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Challenges of and Responses to Climate Variability: A Case Study of Peri-urban Female Farmers in Kenya

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Abstract Although the impact of climate change on a regional scale has been much discussed, the perception of change and the responses this induces at the level of resource-poor smallholder farmers has been less studied, particularly those of female farmers. This study examined challenges faced by a group of Kabuor-Upendo female farmers and the appropriateness of their responses in the context to climate change in a Peri-urban town of Kisumu County in Kenya. Data was collected using semi-structured questionnaires in Kisumu East Sub-County. According to respondents, climate variability is the dominant factor in their set of perceived challenges. These include inadequate and unreliable rainfall and recurrent drought and flood. Their coping strategies as found in this study include crop diversification, planting of drought tolerant crops and irrigation. These are consistent with government policy on climate smart agriculture practices. Therefore, these proactive actions by smallholder female farmers are also areas identified for intervention at both national and local government level. In view of this, it can be concluded that female farmers' challenges and responses will be appropriate entry points for policy initiatives in the context of climate variability.

Keywords: *climate variability, climate change, climate smart agriculture, adaptation, crop diversification, peri-urban farmers*

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1. Introduction

Kenya's agriculture is largely rain-fed making it extremely vulnerable to the effects of climate change. There is increasing evidence that climate change is directly affecting the social, economic and environmental status of the country. According to [1], evidence of climate change is unmistakable, and rainfall has become irregular and unpredictable. The World Bank affirms that poverty and vulnerability to climate change remain the most critical development challenges facing Kenya [2]. Climate change and variability are causing increased crop failures and reduced production of rain-fed agriculture [3]. Droughts lead to reduced yields or total crop failure due to water stress, while floods lead to anaerobic soil conditions. In both circumstances, decreased investment in crop production is likely [4].

The sector is dominated by smallholder subsistence farmers for whom changes in temperature, precipitation and increase in frequency and intensity of extreme climate events particularly droughts and floods have devastating impacts on basic food security and incomes [5]. A specific component of the smallholder farming community, peri-urban farmers, has received relatively little attention. Although these contribute only 6% to annual production [6], they are suppliers of fresh fruit and vegetables, among other products, to nearby, mostly poor urban communities and hence make a critical contribution to nutrition. Adoption of improved inputs such as hybrid seed, concentrate feeds, fertilizer, safe use of pesticides and machinery by small-scale farmers is relatively low, [7].

Climate change affects men and women differently, because of their social roles and responsibilities. In developing countries, women's role is to provide food, water, and fuel for their families, making them the stewards of natural and household resources [8]. They are arguably the most affected by climate change. Women are more vulnerable because of their limited access to natural resources and their dependence on agriculture for livelihood [8]. Therefore, when they are directly hit by climate change, their livelihoods are affected [9].

Peri-urban female farmers have therefore suffered neglect from two different directions simultaneously: the relative neglect of the peri-urban sector as a whole and the neglect of female as compared to their male counterparts. This study sought to identify the major challenges

particularly in relation to climate change that affect agricultural productivity. To achieve this, we selected an informal, self-initiated and self-organized group of female farmers in a peri-urban setting to explore a series of inter-related questions on their challenges to climate change. These respondents provided feedback on their coping mechanisms. Further, the feedback is envisaged to be relevant to the broader context of a national response *via* Climate Smart Agriculture (CSA).

2. Materials and Methods

2.1. Site Selection

Kisumu East sub-county experiences bimodal rainfall pattern from March to June (long rains) and November to December (short rains) with average annual rainfall between 450--600mm. The mean annual maximum temperature ranges from 25°C to 35°C while the mean annual minimum temperature ranges from 9°C to 18°C. The land covers an estimated area of 430.2 km^2 however only 216km^2 is arable land, with average land holding of 0.22 ha per family [10]. Consequently 78% of the population reside in town. Figure 1 shows the site selected for the study.

2.2. Baseline Survey

A household baseline survey targeting female farmers was carried out. The community chosen for study was a typical smallholder farming community in Kisumu County, Kenya-Kabuor-Upendo. Farmers were individually asked to list the challenges they faced. To minimize the likelihood of interviewer-induced bias and to obtain the most informative responses, farmers were not presented with a pre-determined list of possible challenges but rather invited to freely describe their own perceptions. The responses therefore had some ambiguity and overlap. The relative importance of each individual challenge was then represented by the frequency with which it was mentioned, calculated as the number of times it was mentioned relative to the total number of challenges identified by the whole group. The group were first asked to list the main annual crops grown in the area by all farmers

2.3. Data Collection

Primary and secondary data collection methods were used to gather data required for the survey. Primary data was collected from the target female farmers by administering questionnaires to 33 respondents. Data was collected using a semi structured questionnaire in late July and early August 2017. Secondary data sources including relevant sub-sector documents and county climate risk profiles were used.

2.4. Data Analysis

Descriptive statistics were used to describe and summarize variables. The statistics focused on frequencies, percentages, means and standard deviation. The relative importance of each component of the factors considered was calculated by adding the total number of times factors were nominated by the group, followed by expressing each factor as a percentage of the total response. The factors considered in the study included challenges faced, choice of crops, water availability and water utilization. The results were analyzed using the Statistical Package for Social Sciences (SPSS version 20.0).

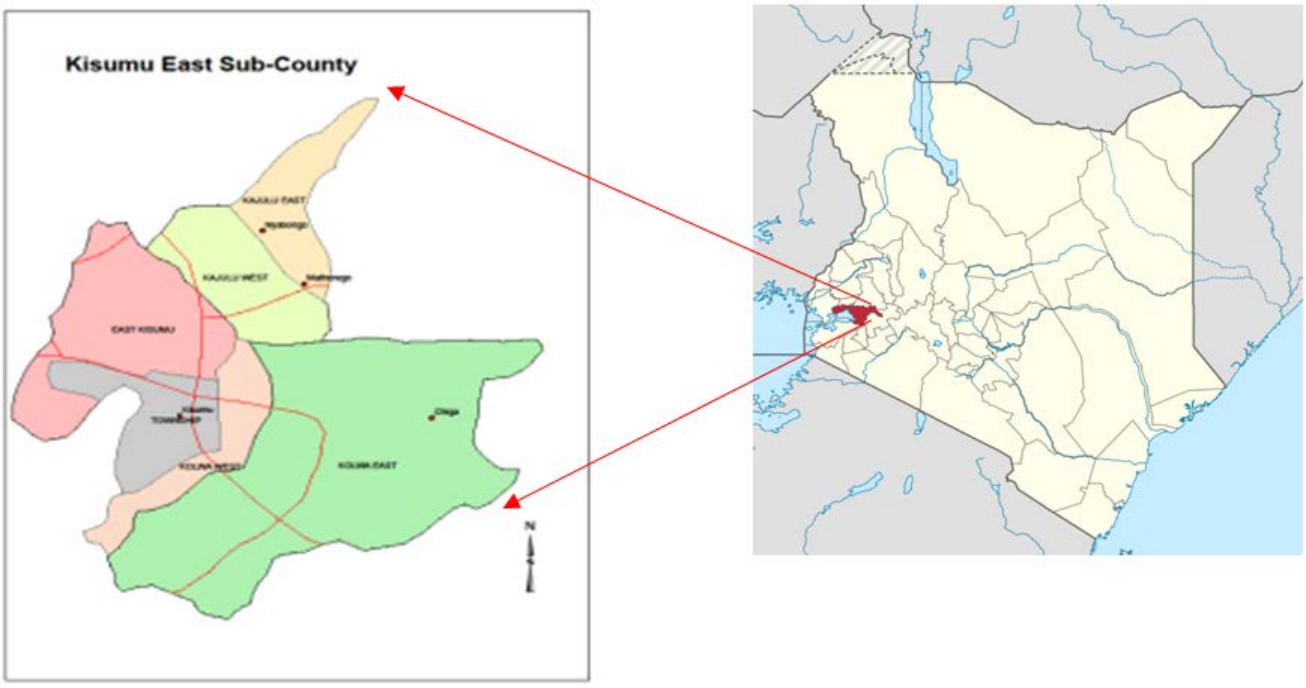

Figure 1. Map of Kisumu East Sub-County, Kenya, showing the location of sampled households for baseline survey

3. Results

3.1. Nature of the Surveyed Group

The Kabuor-Upendo group exists within a typical smallholder farming community in Kisumu County, Kenya. It is a relatively small, local and community-oriented female group formed with a purpose of working collectively and socializing on a regular basis. It is therefore a self-help and social welfare-oriented group. The group comprises 33 members of young, middle aged and senior citizens. Normally, due to the characteristics of membership, the members have a common need that mobilizes them to come together to seek solutions to their needs or problems. The main objective of the group is to improve the wellbeing and living conditions of members by ensuring their inclusion in group savings, while loaning money. Kabuor-Upendo is a registered group and has opened a bank account but mostly uses table banking where they meet once a month to pay their loans and borrow money with interest. The group meets in the open or in members' houses providing an environment for learning and sharing experiences. Members of the group also use meetings as opportunities to sell their local vegetables to one another. All this has had a positive impact on their contribution to household responsibilities such as food security and education of their children.

3.2. Key Demographics

The percentage of male headed households was 56, while female-headed ones represented 44 per cent. The mean age of respondents was 43 years with an average of 4 dependents in every household. The education level shows that 60% of the respondents had attained secondary education while 20% had gone through primary and college education respectively.

3.3. Farmer Perceptions of Major Challenges in Relation to Climate Change

Over 30% of the farmers' agreed that the major challenge was recurrent drought. Inadequate and unreliable rainfall was identified by 16% and 11% of the farmers respectively. Other factors are the downstream consequence of variable rainfall, such as low yields and famine (Figure 2). Famine and low yields have been realized in the recent past in the area. Late ploughing was identified by a small number of farmers, 2%, as a challenge but also subsequently described as a coping strategy.

3.4. First Response Strategy (Crop Choice and Diversification)

Responses to the challenge of climate change showed that the group had adopted two major approaches. The first was in the choice and diversification of crops being grown and the second was using a suite of techniques to increase water availability during phases of irregular and insufficient rainfall. The frequency or number of times with which each crop was identified and the overall percentage as a reflection of crop importance are shown in Table 1. Clearly the main crops grown in the area are maize, beans, sorghum and cowpea.

In contrast, Figure 3 shows the crops that members of the female Kabuor-Upendo group grew themselves. The popularity of each crops shown as a percentage of the total response. Local vegetables, cowpeas and tomatoes were commonly grown as displayed by their percentages of above 30, 25 and 10 respectively. The crop choice shown in Figure 3 therefore reflects, at least in part, a response to climatic challenges. Cowpea was the second most preferred crop after the local vegetables with 26% of the respondents as shown in Figure 3.

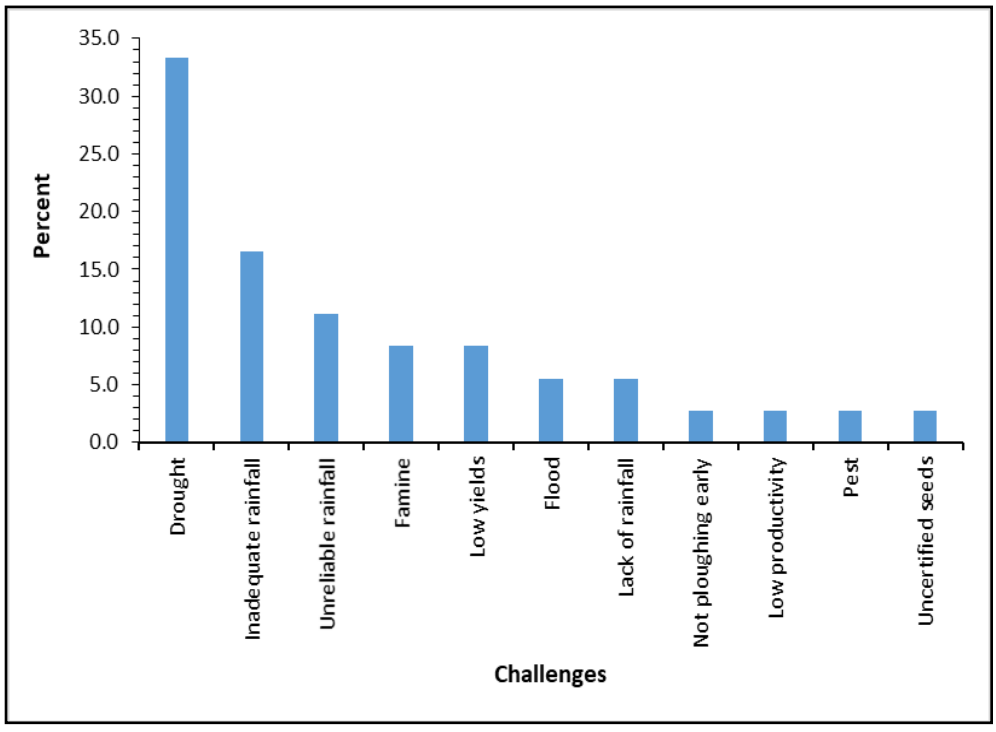

Figure 2. Bar graph showing identified challenges faced by farmers of Kaburo-Upendo women in crop production

Table 1. Frequency of crops planted by the community

Crop	Number (%)
Maize	29 (24.4)
Beans	20 (16.8)
Sorghum	19 (16)
Cowpeas	14 (11.8)
Vegetables	14 (11.8)
Greengrams	5 (4.2)
Osuga (local vegetable)	3 (2.5)
Sweet potatoes	3 (2.5)
Kales	2 (1.7)
Millet	2(1.7)
Apoth (local vegetable)	1 (0.8)
Avocado	1 (0.8)
Black nightshade (local vegetable)	1 (0.8)
Cassava	1 (0.8)
Mangoes	1 (0.8)
Onions	1 (0.8)
Pumpkin	1 (0.8)
Tomato	1 (0.8)
Total	119 (100.0)

The differences in crop preference between the community as a whole and the group of female farmers are clear. The women identified maize and sorghum, two of the three most preferred crops for the area as a whole, as having been severely affected by prolonged drought.

Figure 4 shows the frequency with which multiple different crops are grown. With few exceptions, farmers grew between three and five different crops. The principal reason was to minimize risk because if one crop failed due to drought, the other crop might better tolerate the dry conditions.

The most preferred individual crop was listed as "local vegetables", which were found to be diverse. Thirty percent of the farmers identified *Amaranthus* spp., Cowpeas (*Vigna unguiculata*), Black nightshade (*Solanum nigrum*), Sunnhemp (*Crotalaria brevidens*), Jute plant (*Cochorus olitorius*) and Spider Plant (*Gynandropsis gynandra*).

3.5. Second Response Strategy (Increasing Water Availability and Usage)

Several factors that influence the extent to which farmers adapt to unpredictable and unreliable rainfall are shown in Figure 5. Half of all the farmers identified irrigation as a key to productive farming. Thirteen of the farmers identified the source of water they used for irrigation. Of these, nine obtained it from the river while the others used dam and tap water. Currently, irrigation was applied exclusively to vegetables, perhaps because these are planted at the backyard of their farms and that makes it easy to irrigate.

There was disparity between the numbers of farmers irrigating their crops after rainfall compared with those irrigating during dry periods as shown in Figure 6. When water is readily available after rainfall, it is easy for farmers to harvest this water and later use it for irrigation but when water availability is threatened the number that use it for crop irrigation reduces.

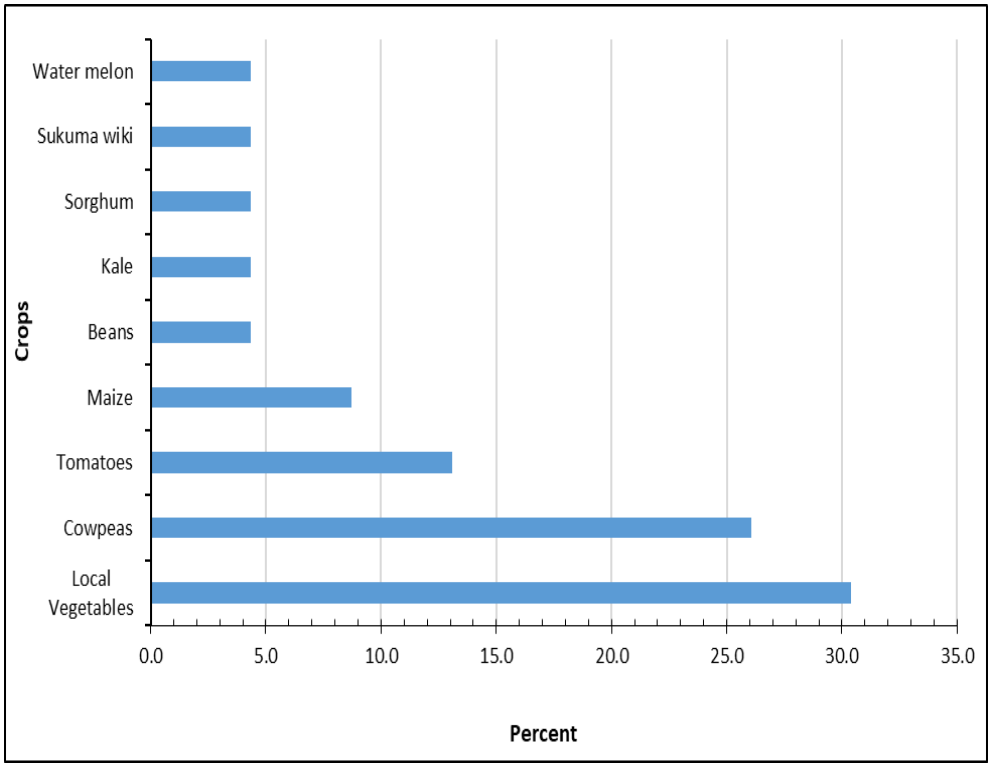

Figure 3. Individual crops grown by female farmers

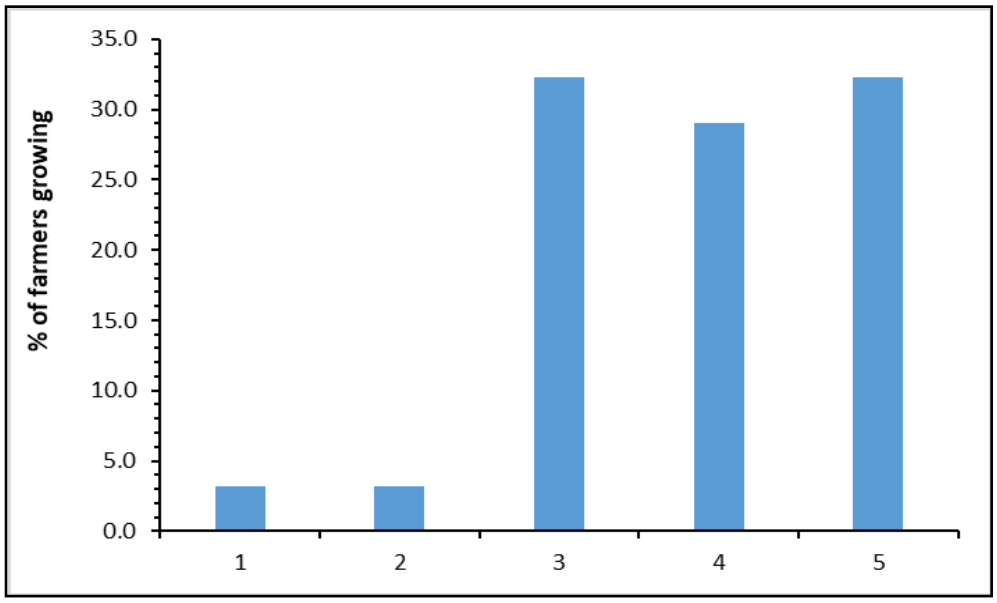

Figure 4. Frequency of planting multiple crops

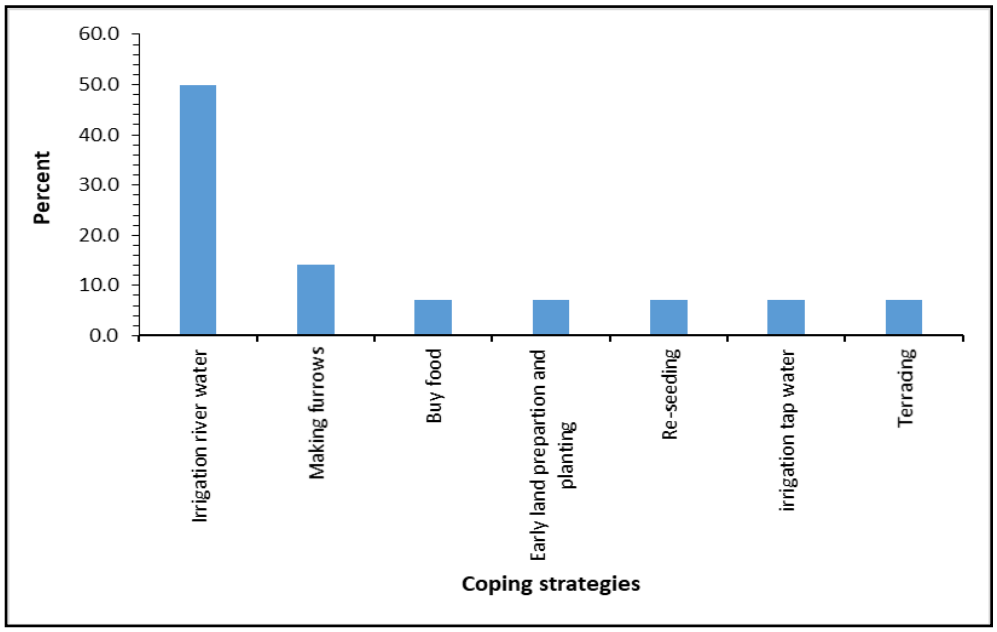

Figure 5. Frequency of response strategies other than crop choice

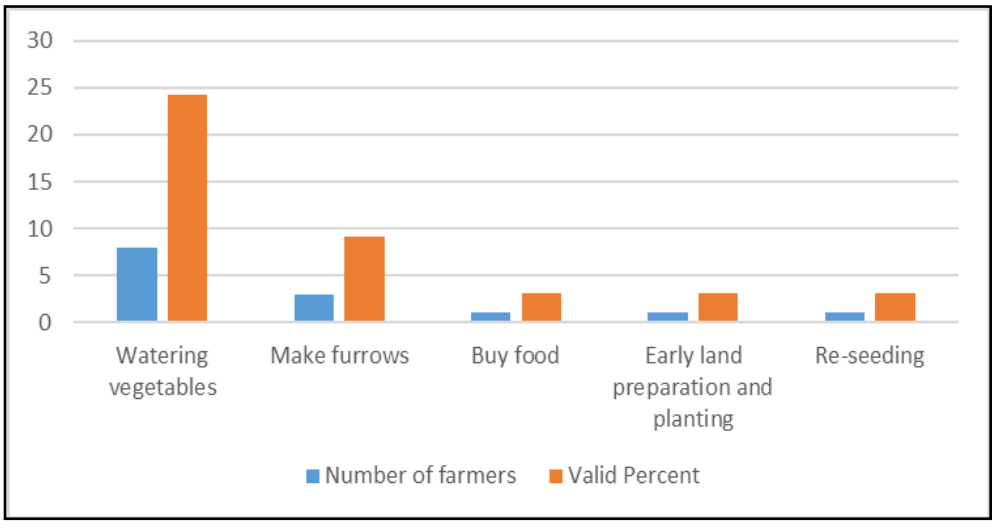

Figure 6. Strategies to cope with lack of water during dry periods

Furrows were used as a means of water retention. Five of the farmers said that when the rains came they made furrows to harvest water so the trapped water is available to the plants after the rains have disappeared. Once more there was a difference between periods of higher and low rainfall, with only 3 farmers using furrows during drought. Furrows as a dry period strategy were identified as a challenge because, though desirable, their perception was that by the time an ox-plough was hired at a fee and their farms ploughed, the rains would have disappeared. The owners of the ox plough normally plough their farms before doing it for people who hire.

3.6. Minor Response Strategies

Only single farmers used other strategies: early planting and reseeding after drought. Similarly, only one respondents purchased food in town to cope with the food deficit when there was no longer enough food from the farm. This would be a coping strategy available only to farmers who had money to purchase food and the surveyed group had low purchasing power.

4. Discussion

At a national and regional level, it is clear that climate change is already seriously impacting Kenyan and East African agriculture, as described in the Introduction. Policy responses at a national level continue to be developed but effective implementation of such policies will depend on a good understanding of the perception of the problems and the nature of the response at the critical level of the smallholder farmer.

In this study we chose a specific group i.e. peri-urban female farmers. The studied group fits the description of Sahbarwal (2003) cited in Makhoha [11] as a self-help group, a voluntary association of poor people "who join efforts, ideas and resources for the purpose of addressing issues affecting them through self-help and mutual help". Many women's groups are grass-root based and carry out projects at the community level [12]. It has been documented IPCC [13] that women's responses to climate-related risks position them well to contribute to livelihood strategies adapted to changing environmental realities. Their significance as change agents and actors has been reported in terms of informing farming households, either directly or through their representatives. They are best placed to identify, execute and counter climate risks using local and traditional knowledge. Women tend to share information related to community well-being and their participation and response is likely to enhance the effectiveness and sustainability of climate change projects and policies. Literature has shown that women tend to be very effective at mobilizing communities and have a clear understanding of what strategies are needed at the local level [14]. It has been argued that women who do not own land are forced to be more proactive in adjusting to harsh weather conditions by developing coping strategies over time [15], including looking for alternative ways to generate money. Women's groups have served as a platform for empowering women, increasing their participation and bringing their ideas and services closer to members [16].

However, most studies target rural farmers in general, typically in male-dominated households, while if female farmers are studied, it is in a rural rather than peri-urban context. This neglects the fact that such farms are an important supply of nutrition for urban dwellers as well as for their own families.

The studied group had two atypical demographic characteristics. The proportion of female-headed households was high at 44%. A recent large study of agricultural households in Kisumu County found that the county average was 18% [17]. The high proportion of female heads may not be surprising given the nature of the group selected for study. More interesting however is the relatively advanced education, 80% having completed either secondary or college studies. The county-wide survey of agricultural households showed that of all households' heads, only 33.8% had secondary or further education, while for female household heads the percentage was significantly lower at 20.4% [17]. The interviewed group therefore was significantly better educated. It is interesting to speculate that this may have contributed to the initiative shown in forming the group initially and to the preparedness to adapt practices to climate challenges. This link however requires further research.

What the results above show is that the awareness of the impact of a variable climate, dominated by reduced rainfall, is acute at the micro level of the smallholder, peri-urban female farmer. "Drought" was clearly the major concern and if other aspects of irregular and unpredictable rainfall are added, the importance of this factor was overwhelming. This is supported by the recent study conducted in Kisumu county [18], which documented that farmers' exposure and vulnerability to climate variability and climate change has intensified the challenges of relying on rain-fed agriculture. Drought was identified as one of the major challenges in recent years and it has become more frequent leading to significant yield reduction. This is in agreement with [4] who documented the losses to agriculture attributed to drought and floods. It is interesting that such traditional challenges as pests and seed quality now seem to be much less pressing than the climate-related ones.

According to FAO [19], one must consider adaptation options that are well evaluated and prioritized by local farmers in relation to prominent climatic risks in that location. In response to challenges, the studied group has adopted two major coping strategies: the diversification of cropping and use of irrigation. Previous studies have found that farmers adapt to perceived climate change mainly through changing the crop type and diversifying their activities [20]. Nevertheless, the response of interviewees as described in Table 1 above suggests that most farming in the community still focusses on drought-susceptible crops like maize. This is consistent with recent survey data from the county [20]. For the surveyed group of female farmers, the results were very different. The major crops were local vegetables and cowpea, and both deserve comment.

The production of local vegetables is popular with female farmers selling to other members during their

meetings. Some of them take their produce to the nearby Kisumu town to generate income. These local vegetables, also known as African indigenous vegetables or African leafy vegetables (ALVs), are very popular due to high demand during the hunger gap between harvests and their nutritious nature especially in the urban communities. Nutritional studies by the Asian Vegetable Research and Development Centre have shown that African vegetables such as amaranth have higher levels of protein than cereals and fruits [21]. Some of the identified underutilized crops in Africa include amaranth, African vegetable nightshade, and traditional vegetable cowpea [22]. The value and importance of these crops include nutrition with high content of micro-nutrients, with health benefits from anti-oxidants and fibre that aid digestion [23]. However they are not given the attention they deserve.

Cowpea contributes both as a vegetable and a grain. The leaves are eaten, while it has been cultivated for a long time as an important legume grain. Farmers plant cowpea due to its drought tolerant nature. It is also not susceptible to pests and diseases. Harvesting of cowpeas is normally associated with women and can be carried out mechanically or by hand in three different stages of maturity depending on market demand. Tender, young leaves are harvested for consumption several times before the crop reaches maturity, while dried grains and green pods can be harvested for home consumption and for sale to generate income.

Cowpea was identified as a coping strategy due to its drought tolerant nature. Some farmers categorized it as a local vegetable because the community consumes the leafy part of the crop before maturity and the dried grain after maturity. Interestingly, when the role of gender in decision making is considered, adult female farmers tend to grow cowpeas as a vegetable rather than grain, whereas for adult male farmers the preference is reversed [24]. Cowpea, known by the local community as boo, is a livelihood source, acts as food security, generates income, is drought tolerant and nitrogen fixing. As a legume crop that is prostrate with long vines, it acts as cover crop, reducing the need for labour-intensive weeding. Cowpea leaves provide protein, vitamins and minerals, the plant increases soil fertility and water infiltration, plant covers the ground and stops rain running off and carrying the soil away and cowpea also reduces weeds when intercropped with other crops like cassava, maize and sorghum. Traditionally, cowpea has helped ensure self-sufficiency in the community.

The findings from this study are in agreement with the Kisumu County Risk Profile [24], that documented cowpeas as a priority value chain crop for Kisumu County. However, the crop has suffered from recognition problem for a long time and has been categorized under minor crops. With the advent of climate variability, this attitude is changing rapidly. Cowpea can withstand considerable drought due to its deep rooting system and can cope with poor soils, though it requires sufficient water supply for satisfactory yield. It is expected to experience more favorable growing conditions as a result of climate change [25].

The second major coping strategy, as well as challenge, was irrigation. Again, multiple strategies for water use were adopted. During drought, farmers adapt by irrigating local vegetables, though some harvest water using furrows. Irrigation came out strongly from the respondents due to recurrent drought in the area, hence the need for irrigation promotion. This is in agreement with the Kisumu County Agricultural Sector Development Support Programme (ASDSP), [17], that has documented water conservation, water harvesting and irrigation to be promoted for adaptation and adoption.

At a national level, working policy documents are already in place such as the National Climate Change Response Strategy (NCCRS, 2010), National Climate Change Action Plan (NCCAP, 2013) and the Kenya climate smart agriculture strategy (KCSAS, 2017-2026), which provides implementation and adaptation options. These documents incorporate the idea of Climate Smart Agriculture, an approach that provides an excellent opportunity for transformation. There are several potential adaptation options to reduce moderate to severe climatic risks in agriculture.

According to [26], Climate Smart Agriculture (CSA) is an integrative adaptation option that sustainably increases productivity, enhances resilience to climatic stresses, and reduce greenhouse gas emissions. It is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate [27] (Kenya Climate-Smart Agriculture Strategy 2017-2026). Hence promotion of CSA approaches requires that we understand farmers' perception of current and future problems and appropriate approaches currently used and the barriers they see to the increased adoption of CSA approaches. Some of the documented practices include water harvesting, small scale irrigation, use of improved drought tolerant crops and crop diversification [28,29]. According to Mwongera, [30] CSA options integrate traditional and innovative practices, technologies and services that are relevant for particular location to adopt climate change and variability.

Our study demonstrates that there is already an important degree of alignment between this national policy approach and the pragmatic response of our small group of female farmers.

5. Conclusions and Recommendations

This study shows that a self-assembled and self-managed group of female farmers can identify climate related risks and take appropriate actions on their own initiative, actions that are consistent with national priorities. Importantly, their actions are not only appropriate, within the limitations imposed by their resources, but differ significantly from those of (mostly male) farmers in aggregate, as shown by large scale surveys. Our sample size is small and the results would therefore require replication to establish their generality. The implication however is that proactive national policy and initiatives are appropriate and therefore likely to be adopted. Key factors would be (a) to focus on women as well as men as change agents (b) to further investigate the importance of education in forming such groups and clearly, if the link is confirmed, to continue to promote the education of women (c) to re-evaluate the role of so-called

minor crops and if their importance for smallholder peri-urban farmers is confirmed, to promote their increased adoption (d) to provide assistance in terms of advice and physical facilities for multiple approaches to the efficient use of water.

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