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Farmer Perception and Adaptation Strategies on Climate Change in Lower Eastern Kenya: A Case of Finger Millet (*Eleusine coracana* (L.) Gaertn) Production

Madegwa Yvonne[1], Onwonga Richard[1], Shibairo Solomon[2] & Karuku George[1]

[1] Department of Land Resource Management and Agricultural Technology, University of Nairobi, Nairobi, Kenya

[2] Department of Plant Science and Crop Protection, University of Nairobi, Nairobi, Kenya

Correspondence: Onwonga Richard, Department of Land Resource Management and Agricultural Technology, University of Nairobi, P.O. Box 29503-00625 Nairobi, Kenya. Tel: 254-20-359-2736. E-mail: richard.onwonga@uonbi.ac

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Abstract

Eastern Kenya, a semi-arid region, is characterized by low and erratic rainfall, high temperatures, and low soil fertility. Climate change has further worsened the situation leading to frequent droughts and hence increased food insecurity. Traditional crops like finger millet are possible solutions to combating changing climate due to their drought resistance nature, ability to produce high yields with little inputs and high nutritional content. It is against this backdrop that a survey was carried out in Mwala and Katangi divisions of Machakos and Kitui counties, respectively, to assess farmer's perception on climate change, coping and adaptation mechanisms in finger millet production systems in smallholder farming systems of lower eastern Kenya. Data was collected, using semi-structured questionnaire, from 120 farmers i.e. 60 in each division. A stratified random sampling procedure, with location as a stratum was used to select respondent's households. A computer random number generator was used to select number of households in each stratum. Maize and beans were the most popular crops grown by over 98% of the farmers in both sub-counties. Farmers also grew drought tolerant legumes; cow peas, green grams pigeon peas and cereals; sorghum and finger millet. Temperature rise was ranked highest with 88% and 98%, followed by prolonged drought with 70% and 72%, irregular rainfall at 69% and 81% and increased wind intensity at 22% and 28% at Machakos and Kitui, respectively, as aspects of climate change perceived by farmers. Farmers had taken up early planting at 88.6% and 93.7%, use of organic inputs at 89% and 92%, introduced new tillage practices, by applying ridges and furrows and tied ridges at 45% and 54%, and by adopting irrigation at 13%, and 9%, as coping strategies to climate change in Machakos and Kitui, respectively.

It can be concluded that farmers in Machakos and Kitui are aware of climate change and its negative effects on crop production. In a bid to minimize crop loss and food insecurity, they have taken up various soil moisture conservation and soil fertility enhancement technologies.

Keywords: arid and semi-arid areas, climate change, coping strategies, finger millet, food security

1. Introduction

The Agricultural sector globally is one of the most vulnerable to effects of climate change (Reilly, 1995). Eastern Kenya being a semi-Arid LandSAL is most vulnerable to effects of climate change due to unstable nature of the environment. The region is prone to low, highly erratic rainfall with long dry seasons, unpredictable rainfall patterns, high evapotranspiration and low soil fertility (Bishaw et al., 2013) leading to poor crop production and food insecurity.

The government of Kenya and efforts through the research community has in recent times promoted adoption of traditional crops in the SALs as a measure to mitigate effects of climate change (Milcah et al., 2013). Such crops include drought tolerant legumes such as cowpeas and green grams and cereals; sorghum and millets. These crops are high in nutrients, drought tolerant and high yielding, disease resistant and have ability to produce yields with little inputs (Holt, 2000; Fetene et al., 2011). However, for their successful adoption understanding and buy in by farmers is needed. In addition, traditional farmers have had their own ways of coping with challenges of crop and food production.

In the past, farmers choose drought tolerant crops to overcome drought challenges, grew a wide range of crops to minimize risks, and cultivated crops that were pest and disease tolerant with high nutritional value (Macharia, 2004). The idea or phenomenon of 'climate change' is new to farmers -they may or may not understand what it is. There is lack of information on how the farmers understand and are facing the challenges of climate change and especially in the SALs of Kenya. Information on crops grown and reasons for their production, farmers' perception on climate change and farmers coping and adaptation mechanisms are therefore, needed. The current study was thus aimed at determining farmer's perceptions and coping mechanisms to climate change in relation to finger millet production.

2. Materials and Methods

2.1 Site Description

The survey was carried out in Mwala and Katangi divisions of Machakos and Kitui counties, respectively, in lower Eastern Kenya.

Machakos county is located between latitudes 0º45′S to 1º31′S from North to South and longitudes 36º45′E and 37º45′E from East to West with a mean altitude of 1714 meters above sea level (Muhammed et al., 2010). Long rains fall between March and May and short rains between October and December. Maximum and minimum temperatures experienced are 24.3 ºC and 11.1 ºC, respectively (Ellenkamp, 2004). Main agricultural activities include livestock keeping and small scale farming of maize, beans, millet, sorghum, cassava, peas, sweet potatoes and Irish potatoes.

Kitui County is located between latitude of 0º3.7′ and 3º0′ South and longitude 37º45′ and 39º0′ East with an altitude of 1151 meters above mean sea level (Pauw et al., 2008). The region receives average rainfall of about 900mm (Droogers & Loon, 2006). Long rains fall between April and May, while short rain between October and December (Pauw et al., 2008). Maximum and minimum temperatures experienced are 30 ºC and 25 ºC, respectively. Main agricultural activities included small scale livestock keeping and farming of tobacco, maize, beans, green grams, cowpea pigeon pea and mangoes.

2.2 Farmer Selection and Data Collection

The survey was carried out on a total of 120 farmers in Mwala (60) and Katangi (60). A stratified random sampling procedure, with location as a stratum was used to select respondent's households. A computer random number generator was used to select number of households in each stratum.

Data was collected on; (i) types of crops grown to mitigate against effects of climate change and reasons thereof, (ii) Farmer's perception on climate change parameters which was determined by evaluating the respondents understanding of aspects of climate change experienced and effects of climate change on finger millet production, and (iii) Coping and adaptation measures of respondents to climate change.

2.3 Data Analysis

The data was analyzed for descriptive statistics using Statistical Packages for Social Sciences (SPSS) version 16.

3. Results and Discussions

3.1 Crops Grown in Eastern Kenya and Reasons for Their Production

Farming was the main occupation of respondents with mixed farming being the main agricultural activity at both sites. Maize was the most popular crop grown in the two regions with cultivation being carried out by over 100% and 99% of respondents in Machakos and Kitui, respectively (Figure 1).

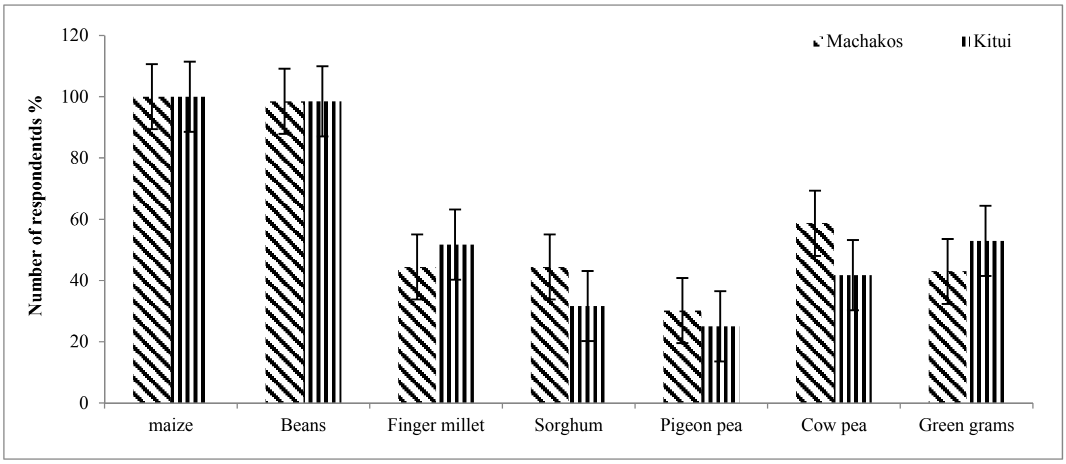

Figure 1. Crops grown in Machakos and Kitui

The farmers identified home consumption and income as the main reasons for cultivation of the cereal. This was due to its importance as a staple food crop consumed daily as ugali (a dish of maize flour cooked with water to a hard consistency) or porridge (a dish of maize and water cooked to a thick paste consistency). The findings are similar to a report by Kibaara (2005) who documented that maize was the main staple food in Kenya accounting for 40% of calories consumed daily. However, other authors (*e.g.* Ngotho, 2013) have reported that over time farmers are opting to invest less area for production of maize and more towards drought resistant crops like cowpea, green grams, sorghum and pigeon pea.

Common beans were the second most important crop in the two regions, with cultivation being carried out by 98.5% of respondents in Machakos, and 98.3% in Kitui (Figure 1). Main reasons for cultivation were reported as income and home consumption (Broughton et al., 2003). High consumption of beans was mainly due to its use in the preparation of the popular food githeri (mixture of maize and beans) playing a major role in high market availability of the crop.

The other crops grown were cowpeas cultivated by 53.7% and 41.7%, green grams cultivated by 43%, and 53% and pigeon peas cultivated by 30.2% and 25% of respondents in Machakos and Kitui, respectively. These crops were grown in small areas ranging from 0.3 ha to 0.6 ha for home consumption, as food and a little sold for income (Figure 1). This can be attributed to the legumes being highly nutritious, having the ability to be produced with little inputs, being able to obtain nitrogen through nitrogen fixation and their drought tolerant nature (Swaminathan et al., 2012).

Green grams, cowpea and pigeon pea crops were cultivated at a slightly higher acreage in Kitui than Machakos. This may be attributed to latter being a higher potential region than Kitui. Resultantly, the climate in Machakos is more suitable for a variety of crops than Kitui. Farmers in Kitui, therefore, focused their production on other drought resistant crops other than maize in order to insure against food insecurity. Ngotho (2013) suggested that with increasing effects of changing climate leading to unreliable rainfall, changing weather patterns and increased disease attacks, production of maize has been decreasing in Kitui. To insure against food insecurity farmers in the region had started to shift away from maize production to planting drought tolerant crops like sorghum, cow pea and pigeon pea among others.

The other crops grown were sorghum cultivated by 44.4% and 31.7% and finger millet cultivated by 44% and 51.7% of the respondents in Kitui and Machakos, respectively (Figure 1). Sorghum was grown at an average area of 0.3 ha, while finger millet was grown on an average land area of 0.05 ha and 0.04 ha in Machakos and Kitui counties, respectively. Both crops were grown for home consumption and income. This was due to the crops drought resistant nature, ability to produce with few inputs and popular consumption as porridge. Mgonja et al. (2007) suggested and advocated for the crops as being suitable for cultivation in dry areas due to their drought resistant nature and ability to produce with low inputs of water and fertilizer.

3.2 Farmers' Perception on Climate Change

Nearly all farmers in Machakos (100%) and Kitui (99%) were aware of climate change. This may have been as result of increased focus on the phenomenon by extension service providers. With increasing effects of climate change and the threat it poses to food security especially in arid and semi-arid regions, extension service providers had been drawing farmers' attention to climate change, its effects, and adaptation and coping mechanisms. This agrees with Baethgen et al. (2003) and Jones (2003) who found that access to extension increased farmer's perception and awareness to climate change.

3.2.1 Aspects of Climate Change Experienced

Most respondents indicated that temperature rise at 88% and 98%, followed by prolonged drought at 70% and 72%, irregular rainfall patterns at 69% and 81%, reduced rainfall and 80% and 84% and increased wind intensity at 22% and 28% in Machakos and Kitui, respectively, were the main aspects of climate change mentioned (Figure 2).

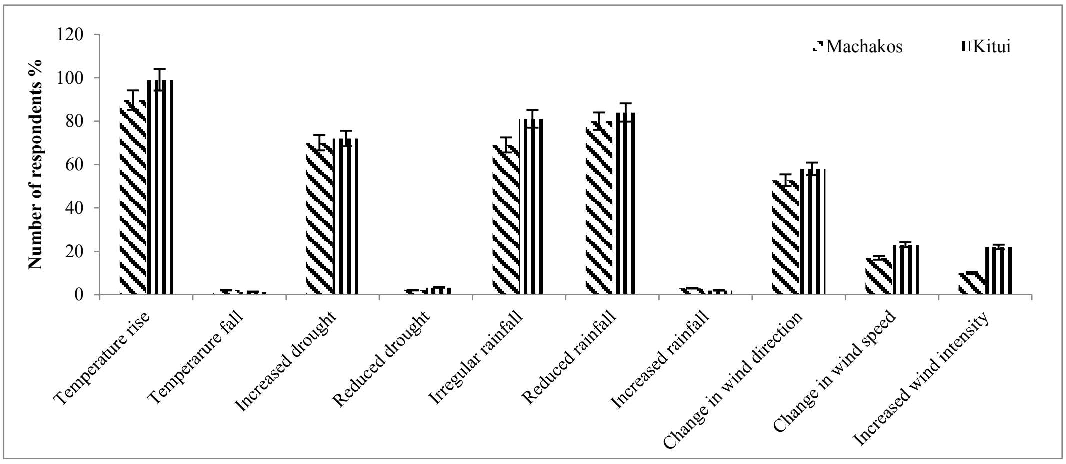

Figure 2. Climate change effects

One reason why the famers at both locations tend to suffer the same effects of climate change of temperature increase, reduced and irregular rainfall and hence increased drought is because, they depend on rain fed agriculture. Consequently, this has made the farmers more sensitive to changes in climate (rainfall and temperature) that may lead to negative effects in yields. Agatsive et al. (2010) noted that communities that depended on rain fed agriculture especially in ASAL regions noticed reduced rainfall, temperature increase and drought faster than other effects of climate change. The is in agreement with the suggestions of Macharia et al. (2012) who in his study in semi-arid regions of Nyeri north and Laikipia east districts indicated that the main indicators of climate change were changes in rainfall patterns, high temperatures and increase of drought leading to low crop yields.

3.2.2 Effects of Climate Change on Finger Millet Production

Of the farmers interviewed, 98%, in both regions, had observed that finger millet production had adversely reduced with increasing effects of climate change (Figure 3).

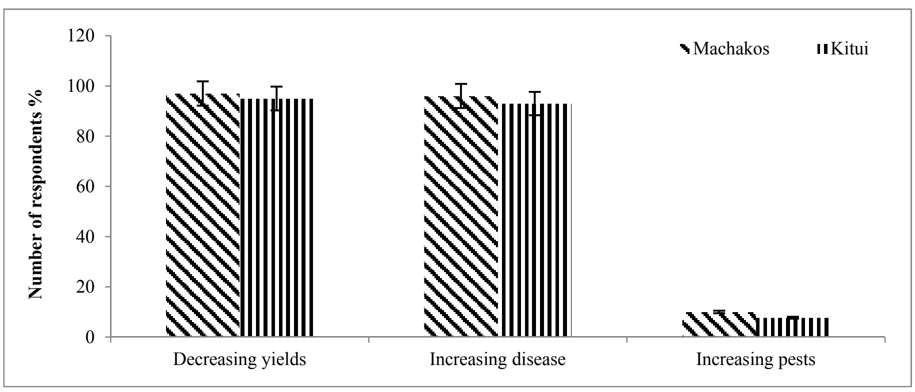

Figure 3. Effect of climate change on finger millet production

The farmers suggested that there was decreased finger millet production because of overdependence on rain fed agriculture which was now being challenged by increased occurrence of drought, reduced rainfall, increased pests and disease attacks as a result of climate change. Increased occurrence of drought and reduced rainfall had led to reduced soil moisture especially during critical plant growth phases leading to low finger millet yields. This is in agreement with findings of Tadesse (2010) who suggested that overdependence on rain fed agriculture by majority of people living in ASALs increased vulnerabilities to climate change parameters such as rising temperatures, rainfall variability, increased occurrence of drought and dependence on rain fed agriculture resulting in low crop yields.

Increase in diseases was also identified as one of the effects of climate change by 96% and 93% of repondents in Machakos and Kitui, respectively. Increased variability to climate change, especially increased temperature and reduced rainfall may have improved environmental conditions for establishment of disease pathogens. Goodman and Newton (2005) found that climate change would negatively affect plant disease resistance resulting in increased disease infestations.

Of the respondents 10.2% in Machakos and 7.7% in Kitui had noticed a slight increase in finger millet insect pests. The increase may be as a result of climate change that may have improved habitat for pest infestation. Harrington and Stork (1995) and Patterson et al. (1999) suggested that higher temperatures were expected to increase rates of development and the number of crop pests.

3.3 Coping and Adaptation Measures to Climate Change

Many respondents had taken up early planting followed by, use of organic inputs, tillage practices and irrigation and use of organic fertilizers as adaptation measures to climate change (Figure 4).

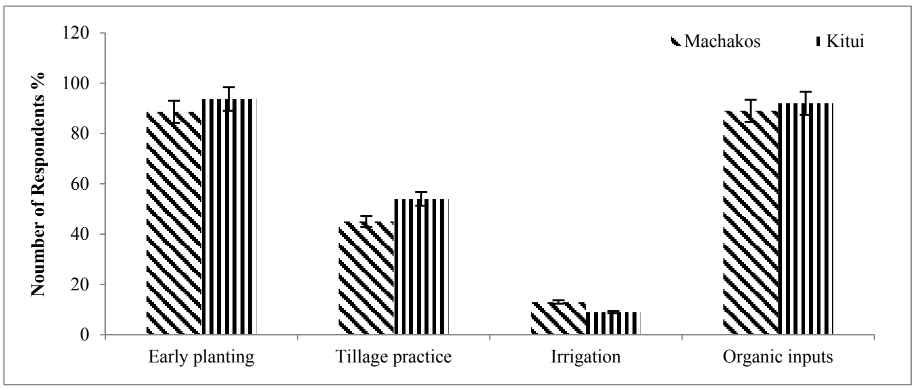

Figure 4. Coping and adaptation mechanisms to climate change

Farmers, 88.6% in Machakos and 93.7% in Kitui, considered early planting as a reliable method to mitigate against the effects of reduced and change in rainfall patterns. As rains had become more unpredictable and unreliable, crop failure was on the rise. Early planting was seen as a viable climate change adaptation mechanism as it allows for optimization of unpredictable, unreliable rainfall by ensuring crops were already established on the farm when the rains commenced. This agrees with work done by Pandey (2009) which showed that farmers commonly practiced early planting as drought coping mechanism so as to maximize on any rainfall events, for improvement of soil water management and consequently improved yields. Similarly, Larson (2010) showed that early planting had a positive effect on crop yields due to better water-use efficiency despite receiving less rainfall.

Respondents, 89% of Machakos and 92% of Kitui indicated using organic inputs as another coping mechanism for dealing with climate change. Through extension service providers farmers were aware of the importance of organic inputs, especially manure for soil water conservation. It has been reported that increase in soil organic matter improves water holding capacity and conductivity through improved soil aggregation and thus helping plants withstand vagaries of drought (Adeleye et al., 2010).

Use of water conserving tillage practices was carried out by 45% of respondents in Machakos and 54% in Kitui to cope with water stress which is a resultant of climate change (Figure 4). Establishment of different tillage practices was seen as a way to optimize on the limited rainfall events, through reduced loss of soil water by erosion, runoff and evapotranspiration. Practices in common use were tied ridges, ridges and furrows and building trenches around the farm. These tillage practices if appropriately established increased soil water conservation (Gichangi, 2012). Methods like ridges and furrows increased the area of soil water infiltration, consequently increasing the amount of plant available soil moisture. Increased soil moisture will lead to higher yields, and as such improve food security. This is in congruent with findings of Tian et al. (2003) and Wang et al. (2008) who reported that conservation tillage was one of the most efficient ways to conserving available soil water through reduced water and nutrient losses through erosion, leaching and runoff.

Irrigation was not a very common practice used to cope with climate change in the two regions. Only 13% and 9% of respondents in Machakos and Kitui, respectively, practiced irrigation (Figure 4). Through irrigation, farmers were able to provide crops with required soil moisture especially during periods of drought. This mirrors views by Kibet (2011) to the effect that irrigation could be used as a reliable supplement for natural rainfall, especially during periods of drought resulting in improved yields.

4. Conclusion

Apart from the popular maize which is used as food and income, farmers in the drought prone regions of eastern Kenya grew drought tolerant legumes including cowpeas, green grams and pigeon peas to mitigate the risks of climate change. Main aspects of climate change experienced were temperature rise, prolonged drought and irregular rainfall patterns. Early planting, tillage practices, use of organic inputs, and irrigation were identified as main adaptation measures to mitigate against the effects of climate change. Farmers have put emphasis on soil moisture conservation and soil fertility in adapting to effects of climate change. However, attention needs to be brought on traditional crops, which are naturally better suited to the harsh arid and semi arid environment, as a viable method to combat climate change. Although some farmers cultivated these crops, they did not consider them as a climate change adaptation mechanisms and focused on their subsistence production. Extension service providers need to educate farmers on traditional crops and their role as a feasible climate change adaptation mechanism.

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