erosion (Abdul-Hanan, 2017). More so, farmers in developing countries have a low perception of modern technologies and therefore are attached to traditional farming methods which are characterized by low usage of chemical fertilizer, traditional seeds usage and zero tillage (Mango *et al.*, 2017).

Nevertheless, Kipsat *et al.* (2022) and Darkwah *et al.* (2019) have emphasized the need to adopt soil conservation technologies to maintain soil fertility, mitigate erosion, minimize pollution, and avoid degradation across the globe. While strip cropping, for instance, enables a combination of high and low-growing crops, contour farming is more efficient in sloppy areas with crop rotation encompassing a change in agro species in subsequent planting seasons (Ogunsola *et al.*, 2020). Their study also argues that fallows can be used by leaving the land to rest for some time from cultivation and instead is enriched with legumes to speed up soil fertility replenishment.

Other measures employed are of indigenous nature and include, agro forestry where farmers plant trees or shrubs strategically in the farms, minimum or no-tillage which limits soil disturbance during planting by digging a hole and inserting the seed and installation of physical structures such as building gabions, ridges, terraces, and drainages which are mainly used in sloppy areas (Kipsat *et al.*, 2022).

Small-scale farmers, who constitute a majority of agricultural producers in the region, face significant challenges, among them limited access to capital, information, and credit preventing them from adopting modern technologies. In many cases, farmers are wary of new methods, considering them risky and complex, especially when they are not adequately trained (Darkwah *et al.*, 2019). The lack of proper infrastructure and support systems further impedes the implementation of soil conservation practices (Mango *et al.*, 2017).

Despite these challenges, studies highlight the importance of adopting conservation technologies to maintain soil health, improve yields, and sustain livelihoods. Methods like strip cropping, terracing, and the use of organic fertilizers are being explored as potential solutions to the region's agricultural problems (Kipsat *et al.*, 2022). Additionally, integrating indigenous practices with modern technologies could enhance effectiveness and promote adoption among small-scale farmers (Ogunsola *et al.*, 2020).

3. Material and Methods

The study adopted a cross-sectional research design with a descriptive approach using both qualitative and quantitative data to directly explore in detail the study variables in gaining information that was used during analysis (Copper & Schindler, 2014). The descriptive research design is highly recommended by Babbie (2016), who opines that it is best fit for studies that seek to use the survey method in collecting data from a wide population coverage with standardized responses that ensure representation of responses in support of the procedures used in measuring the study variables (Babbie, 2016).

Carried out in Kipkelion West Sub County in Kericho County, Kenya, it was noted that the area is characterized by deep soil covers and buried horizons. However, most deforested areas in the area do not have buried horizons, presumably because they have been eroded through various practices, among them traditional methods of land cultivation and plantations that are export-oriented. The area is sparsely populated, and the general population is at 122, 530 according to the 2019 census results (KNBS, 2019). Kericho County receives abundant rainfall, averaging 1915mm per year, with the driest month being January with an average rainfall of 85mm, while April is the wettest with 265mm (Climates to travel, 2023). According to the KALRO (2015) report on topography and soil types conducted through KAINet, soils in Kericho County are reddish brown heavy clays weathered from phonolites. While studying land use effects on saturated hydraulic conductivity, soil infiltration, sorptivity, soil moisture retention and bulk density, Owuor *et al.* (2017) point out that the conservation of native forests and water resources are heavily impacted, thus the soil texture.

The target population constituted households, the county officials in the agricultural department and extension officers on the role they play in promoting soil conservation in the sub-county. According to the Population and Housing Census, (KNBS, 2019), the number of households in Kipkelion Sub County at the time of this study was 24,688, which represents the target population.

A random sampling technique was used to determine the participants, particularly in the representation of farmers. Yamane's (1967) formula, as cited by Anokye, was used to arrive at the sample size since it provides for the acceptable sampling error with 95% confidence level and 0.05 as the attribute in the selected population (Anokye, 2020). Hence:

$$n = \frac{N}{1 + N(e)^2}$$

N = 24,688, and
e = 0.05.

$$Population\ (n) = \frac{24{,}688}{(1 + 24{,}688(0.05)^2)}$$

n = 393.62.
Thus, Sample size = 394 farmers

Where, the error term (e 0.05) represents the desired precision level of the selected Data collection was done by administering questionnaires to the farmers. The questionnaires were used because they allowed assessing the large population with relative ease (Queirós *et al.* 2017). The qualitative research instruments included focus group interviews and on-farm observation. The focus group entailed conducting discussions in reference to the focus group questionnaire with selected farmers.

To assess different soil conservation technologies, both primary and secondary data were collected for analysis. The questionnaire contained closed-ended and open-ended questions on soil conservation technologies. A 5-point Likert scale was used to indicate the respondents' likelihood to which various soil technologies were practiced to promote sustainable soil conservation. Focus group interviews and discussions investigated the role played by the Kericho County in promoting sustainable soil conservation. On-farm observation focused on soil conservation technologies in the area (such as agronomic, strip cropping, and mulching), mechanical measures of soil conservation and erosion control, soil conservation status, threats to soil conservation, and land use systems in Kericho County.

Data obtained from the comprehensive survey questionnaires was analyzed using the Statistical Package for Social Sciences (SPSS), version 21. For descriptive analysis, the findings are presented in tables and charts using frequencies, percentages, means and standard deviation. On the other hand, inferential statistics were generated through multiple regression analysis at a p-value of <0.05 level of significance. The focus group discussions were analyzed through discourse analysis and using the participants' quotations and supporting them with previous studies and existing literature. On-farm observations complemented questionnaires and focus group findings through the pictorial presentation of the area.

4. Results and Discussion

4.1 Socio-demographic Characteristics

Objectively, it was necessary to ascertain the socio-demographic characteristics of the participants. The demographics constituted age, gender and education level of the respondents as presented in Figures 1, 2 and 3, respectively.

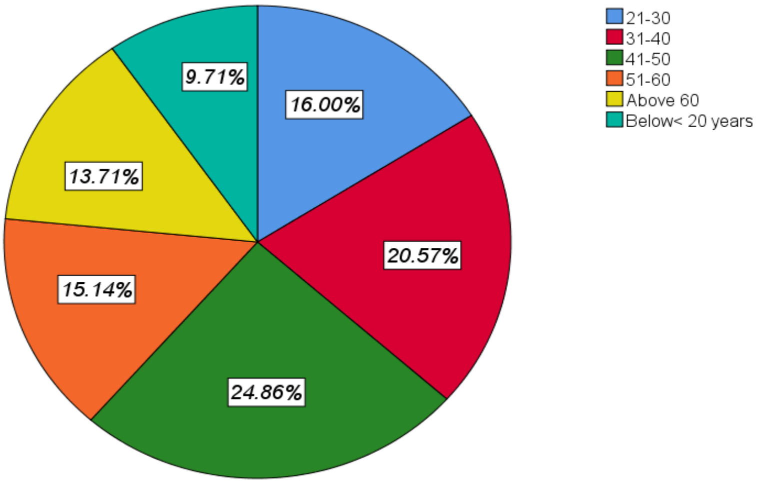

Figure 1: Age Distribution

Figure 1 indicates that most farmers were aged between 41 and 50 years, represented by 24.9%, followed by those aged between 31 and 40 years and 21-30 years at 20.6% and 16%, respectively. This implied that the majority of the sampled farmers in the Kipkelion sub-county were young adults. Nevertheless, quite a number were aged between 51-60 years and above 60 years, denoting 15.1% and 13.7% respectively. It was evident that youths are also coming up as farmers in the region as 9.7% of the respondents were aged below 20 years. The findings are consistent with Birch's (2018) report, which indicates that even though the average age of Kenyan farmers is 60 60years, over 75% of the farmers population in Kenya is below the age of 45 years.

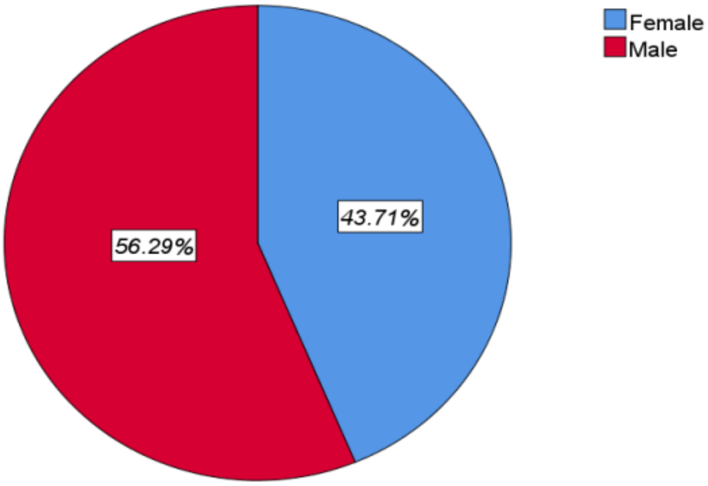

Figure 2: Gender of the Farmers

The results indicate that the majority of the respondents are male (56.3%), with a 43.7% female representation. This implies that more men than women were engaged in farming activities in the Kipkelion sub-county. In his study, Ongile found that licensing of tea growers in Kericho County favors men more than women as they are mostly the owners of land in the region. The findings are, however, not in tandem with the report presented to the OECD by Rozel (2021), identifying women as farmers who, in most developing countries, do a larger share of farming activities than men.

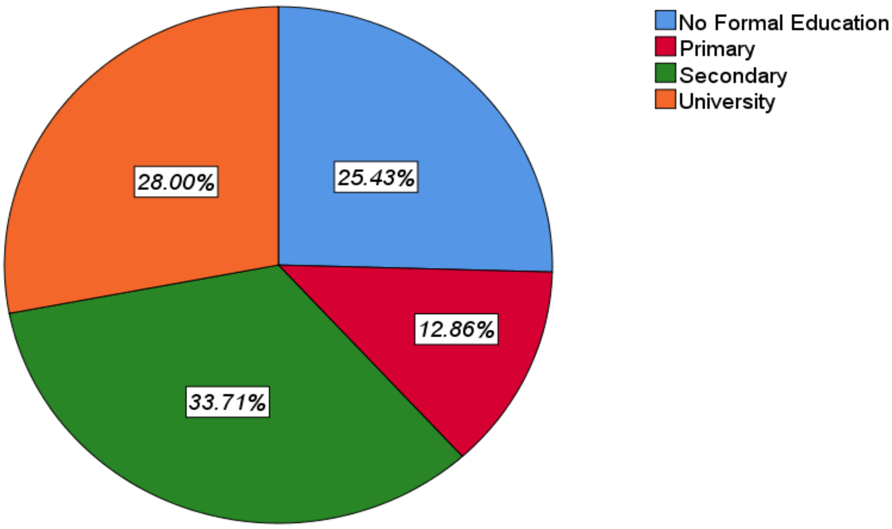

Figure 3: Respondents' education level

Education is considered a crucial element in economic development and, thus, a key factor in individuals' access and understanding of knowledge relating to soil conservation technologies. Figure 3 shows that most 33.7% of the farmers had attained a secondary level of education, followed by 28% of the farmers who had acquired a university degree. Only 12.9% had obtained basic primary education, with quite a number of 25.4% having no formal education.

4.2 Land Ownership

Table 1: Land Ownership in the Region

Item		Frequency	%	Min	Max	Mean	SD
Land Ownership (n=350)	Communal land	84	24.0	1	4	2.37	1.062
	Family/Ancestral land	124	35.4				
	Leased land	70	20.0				
	Own land	72	20.6				

The responses on land ownership were average depicted by (M=2.37; SD 1.062). The findings show that most of the lands in Kipkelion are family/ancestral owned, representing 124 (35.4%) of the respondents. Seventy-two 72(20.6%) of the respondents admitted to owning land, which would have been obtained through purchase or gifting, while 70 (20%) indicated that they leased land. Quite a number of the respondents had communal illustrated by 84(24%) of the farmers. As shown in Table 1, it should be noted that Kenya's just like other African countries, has most of its lands being owned communally and unregistered, implying that the land was acquired or transferred under customary/generational tenure, a system that has survived through to the 21st century (Alden, 2015). Alden (2018) portrays land laws referring to customary or communal land as being community land.

4.3 Adoption of Soil Conservation Technologies

The objective of this study was to determine whether the farmers in the Kipkelion sub-county employed the use of various soil conservation technologies. By stating technologies, the respondents were asked to indicate the likelihood of engaging various soil conservation technologies on their farms, as shown in Table 2.

Table 2: Adoption of Soil Conservation Technologies

Statement	5	4	3	2	1	Min	Max	Mean	SD
No Tillage Technique	87(24.9%)	224(64%)	23(6.6%)	5(1.4%)	11(3.1%)	1	5	4.06	.808
Improved Tillage Practice	67(19.1%)	195(55.7%)	26(7.4%)	50(14.3%)	12(3.4%)	1	5	3.73	1.037
Conservation Agriculture	48(13.7%)	149(42.6%)	75(21.4%)	53(15.1%)	25(7.1%)	1	5	3.41	1.118
Strip cropping	10(2.9%)	34(9.7%)	16(4.6%)	198(56.6%)	92(26.3%)	1	5	2.06	.976
Terracing	61(17.4%)	181(51.7%)	32(9.1%)	61(17.4%)	15(17.4%)	1	5	3.61	1.094

Key: n- Sample Size, Min- Minimum, Max- Maximum, SD-Standard deviation
Source: Author (2023)

The responses were given on a Likert scale of 1-Very likely, 2-Likely, 3-Neutral, 4-Unlikely and 5-Very Unlikely.

With respect to the farmers' responses on their likelihood to practice sustainable soil conservation technologies, Table 2 shows that on average, the farmers would sometimes employ specific soil conservation techniques. With a representation of (M=2.06; SD=.976), the likelihood of farmers practicing strip cropping was higher than all other conservation techniques highlighted. In this case, more than half, 198(56.6%), of the respondents said that it was likely that they practice strip cropping while 92 (26.3%) were very likely to practice strip cropping. Only 10(2.9%) of the farmers indicated that they were very unlikely to adopt strip cropping as a soil conservation method.

The least used soil conservation technique was no tillage technique with more than half of the respondents, 224(64%), pointing out that they were unlikely to use no tillage technique. Quite a number of them were very unlikely to use the no-tillage technique 87(24.9%) with only 5(1.4%) and 11(3.1%) showing that they were likely and very likely to use no-tillage technique. The average score of (M=4.06; SD= .808) was skewed towards the unlikelihood of the farmers using this technique. Nevertheless, 23(6.6%) of the farmers gave a neutral response to using no tillage technique, an impression that they were not sure whether they would practice it or not. It would be noted that such a response can be attributed to the large number of farmers who lacked formal knowledge and therefore would also lack the knowledge of what these soil conservation techniques are.

Nevertheless, the farmers were more likely to practice improved tillage denoted by 50(14.3%) and 12(3.4%) who indicated likely and very likely respectively as opposed to those who were likely to adopt tillage technique 5(1.4%). With improved tillage, however, there was still a large number of farmers, 195(55.7%), who were unlikely to practice the soil conservation technique. On average, (M=3.73; SD=1.037) indicated low levels of farmers adopting improved tillage technique while 26(7.4%) of them provided a neutral response indicating that they were neither likely nor unlikely to practice improved tillage.

Conservation Agriculture was another soil conservation technique (M=3.41; SD=1.118) that farmers in Kipkelion rated as being unlikely and very unlikely to be adopted 149(42.6%) and 48(13.7%), respectively. The highest number among our respondents being neutral about adopting any of the five soil conservation technologies was highlighted by 75(21.4%) in conservation agriculture. This could imply that for most of the techniques highlighted, the farmers could know little information on conservation agriculture. Therefore, they were neither likely nor unlikely to adopt it as a soil conservation technique.

However, a commonly known technique in farming, more than half of the respondents, 181(51.7%), were unlikely to use terracing while 61(17.4%) were very unlikely. Only 61(17.4%) and 15(17.4%) affirmed that they were likely and very likely to practice the terracing technique, respectively, with a mean of (M=3.61; SD=1.094). From the foregoing results, it cannot be concluded that farmers in the Kipkelion sub-county do not completely practice soil conservation technologies or do not fully practice them. This can be explained by the findings of Walie and Fisseha (2015), who argue that despite the availability of several soil conservation technologies, only a few are adopted, while others fail due to various factors, such as farmers' lack of understanding of the technology.

In addition, the study conducted by Kiboi *et al.* (2017) in the central highlands of Kenya indicated that different soil conservation technologies present varying characteristics like compatibility, trialability, relative advantage, observability and complexity that may largely influence their adoption by farmers. These attributes may play a significant role in the objective determination of which technologies to adopt for soil conservation in Kipkelion, thus the highly unlikely responses provided by the farmers for lack of adequate knowledge on the methods. Consequently, all the soil conservation technologies, including improved tillage practice, conservation agriculture, strip cropping, and terracing, were practiced by farmers in Kipkelion Sub County at different levels. In particular, no tillage, improved tillage practice, conservation agriculture, and terracing are unlikely practiced in Kipkelion. However, there is a high probability of practicing strip in the region. The participants cited high investment costs, labor challenges, and lack of technical support as the reasons for not practicing soil conservation technologies.

4.4 Importance of adopting soil conservation technologies

Given the responses provided by the farmers on their likelihood of practicing soil conservation technologies, it was necessary to establish whether the farmers had accorded some importance to specific conservation technologies. The findings are shown in Table 3.

Table 3: Descriptive Statistics on the Importance of Soil Conservation Technologies

	Frequency	Percent	Min	Max	Mean	SD
Very Bad	44	12.6	1	6	3.11	1.222
Bad	35	10.0				
Average	169	48.3				
Good	56	16.0				
Very Good	31	8.9				
Excellent	15	4.3				
Total	**350**	**100.0**				

The results are indicative of the farmers' perception of the importance of soil conservation technologies. According to the farmers, soil conservation technologies were averagely rated (M=3.11; SD=1.222) as almost half, of them, 169(48.3%), said the technologies are average. This was followed by 56(16%) of the respondents who rated the soil conservation technologies as good, with 31(8.9%) and 15(4.3%) saying the technologies are very good and excellent, respectively. However, 44(12.6%) of the farmers considered the use of soil conservation technologies as being very bad, and 35(10%) were of the opinion that it is bad.

While these findings attach some importance to the adoption of various soil conservation technologies in Kipkelion sub county 169(48.3%), it is no doubt that some farmers consider these technologies as not being important, depicted by the 44(12.6%) who rated as very bad. In the same vein, while scholars like Ojo *et al.* (2019) and, Abdulai and Huffman (2014) have largely explored the importance and impact of soil conservation technologies intimating its high link to improved sustainability, land over use brought about by adoption of some of these technologies also impact negatively on the farms thus the lack of adoption. Excessive land use through tillage techniques can exacerbate soil erosion due to increased human activities, hence depleting the natural vegetation cover (Feeney *et al.*, 2023). Ogunsola *et al.* (2020) emphasize the need to adopt soil conservation technologies to maintain soil fertility, mitigate erosion, minimize pollution and avoid degradation.

4.5 Forms of Soil Conservation Technologies Used in Kipkelion

Objectively, this section presents results on the physical/mechanical soil conservation technologies used by farmers in Kipkelion, the vegetative structures, soil fertility practices and crop management practices employed by the farmers.

Table 4: Soil Conservation Methods in Kipkelion

Soil Conservation Methods	Frequency	Percent
Physical/mechanical technologies		
Contour bunds	87	24.9%
Surface D/Ways	58	16.6%
Terraces	92	26.3%
Trenches	113	32.3%
Vegetative structures		
Cover crops	95	27.1%
Grass bunds	63	18.0%
Mulch	87	24.9%
Others	23	6.6%
Trees	71	20.3%
Woodlots	11	3.1%
Soil fertility practices		
Animal manure	72	20.6%
Chemical fertilizers	56	16.0%
Cover crops	62	17.7%
Crop rotation	58	16.6%
Intercropping	95	27.1%
Others	7	2.0%
Crop management practices		
Planting on raised beds	121	34.6%
Row planting	229	65.4%
Total	**350**	**100.0%**

From the foregoing, the use of trenches was identified as the most 113(32.3%) used form of physical/mechanical soil conservation method followed by terracing 92(26.3%) and contour bunds 87(24.9%). D/Ways only took a small percentage. On the use of vegetative structures, the largest population of farmers performed cover crops 95(27.1%) with 87 (24.9%) and 71(20.3%) considering mulching and tree planting as a soil conservation method, respectively. At least 63(18%) of the farmers admitted that they used grass bunds and woodlots 11(3.1%). This agrees with the findings of Garrity *et al.* (2017). The study explored the development and spread of a conservation farming system based on natural vegetative contour buffer strips in smallholder production systems in Southeast Asia. In another study, Garrity *et al.* (2017) opines that the use of natural vegetative buffer strips among smallholder farmers in Asia gradually increased the crop yield with an estimated benefit of 0.5 t/ha/crop. Notably, this study indicates that farmers in the Kipkelion sub-county would adopt not only one but several soil conservation technologies depending on their level of necessity and importance. This finding is in congruence with the results of Willy, Zhunusova and Holm-Müller (2014), who establish a significantly positive impact of adopting multiple soil conservation technologies on crop productivity among farmers in Lake Naivasha basin, Kenya.

Soil conservation is often conducted to enhance the fertility of the soils; thus, it was deemed necessary to establish how farmers increased the fertility of their soils. Intercropping 95(27.1%) was identified as the soil fertility method used by the majority of the farmers while 72(20.6%) preferred animal manure to chemical fertilizers 56(16.0%). Other methods through which the farmers retailed the soil fertility were cover crops 62(17.7%) and crop rotation 58(16.6%). Improving and retaining soil fertility is one of the significant aspects of farming as it helps in providing the essential plant nutrients that help in their growth sustainability (Rusoke, 2017), while some soil fertility methods help to control pests (Altieri, Ponti, & Nicholls, 2012). According to Altieri *et al.* (2012), intercropping and the use of cover crops help in controlling pests in farms to enhance plant nutrition and control pests. They also argue that the use of organic fertilizers like animal manure increases natural pest control. In support of these findings is also the study by Nandjui *et al.* (2018), which found out that soil fertility by use of fertilizers had nothing to do with borer infestation and thus plants' survival was through increased plant nitrogen content.

In focused group representation, the participants were asked about soil conservation technologies in their area. Their responses revolved around strip cropping, terracing, trenching, use of contour bunds, mulching, tree planting, intercropping, crop rotation, row planting, and planting on raised beds. This shows that the participants were aware of the technologies that can be used to conserve soil, although some, such as the no-tillage technique and surface D/Ways are uncommon in their area. Besides the participants' mentioned soil conservation technologies, others include agro forestry where farmers plant trees or shrubs strategically in the farms, minimum or no-tillage which limits soil disturbance during planting by digging a hole and inserting the seed, and installation of physical structures such as building gabions, ridges, terraces, and drainages common in sloppy areas (Kipsat *et al.*, 2022).

5. Conclusion

Farmers in Kipkelion use a mix of soil conservation techniques, but adoption is influenced by factors such as knowledge, costs, and labor. This study finds that soil conservation technologies are practiced in Kipkelion, Kericho county, although the adoption rate is moderate as some farmers do not see the need to do so. No tillage technique, improved tillage technique, conservation agriculture, strip cropping, terracing, trenches, contour bunds, surface D/Ways, row planting, planting on raised beds, crop rotation, intercropping, and use of vegetative structures such as cover crops, mulch, trees, grass bunds, and woodlots are among the soil conservation technologies used. Nevertheless, some soil conservation technologies are practiced more than others. Some of the reasons leading to moderate adoption of soil conservation technologies as established in the initial research from which this paper is drawn include minimal training from legislative institutions, lack of technical support, fear of crop yield reductions, and high-investment costs.

6. Recommendations

From the foregoing, this study recommends the following:

1) Strengthening of institutions by enhancing the roles of research stations, NGOs, and community organizations in providing ongoing training on soil conservation technologies.
2) Develop a frequent training program by implementing systematic training programs tailored to farmers' needs. This could involve a shift from annual to monthly training sessions to improve adoption rates.
3) Creating a clear legislative framework that promotes soil conservation to leverage existing national policies.

7. Recommendations for Further Studies

1. The study recommends having a broader geographical scope in future research. Thus, future studies should be extended to other sub-counties in Kericho (e.g., Belgut, Ainamoi) to gather comprehensive data on soil conservation practices across the region.
2. This study was a cross-sectional one; thus, the author recommends considering future longitudinal studies. Studies should be conducted over more extended periods to assess the adoption of soil conservation technologies before and after the implementation of support programs.

Conflict of Interest Statement

The author declares no conflicts of interest related to this manuscript. The author also confirms that all intellectual property rights, including but not limited to copyrights, have been appropriately assigned or licensed to the publisher, and that there are no competing interests in the publication, dissemination, or commercial use of the research findings.

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The author is an environmental professional with interests in soil conservation, sustainable agriculture, green spaces and the development of resilient urban environments; passionate about building climate-smart cities through strategic conservation efforts and cross-sector collaboration. With a strong background in environmental social science and urban sustainability, Maureen has participated in several workshops and conferences seeking to integrate nature-based solutions into city systems, promoting food security, enhancing biodiversity and green infrastructure.

References

Abbasian, A. Chizari, M., & Bijani, M. (2017). Farmers' views on the factors inhibiting the implementation of soil conservation practices in Koohdasht, Iran. *Journal of Agricultural Science and Technology 19*(4), 797-807. Retrieved from https://jast.modares.ac.ir/article-23-4727-en.pdf

Abdul-Hanan, A. (2017). Determinants of adoption of soil and water and conservation techniques: Evidence from Northern Ghana. *International Journal of Sustainable Agricultural Management and Informatics, 3*(1), 31-43. Retrieved from http://dx.doi.org/10.1504/IJSAMI.2017.10003795

Abdulai, A. & Huffman, W. (2014). The adoption and impact of soil and water conservation technology: an endogenous switching regression application. land economics, 90, 26-43. https://doi.org/10.3368/le.90.1.26

Alden W. L. (2018). Collective land ownership in the 21st century: Overview of global trends. *Land, 7*(2), 68.

Alden W.L. (2015). Estimating national percentages of indigenous and community lands: methods and findings for Africa. LandMark: The Global Platform of Indigenous and Community Lands. Retrieved from http://communityland.s3.amazonaws.com/LandMark_public/LandMark-MethodsPercentage_Africa01Nov15.pdf

Altieri, M.A., Ponti, L., Nicholls, C.I., (2012). Soil fertility, biodiversity and pest management. In: Gurr, G.M., Wratten, S.D., Snyder, W.E., Read, D.M.Y., (eds.), *Biodiversity and Insect Pests: Key Issues for Sustainable Management.* John Wiley & Sons, Chichester, DOI: 10.1002/9781118231838.ch5

Anokye, M. A. (2020). Sample size determination in survey research. *Journal of Scientific Research and Reports 26*(5), 90-97. https://doi.org/10.9734/jsrr/2020/v26i530263

Babbie, E.R. (2016). *The practice of social research. 14th Edition*. Cengage Learning, Belmont. Retrieved from https://www.cengage.com/c/the-practice-of-social-research-14e-babbie/9781305104945/

Birch, I. (2018). *Agricultural productivity in Kenya: barriers and opportunities.* The K4D Helpdesk report.

Climates to travel, 2023. *Climates to travel.* [Online] Retrieved from https://www.climatestotravel.com/climate/kenya/kericho#:~:text=Kericho%20%2D%20Climate%20data&text=Here%20are%20the%20average%20temperatures.&text=Precipitation%20amounts%20to%201915%20millimeters,the%20wettest%20one%20(April).

Commodities Fund (2016). Kipkelion farmers get kshs. 55.8 million for coffee. *Newsletter issue 1 January – March.*

Cooper, D.R., & Schindler, P.S. (2014). *Business research methods. 12th edition*. McGraw Hill International Edition, New York. Retrieved from https://contents.lspr.ac.id/2022/05/Donald-R-Cooper-Pamela-S-Schindler-Business-Research-Methods.pdf

Darkwah, K. A., Kwawu, J.D., Agyire-Tettey, F. & Sarpong, D.B. (2019). Assessment of the determinants that influence the adoption of sustainable soil and water conservation practices in Techiman Municipality of Ghana. *International Soil and Water Conservation Research 7* (2019) 248-257. http://dx.doi.org/10.1016/j.iswcr.2019.04.003

FAO (2020). *Three principles of conservation agriculture: minimum mechanical soil disturbance.* FAO Rome.

Feeney, J., C. Robinson, D. A. Keith, A. M., & Vigier, A. (2023). Development of soil health benchmarks for managed and semi-natural landscapes. *The Science of The Total Environment 886*(6235), 163973. http://dx.doi.org/10.1016/j.scitotenv.2023.163973

Garrity, D., Dixon, J. & Boffa, J.-M. (2017). Understanding African farming systems as a basis for sustainable intensification. IN: Öborn, I., Vanlauwe, B., Phillips, M., Thomas, R., Brooijmans, W. and Atta-Krah, K. (eds.), Sustainable intensification in smallholder agriculture: An integrated systems research approach. London, UK: Routledge: 58-70.

Heumesser, C., & Kray, H. A. (2019). *Productive diversification in African agriculture and its effects on resilience and nutrition.* International Bank for Reconstruction and Development / World Bank. Retrieved from https://www.worldbank.org/en/topic/agriculture/publication/productive-diversification-of-african-agriculture-and-effects-on-resilience-and-nutrition

KALRO (2015). *Topography and soil types.* Kenya Agricultural Research Institute

Kamara, A., Conteh, A., Rhodes, E.R., & Cooke, R.A. (2019). The relevance of smallholder farming to African agricultural growth and development. *Afr J Food Agric Nutr Dev*, *19*(1), 14043-14065. Retrieved from https://www.ajol.info/index.php/ajfand/article/view/185577

Kericho Annual Development Plan (2015). *Kericho County Annual Development Plan 2015/2016. Public Policy Repository, County Government of Kericho.* Retrieved from http://10.0.0.19/handle/123456789/1055

Kiboi, M., Kipchirchir , F., Ngetich, J. D., Mucheru-Muna, M. (2017). Minimum tillage, tied ridging and mulching for better maize yield and yield stability in the Central

Highlands of Kenya. *Soil and Tillage Research* *170*,157-166. http://dx.doi.org/10.1016/j.still.2017.04.001

Kipsat, M., Bwari, M., & Osewe, D. (2022). *A binomial logit analysis of factors affecting adoption of soil conservation structures in Kericho County, Kenya.* https://doi.org/10.7176/EJBM/14-5-01

KNBS (2019). *Kenya population and housing census.* Retrieved from https://www.knbs.or.ke/constituency-population-by-sexnumberofhouseholds-area.

Knowledge 4 Policy, 2023. *Kenya: Acute Food Insecurity Situation February 2023 and Projection for March - June 2023.* [Online] Retrieved from https://knowledge4policy.ec.europa.eu/publication/kenya-acute-food-insecurity-situation-february-2023-projection-march-june-2023_en#:~:text=In%20the%20current%20period%2C%20it,AFI%20Phase%204%20(Emergency).
[Accessed 29 August 2023].

Kust, G., Andreeva, O. & Cowie, A. (2017). Land degradation neutrality: Concept development, practical applications, and assessment. *Journal of Environmental Management 195*(1). https://doi.org/10.1016/j.jenvman.2016.10.043

Mango, N., Makate, C., Tamene, L., Mponela, P., & Ndengu, G. (2017). Awareness and adoption of land, soil and water conservation practices in the Chinyanja Triangle, Southern Africa. *International Soil and Water Conservation Research, 5*(2), 122-129. https://doi.org/10.1016/j.iswcr.2017.04.003

Nandjui, J., Armand, A.N., Kouadio , K.T., & N'gouandi, M.A. (2018). Impact of Soil Fertility Management Practices on Insect Pests and Diseases of Maize in Southwest Cote d'Ivoire. *Journal of Applied Biosciences 127*(1), DOI:10.4314/jab.v127i1.6

OECD (2021). *Adoption of technologies for sustainable farming systems.* Wageningen Workshop Proceedings. Paris. Retrieved from https://books.google.ro/books/about/Adoption_of_Technologies_for_Sustainable.html?id=PoptMgAACAAJ&redir_esc=y

Ogunsola, O. A., Adeniyi, O. D., & Adedokun, V. A. (2020). Soil management and conservation: An approach to mitigate and ameliorate soil contamination. In M. L. Larramendy, & S. Soloneski (Eds.), *Soil Contamination - Threats and Sustainable Solutions.* Intech Open. https://doi.org/10.5772/intechopen.94526

Ojo, T.O., & Baiyegunhi, L.J.S., (2020a). Determinants of climate change adaptation strategies and its impact on the net farm income of rice farmers in south-west Nigeria. *Land Use Policy, 95*(C). https://doi.org/10.1016/j.landusepol.2019.04.007

Olsson, L., Barbosa, H., Bhadwal, S., Cowie, A., Delusca, K., Flores-Renteria, D., Hermans, K., Jobbagy, E., Kurz, W., Li, D., Sonwa, D.J., & Stringer, L., (2019). Land Degradation. In: *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems.* Lund University Centre for Sustainability Studies, 184 p.

Owuor, M.A., Icely, J., Newton, A., Nyunja, J., Otieno, P., Tuda, A.O., & Oduor, N. (2017). Mapping of ecosystem services flow in Mida Creek, Kenya. Ocean & Coastal Management, 140, 11-21.

Pawlak, K., & Kołodziejczak, M. (2020). *The role of agriculture in ensuring food security in developing countries: considerations in the context of the problem of sustainable food production.* Sustainability 2020, 12, 5488. https://doi.org/10.3390/su12135488

Queirós, A., Faria, D. & Almeda, F. (2017). Strengths and limitations of qualitative and quantitative research methods. *European Journal of Education Studies, 3*(9), http://dx.doi.org/10.5281/zenodo.887089.

Walie, S. D., & Fisseha, G. (2015). Evaluation of land use types and physical soil and water conservation structures in Wyebla Watershed, Northwest Ethiopia. *The International Journal of Environmental Protection* *6*(1), 90-96. http://dx.doi.org/10.5963/IJEP0601008

Willy, D. K., Zhunusova, E., & Holm-Müller, K., (2014). Estimating the joint effect of multiple soil conservation practices: A case study of smallholder farmers in the Lake Naivasha basin, Kenya. Land Use Policy, 39, 177-187.

Yengoh, G. T., Ato Armah, F., & Mats, S. (2010). *Technology adoption in small-scale agriculture.* http://dx.doi.org/10.17877/DE290R-8685