Climate Smart Agriculture and its Implication on Climate Change Adaptation Measures within Smallholder Farming Systems in Gatundu South, Kenya

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Abstract

The impacts of climate change and the need for implementing adaptation and mitigation measures continues to dominate global environmental dialogue, with the Africa Climate Summit 2023 and Conference of Parties 28 being the most recent in this series. A hitherto marginalised aspect is the level of adoption of climate-smart agriculture practices in smallholder production systems. This study explored this dimension using Gatundu South as a case study. Rainfall data was obtained from the Climate Hazards Group Infrared Precipitation with Station data. Socio-economic data targeting 384 respondents was collected using questionnaires. Standard procedures were used to analyse these data. Results showed that farmers are generally aware of climatic variability especially as evidenced by changes in rainfall patterns. Farmers adapt and attempt to mitigate effects of climate change and variability by using practices that deliver direct economic benefits and not necessarily the climate-smartness of the practices. Farmers did not associate their adaptation measures with the need to reduce emission of greenhouse gasses. To smallholder farmers, direct economic benefits are the primary incentives for the adoption of climate-smart practices. Further, the link between climate change and the invisible greenhouse gases is a knowledge gap among smallholder farmers. Therefore, adoption of climate smart agriculture practices can be enhanced if the narrative shifts to emphasise the negative contribution of greenhouse gases to farmers' health and the concomitant medical costs, through their role in exacerbating air pollution.

Keywords: Climate Smart Agriculture, Adaptation Measures, Smallholder Farmers

Introduction

The debate on climate change and its consequences on human well-being, including on agricultural production and other development issues shall be with us for a long time (Khatri-Chhetri *et al.*, 2017; Wreford *et al.*, 2017; UNEP, 2023). Efforts to address the threat of climate change to the global population have gained momentum from the establishment of the signing of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, the Kyoto Protocol in 1997 and the Paris Agreement in 2015. It widely acknowledged that climate change is responsible for increasingly unpredictable variations in temperature and rainfall patterns in the Horn of Africa, a trend that is only expected to intensify. According to UNICEF (2022), over 20 million people in Djibouti, Eritrea, Ethiopia, Kenya, and Somalia, including 10 million children, are still threatened with water and food insecurity due to drought, insecurity, economic challenges, and conflict. With increasingly population particular in developing nations, both the global and local food footprints are bound to expand thus increasing the contribution of agriculture to global environmental changes (Fellmann et al., 2018; Agesa *et al.*, 2019). While the bulk of greenhouse gas (GHG) emissions is through industrialization value-chains powered by fossil fuels, agriculture generates only 19-29% of the total GHG emissions (World Bank, 2021), yet bears the brunt of its impacts. Regional trends however show that emissions due to agriculture in Africa increased during the 2000–2018 period, reaching 24% of world total agricultural emissions in 2018, up from 18% in 2000 (FAO, 2020). Since the bulk of agriculture is at small-scale farming and largely in rural areas, investing in mitigation and adaptation measures at the farm level and related land use changes merit urgent attention in Africa's climate change policy frameworks.

The frequency of severe droughts, famines, water scarcity, devastating floods, heat waves, rising sea levels, shifting seasons, and extreme heat waves and wildfires that have devastated forests in the Americas and Europe, and violent storms that bombard coastal cities around the world (World Meteorological Organization, 2023), point to a disconnect between talk and actions when it comes to actualising global dialogue outcomes around climate change and global warming. While Africa appears to have been spared such extreme climatic events, there occurrence would be a disaster of imaginable proportions given the wanting state of disaster preparedness in most counties in the continent. If nothing tangible is done a rise in the world's average surface temperature beyond 3°C in the twenty-first century is very likely, with the consequence of destroyed ecosystems and hence human civilizations (Obergassel, 2018). This anticipatory scenarios analysis is responsible for the emerging use of eschatological terms like climate catastrophes or climate apocalypse in attempts to mobilise global unit of purpose and resources against climate change (Kemp *et al*, 2022; Scholarly Community Encyclopaedia, 2022). Again, whether use of "extreme fear" can galvanise envisaged collective action remains an open question. Just as industrial pollution through emission of GHGs remains a challenge in developed nations, destruction of carbon sinks through extensive agriculture remains a challenge in developing nations. In this sense, different strategies and approaches are needed going forward. Magnifying the relationship between climate change and human health through atmospheric pollution (emission of noxious gases, which include GHGs) is a dimension already recognised (World Health Organization, 2023). By implication, pursuing this dimension is most likely to attract the attention of grassroots stakeholders (i.e. land users) and hence their governments. Action plans could then be cascaded to regional and global levels through the laid down protocols.

Africa is clearly the most vulnerable continent to climate change and its impacts due to among other factors its high poverty levels and inadequate governance, policy and institutional frameworks (Wreford *et al.*, 2017). Despite contributing the least to global warming and having the lowest emissions, Africa faces exponential collateral damage, posing systemic risks to its economies, infrastructure, water and food systems, public health, and livelihoods (Africa Development Bank Group, 2023). This in part explains why the Africa Climate Summit ended by calling for among others a more just climate mitigation and adaptation financing system that reduces the unfair burden imposed on Africa by the biggest emitters of greenhouse gases (African Union, 2023). Such climate financing is meant to be part and parcel of an integrated approach supporting various initiatives like robust early warning systems and climate advisories, decarbonisation of industrial systems through reduced reliance on fossil fuels, enhanced carbon credit trading and increased investment in clean renewable energy sources. Ironically only 40% of the African population has access to early warning systems (ReliefWeb, 2023), which exacerbates the vulnerability of the continent to the negative impacts of climate change. This brings to the fore the need for progressive shifts in narratives away from developed nation as culprits and developing nation as victims to collaborative action plan with emphasis on financing grassroots solutions by leveraging on indigenous knowledge systems, which have from time immemorial integrated environment-smart practices, where-in is climate smart agriculture as well.

Inherent in FAO (2023) definition of climate smart-agriculture (an approach that helps guide actions to transform agri-food systems toward green and climate resilient practices) is the need to increase agricultural productivity and incomes, adapting and building resilience of people and agri-food systems to climate change, and reducing and or removing greenhouse gas emissions where possible. Increasing agricultural productivity and incomes is what farmers struggling to enhance their well-being easily resonate with. While their practices at the farm may entail elements of being climate smart, the yield aspect remains core to their ultimate goal. Also what modern science categorises as climate-smart agricultural practices, may not be new in rural farming communities in Africa. For example, in Somalia over 80 practices which by default met the CSA criteria were identified and classified into seven major categories (crops, livestock, energy, soils, water, forestry and aquaculture) with various sub-categories (FAO, 2021). Such an expanded categorisation further supports the thesis of changing the narrative from climate-smart to perhaps environment-smart where-in climate-smart practices will be part and parcel.

Finally, it should be emphasised that empowered farmers through access to education (Kiyingi *et al.*, 2017), information and knowledge (Khatri-Chhetri *et al.*, 2017), and higher incomes (Marie *et al.*, 2020), are likely to more readily adopt climate smart agricultural practices when appropriately packaged and disseminated (Abegunde & Sibanda, 2018). This position is also held by UNESCO (2019), which affirmed that climate change is the defining challenge of this time in history and education is an essential element for mounting an adequate response to it (UNESCO, 2019). As such, the main objective of this study was to assess the status of climate-smart agriculture practices in the context of climate response mechanisms using Gatundu South in Kenya as a case study. The main research question was to determine the extent to which farmers use climate-smart agriculture practices as adaptation and or mitigation measures against the negative impacts of climate change and variability. The ensuing knowledge would add to policy and technical measures continuously being developed at various levels (national, regional and global) to align agriculture to environmental sustainability and human-well-being.

Methodology

Study Area Characteristics

This study was conducted in the four wards of Gatundu South Constituency of Kiambu County namely; Kiamwangi, Kiganjo, Ndarugo and Ng'enda (Figure 1). Gatundu South lies in the lower highland zone, which is characterized by hills, plateaus, and high-elevation plains. The altitude ranges from 1500-1800 metres above sea level. In terms of agro-climatic zonation, this area is a high potential zone with nitisols as the dominant soil type. As such it is generally a tea and dairy zone though some activities like maize, horticultural crops and sheep farming are also practiced (County Government of Kiambu, 2018). Majority of residents are small scale farmers, taking advantage of the areas proximity to ready market from surrounding urban and peri-urban settlements for intensive commercial agriculture.

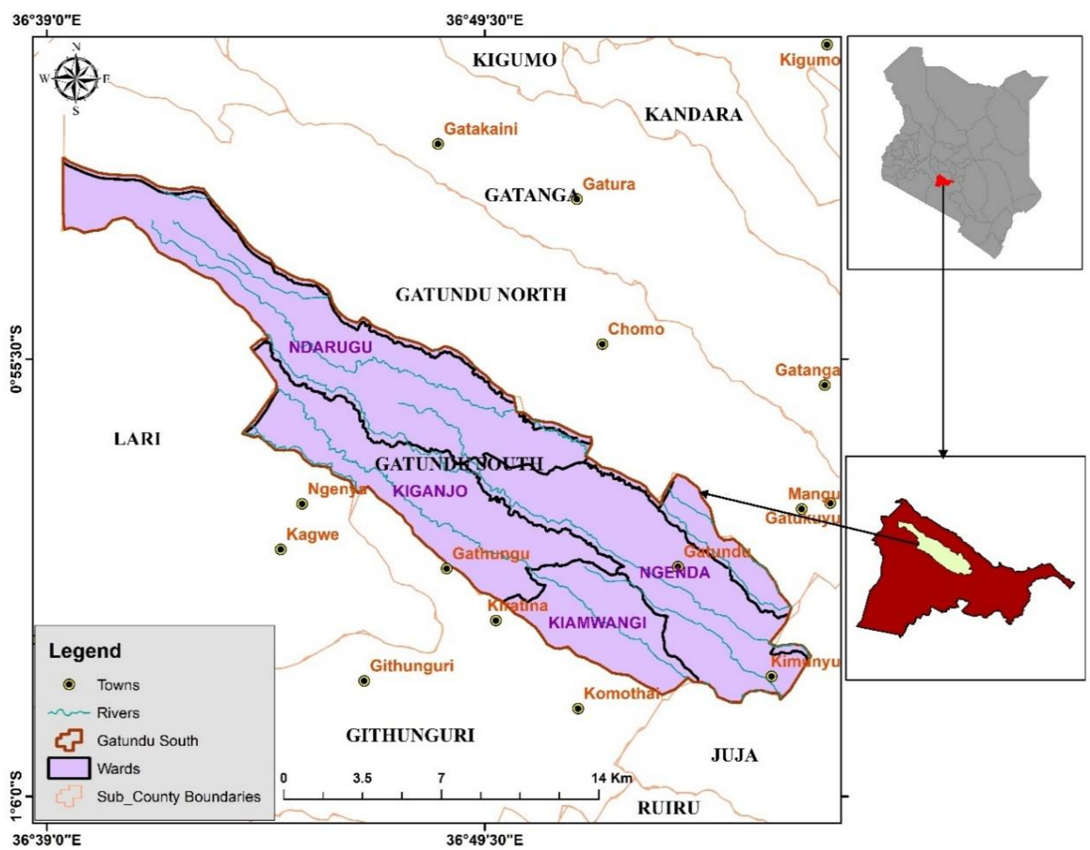

Figure 1: Location of The Study Area

Research Design and Data Management

This study was based on an exploratory survey design that involved collecting data from a representative sample using a questionnaire to describe general trends on selected variables under study. The standard Fischer Formula as described by Charan and Biswas (2013) was used to compute the sample size, thus:

$$n = Z^2pq/d^2$$

Where:

n = sample size

Z = standard normal variate, which at 95% confidence level = 1.96

p = estimated proportion of an attribute that is present in the population in this case (at least 50%)

q=1-p, and

d = Absolute error or precision desired set at α=0.05

$$\text{Accordingly, } n = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384$$

This sample size was proportionately distributed across the Wards as shown in table 1 below.

Table 1: Distribution of Sample Size Across the Wards

Ward	Kiamwangi	Kiganjo	Ndarugo	Ng'enda	Total
Estimated Population	20,923	28,745	22,793	49,642	122,103
No. of households	6,038	8,369	6,461	14,709	35,577
Number of respondents	65	90	70	159	384

Rainfall data was obtained from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) and analysed for variability in the period 1981-2020. The CHIRPS data is provided for free by the Climate Hazards Centre in collaboration with the US Geological Survey and uses both rain gauge and satellite observations. This dataset has been validated and approved for use as a reference for researchers in East Africa (Dinku *et al.*, 2018; Cattani *et al.*, 2018; MacLeod, 2018; Ogega *et al.*, 2020). Farmers' responses on several issues under study was collected using a researcher administered questionnaire, while interviews were used to collect data from key informants, who comprised line officers from the ministries of agriculture and environment. Data was cleaned, coded and analysed using SPSS software with emphasis on descriptive statistics to generate general trends that may guide policy development.

Results and Discussion

Socio-Economic Aspects

More women than men; 62.5% and 37.5% respectively participated in the study. The role of women in farm labour still plays a key role in agricultural development in Kenya. The rather high proportion of aging labour (45%) is indicative of the declining visibility of the youth who should be the future farmers. With more than 70% having attained only primary and secondary education is indicative of low exposure and knowledge base that manifests in the low level of technology adoption. The income insecurity is reflected in the over 70% earning less than Kenya shillings 20,000 (Less than USD 200) (Table 2).

The rather high number of aging population at the farm (70.3%) is indicative of rural-urban migration of the youth. Besides posing a labour challenge in future, the extension packages in pursuit of CSA will need to be customised to this age group, whose level of education is equally average with more than 70% having attained primary and secondary education. The low monthly income for the majority (approx. USD 140) means that significant climate adaptation and mitigation financing will have to come from external sources, since much of the observed income must meet basic needs as priority. The significance of small farms (80% being equal or less than 2 acres) speaks to the need to focus on ordinary, resource-challenged farmers in the narrative about agriculture designed for the environment. Marie *et al (*2020) has observed that farm size plays a key role in farmer's decisions on strategies to be implemented.

Table 2: Socio-Economic Parameters of Respondents (N=384)

Variable		Frequency	% F
Gender	Male	240	62.5
	Female	144	37.5
Age	Under 25 years	39	10.2
	26 - 35 years	75	19.5
	36 - 45 years	95	24.7
	Over 45 years	175	45.6
Highest level of education	Primary school	132	34.4
	Secondary school	151	39.3
	Diploma or Certificate	91	23.7
	Degree	10	2.6
Monthly income in Kenya Shillings	Less than 20,000	282	73.4
	21,000 to 40,000	74	19.3
	41,000 to 60,000	18	4.7
	Over 60,000	10	2.6
Farm Size (Acres)	≤ 1	209	54.4
	1-2	102	26.6
	2-3 Acres	44	11.5
	≥ 4	29	7.6

Trends In Rainfall Patterns and Perception Of Climate Change

For the two seasons studied, a depiction of year-to-year standardized precipitation anomalies for Gatundu South reveals high rainfall variability (Figure 2). The majority of this variation, however, lies within the normal range (-1 to 1). With the exception of some occurrences of above normal (1981, 2013, 2018, and 2020) and below normal (1984, 1993, 2000, 2009, and 2011). March-April and May (MAM) rainfall variability was largely within the normal range. The October and November (ON) season also showed normal rainfall patterns, with the exception of a few occurrences of above normal (1982, 1994, 1997, 2006, 2011, 2015, and 2019) and below normal (1981, 1987, 1998, 2005, and 2007). Extreme rainfall (above 2) was recorded in the area during the October-November (ON) seasons of 1997 and 2019, as well as the MAM season of 2018. This is the period Kenya experienced the last El Nino rains. Overall rainfall variability seems to be increasing as indicated from the period 2017. Whether farmers in Gatundu view this as an aspect of climate change remains a moot question.

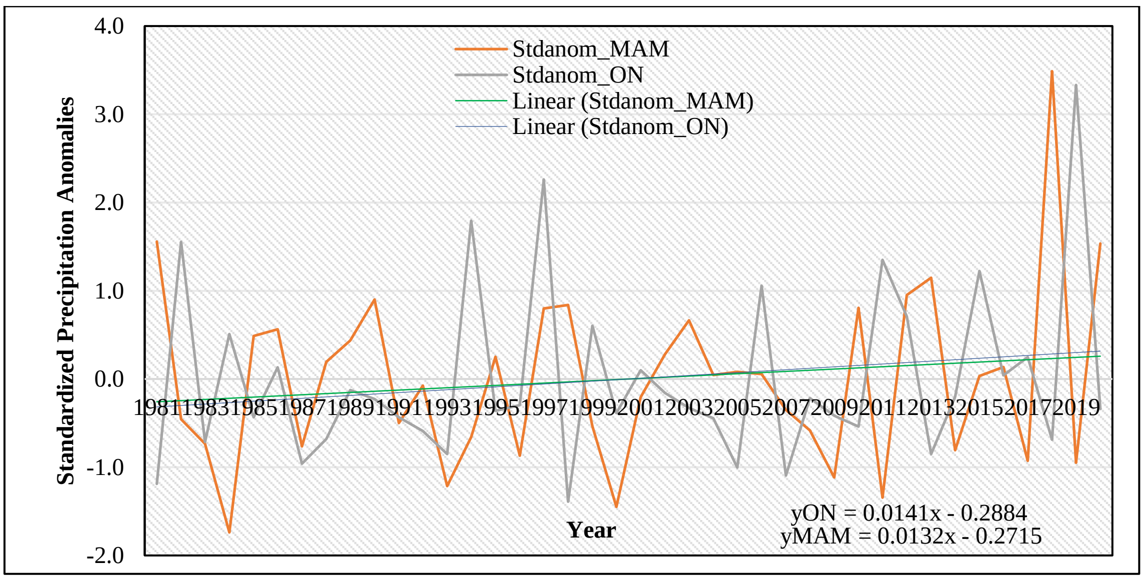

Figure 2 Seasonal Precipitation Variability Over Gatundu South (1981 To 2020)

Nevertheless, as observed by (Krätli, 2015) farmers will have to adopt dynamic management strategies that maximise on both extremes of wetness and dryness to guarantee economic yields from their land. In terms of climate change awareness (perception) 94.8% farmers agreed that the climate had changed. The main sources of climate information were radio, TV and from inter-farmer interactions. Since the devolution of agriculture, it is widely acknowledged that the visibility of farmers at the farm level reduced (Waswa, 2018). As such it is plausible to suggest that farmers have not consistently received agriculture and climate advisories as would be expected. Climate change was mainly evidenced by declining crop yields, low rainfall and increasing temperatures (Table 3). When asked to respond to Likert Scale statements to determine the magnitude of their responses on perceptions of climate change on agriculture, most agreed to a high extent that climate change had led to reduced production (Mean 4.18). Farmers were in agreement to a high extent that climate change had led to reduced rainfall thus leading to poor harvests (Mean 4.01) and that climate change had led to short rainfall season which leads to crop failures (Mean 3.66). However, farmers indicated that to a fair extent, climate change has contributed to heavy rainfall, which may result in floods in some seasons (Mean 3.03) (Table 4).

Table 3: Farmers' Indicators of Climate Change (n=384)

Indicators	Frequency	% F*	Weighted % F
Low crop yields	267	69.5	25.9
Less rainfall	241	62.8	23.4
Increasing temperature	190	49.5	18.5
Destruction of crops by droughts/floods	160	41.7	15.6
Outbreak of pests and diseases	132	34.4	12.8
Other factors	39	10.2	3.8

**Multiple responses were allowed*

Although seasonal droughts have severely impacted food security in some parts of Gatundu South this study revealed that water scarcity is largely mitigated by the use of metered water, for which they have no much control in terms of available quantities and scheduling of supply (Table 5). In addition, relying on metered water means increased monthly costs, which are likely to undermine the entire adaptation process. The sustainability of rivers as water sources is increasingly being limited by recurrent droughts and water pollution. Sinking boreholes is generally out of reach to many farmers due to the cost implications. The remaining option, which in the context of climate-smart agriculture would be more sustainable, is rainwater harvesting and storage technologies, which however appears highly marginalised and untapped.

Table 4: Perceptions of Climate Change on Agriculture (n=384)

Statement	Mean	SD	Interpretation
Climate change has led to reduced production	4.18	1.119	High
Climate change has led to reduced rainfall hence poor harvests	4.01	1.186	High
Climate change has led to occasional floods in some seasons	3.03	1.436	Fair
Climate change has led to shortened rainfall	3.66	1.416	High

**Likert Key: 1-Strongly Disagree, 2-Disagree, 3-Moderately Agree, 4-Agree, 5-Strongly Agree*

Table 5: Farmers' Source of Water For Agriculture In Gatundu (N = 384)

Source of Water	Frequency (F)	% F*	Weighted % F
Metered Water	245	63.8	35.4
River	223	58.1	32.2
Borehole	125	32.6	18.1
Springs	88	22.9	12.5
Dam	6	1.6	0.009
Rainwater Harvesting	5	1.3	0.007

* *Multiple responses were allowed*

A study by Muriu-Nganga *et al*., (2017) showed that farmers can still harvest sufficient water in situ and raise economic yields using simple and cost-effective technologies like zai pits and trapezoidal bunds. Similarly, Waswa *et al* (2020) demonstrated the potential for huge amounts of roof catchment harvests that is lost as drainage water during the two rainy seasons typical in most agro-ecological zones. Based on the available surface, sub-surface water and water harvesting capacity. The government of Kiambu County observed that the county's irrigation potential is over 62,812 acres of which only 7,500 acres (12%) has been harnessed (County Government of Kiambu, 2018). Here-in is the potential for investing in water efficient irrigation systems. Government on the other hand is slow to invest in huge dams that could store huge amounts of water during peaks seasons or during extreme rainfall events. Going forward climate-smart agriculture in Kenya needs to prioritise farm-level interventions based on simple, cost-effective and yet practical solutions that already exist, instead of discussing huge capital-intensive solutions that tend to marginalise majority small-scale farmers, thus reducing tangible benefits from occasional mega summits and conferences on climate change adaptation and mitigation.

Potential in Crop Diversification

Crop diversification with emphasis on ecologically suitable crop varieties is a key component in conservation agriculture and hence climate-smart agriculture. Results from this study revealed that farmers grow a wide range of crops both for subsistence and commercial purposes with trends suggesting a decline in industrial crop like coffee and an increase in maize and beans, which key subsistence crops in Kenya. (Figure 3). Being a woody perennial, decline in land area under coffee implies a decline in carbon sinks. This loss in environmental benefit should be compensated through deliberate integration of climate-smart practices in emerging crops of choice. Since yields are often constrained by unreliable rainfall and low soil fertility, capacity building in an integrated strategy of dryland farming, conservation farming and organic farming needs to be explored. The availability of manure is guaranteed by virtue of most households having some form of intensive animal production systems (Table 6).

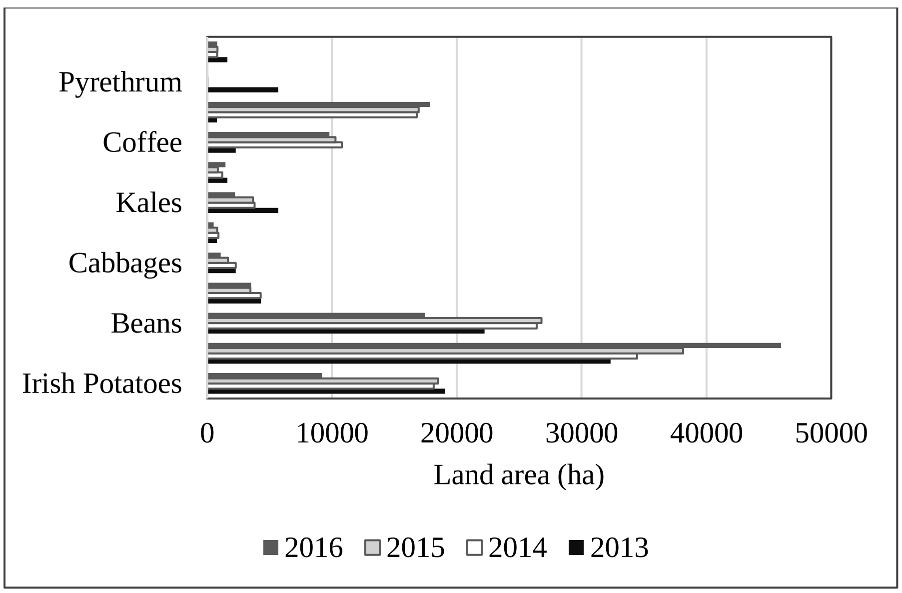

Figure 3: Trends in Crop Production In Kiambu County (2013-2016) In Hectares

Table 6: Farmers Having Animal Production Systems in the Constituency (N= 384)

Animal Production	Frequency (F)	% F	Weighted % F
Poultry	285	74.2	36.35
Dairy Cows	255	66.4	32.53
Goats	171	44.5	21.80
Pigs	51	13.3	6.52
None	22	5.7	2.79

* *Multiple responses were allowed*

Nearly all the farmers, 360 (84.5%) used manure from their animal production on their crop fields. Those who sell for income generation accounted for 4.2 % while those who just gave it away comprised 11.3%. With increasing popularity of manure as a tradable commodity, its value-chain merits attention for improved performance. Value-addition in climate-smart agriculture in such small-scale production systems calls for deliberate investments in biogas production in order to reduce demand for firewood and hence pressure on tree cover. Wachera and Waswa (2017) working in a region of similar climatic and socio-economic characteristics showed that with only 2 dairy cows, a typical household can have a simple functional digester. However due to the high initial costs, dialogue on climate change financing needs to also focus on how to cushion farmers against such costs and thus make biogas systems affordable to ordinary farmers in Kenya.

Status of Climate-Smart Agricultural Practices

From a list of 13 crop and land husbandry practices identified, use of manure and compost was the most popular at over 80% adoption (Figure 4). This was attributed to the readily available manure from zero-grazing systems within households in the County. The importance of agroforestry stems from its multiple benefits that include supply of firewood, building material and to a lesser effect fruits and fodder depending on the tree species. Although crop insurance increases farmers' adaptive capacity and reduces their vulnerability to climatic shocks, biological perils that include pests and disease outbreaks, and risk such as hail and fire, its adoption is yet to gain traction due to among other factors the high cost of insurance premium (Republic of Kenya, 2021). Smallholder farmers are unlikely to invest their money into crop insurance, when meeting their basic needs is still pressing daily challenge.

Despite the proven benefits of the majority practices identified, their use is below average and most of the time as a short-term adaptation measure to address an emerging challenge at that time. Also whether farmers apply these interventions based on their climate-smartness remains a moot question. Suffice is to emphasise that inherent in all these practices are climate-smart benefits that farmers need to be made aware of and incentivised to leverage on them continuously. These practices point to the need to scale-out and scale-up conservation agriculture principles and practices within smallholder production systems with focus on crop rotation and diversification, minimum soil disturbance, permanent soil cover and efficient water use practices.

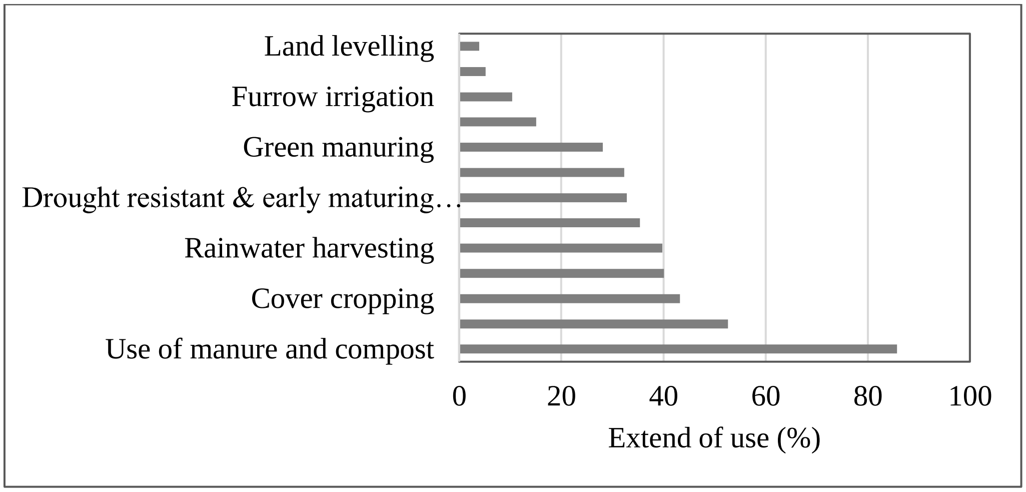

Figure 4: Relative Importance of Identified Climate-Smart Practices

The apparent invisibility of fertilisers was not due to their contribution to environmental pollution, but rather their high costs, which made them unaffordable to farmers. This dimension becomes a good entry point to promote organic farming as a climate-smart and yet profitable practice within smallholder production systems. While drought resistant and early maturing varieties are now readily available, farmers have sometimes missed out on their benefits due to untimely planting. Affordable, simple and clear climate advisories become critical inputs in the farming system going forward. This calls for agricultural planning that would operationalise working partnerships involving the extension service, the meteorological department and other key service providers. With climate trends suggesting increasing scarcity of water and frequency of dry seasons in high potential areas, promotion of climate-smart agriculture in such areas should also integrate apiculture given its importance in environmental resilience and household incomes (Mutua *et al*., 2023). According to Kiambu County Government (2018), production of honey rose from 102,397 kilograms in 2014 to 114,000 kilograms in 2017. With more incentives and awareness, more farmers experiencing water scarcity are likely to adopt this land use and thus reduce pressure on land occasioned by tillage for crop farming. The long run benefits include conservation of trees and hence carbon sequestration. Results further revealed that adoption of CSA practices was influenced by knowledge and awareness thereof, the farm sizes, trainings on climate change adaptation measures and availability of extension services (Table 7).

Table 7: Factors Influencing Adoption of CSA Practices (N=384)

Statement	**Mean**	SD	**Interpretation**
Gender	**2.25**	**1.373**	**Low**
Level of education	**2.74**	**1.459**	**Fair**
Size of cultivated farm	**3.61**	**1.341**	**High**
Knowledge and awareness of climate change	**3.97**	**1.156**	**High**
Training on climate change adaptation	**3.56**	**1.366**	**High**
Membership to climate focus organization	**3.09**	**1.294**	**Fair**
Availability of support extension service	**3.29**	**1.324**	**Fair**

**Likert Scale: 1-Strongly Disagree, 2-Disagree, 3-Moderately Agree, 4-Agree, 5-Strongly Agree*

Enhancing Adoption of Climate-Smart Agricultural Practices

In terms of enhancing adoption of climate-smart agricultural practices, farmers identified access to funding (86.1%), training (82%) and timely access to climate information (34.6%) as priority strategies. (Figure 5).

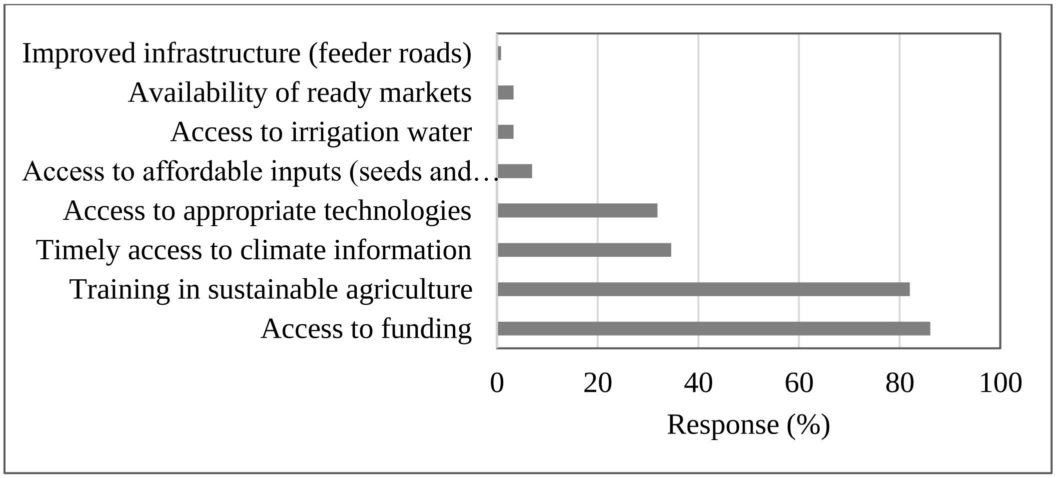

Figure 5: Farmers' Opinions on How To Enhance Adoption Of Climate-Smart Agriculture Practices

Despite the convergence of climate-relate challenges in the farming system across agro-ecological zones, the future calls for climate-smart locality specific solutions that promise farmers economic yields (direct benefit) while mitigating climate change impacts (indirect benefits). For being generally unaware of the relationship between climate change and emission of greenhouse gases, interventions that emphasise this narrative may take time to trigger spontaneous farmer adoption. Therefore, linking emission of GHGs to impacts that directly undermine farmers' well-being, such as pollution and its effect on the farmers' health, has a better chance of boosting and galvanising climate-smart agriculture practices within smallholder production systems. By implication, interventions like relevant climate financing (an aspect that was emphasised in the September 2023 Africa Climate Summit) should be extended to to both rural and peri-urban agro-ecosystems to enhance actualization of the desired changes.

Conclusions and Recommendations

Farmers in Gatundu South are generally aware of climate change and recognise it through seasonal rainfall variability, scarcity of water and declining yields from land. Consequent adaptation measures entail a variety of crop and land husbandry practices mainly crop diversification with focus on early maturing and drought resistant varieties, and the use of manure. Opportunities to counter water shortages however exist in rainwater harvesting and storage technologies. The marked decline of land under coffee corresponds to a decline in carbon sinks. Compensating for this loss through strategic agroforestry merits consideration in planning for requisite climate smart practices. The readily available animal manure within households provides a strategic entry point for the promotion of organic farming, all the way to biogas production value-chain for purposes of reducing pressure on wood fuel.

Although the adaptation measure used espouse the principles of climate-smart agriculture, local farmers use these practices primarily in pursuit of yield maximization not the envisaged environmental performance of reduction in the emission of GHGs. As such evidence of direct economic benefit is key to the adoption of any climate smart agriculture practice. On the other hand, the apparent knowledge gap on the relationship between climate change and emission of GHGs necessitates a shift in conventional narrative to now link climate change to aspects that directly resonate with the farmers. In this regard, linking climate change to air pollution and its effect on the farmers' health, and packaging the narrative within the broader concept of environment-smart agriculture, would have a better chance of increasing adoption of climate-smart agriculture practices within smallholder production systems.

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