Smallholder Farmers' Perception, Level of Awareness and Adaptation to Climate Change in Masinga Sub County, Machakos County, Kenya

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Abstract

Climate change and variability negatively affects the contribution by smallholder farmers towards household and community food security. Masinga sub-county being one of the most vulnerable regions to climate change has experienced unreliable rainfall, increased temperature as well as pests and disease occurrences which has resulted to decreased yields. The study sought to analyze smallholder farmers' perceptions to climate change, and adaptation strategies to climate change. The main objective of this research was to investigate smallholder farmers' adaptation strategies to climate change in Kithyoko, Kangonde and Masinga Locations. The closed and open-ended questionnaires and structured interview guides were used to collect data. Basically, questionnaires were employed to gather data from smallholder farmers' perceptions, adaptations strategies and constrains of adaptation practices to climate change in Masinga sub-county. The qualitative data was collected from the key informants by use of interview guides in the three selected locations. The study employed Krejcie and Morgan's (1970) formula for calculating the sample size, which states that, for a sample of 36,251, a sample size of 300 is appropriate. Based on this, therefore, the study targeted 300 households in three locations namely: Kithyoko, Kangonde and Masinga in Masinga Sub-County and 30 key informants in the three locations). Quantitative data was analyzed using descriptive statistics. Findings were expressed in frequencies and percentages as well as means and standard deviation before being presented in figures and tables. The results showed that 90% of the respondents were carrying out adaptation practices in response to unpredictable rainfall patterns and 10% were not carrying out adaptation practices at all. The smallholder farmers who were not carrying out adaptation practices were more vulnerable to climatic variations unlike those who were carrying out adaptation practices as a way of cushioning climate changes. Commonly practiced adaptation strategies were growing of drought resistant crops, planting improved crop varieties, conservation practices and use of pesticides. There was need to sensitize households on climatic variations and benefits of carrying out adaptation practices. Smallholder farmers need to be provided with resources by national and county government so as to carry out adaptation practices and therefore change from outdated methods of agriculture and be able to build resilience to climatic effects.

Keywords: Smallholder farmers, climate change, adaptation strategies

1.0 Introduction

Climate change and variability has been a global phenomenon that is affecting the future of humanity (IPPC, 2014). It requires close attention for it is directly affecting food production and farming communities (Jamshidi *et al.,* 2019; Menike & Arachchi, 2016) and thus impacting livelihoods of billions of people over the world and especially women and children. The smallholder farmers` play a very vital role to ensure accessibility to balanced meals that attains peoples nutritional and dietary purpose, and reduce poverty which enhances livelihoods (Baya *et al.,* 2019). Global heating shows a significant hindrance to geographical agricultural growth and nutrition to sustainable management of the environment implication. This becomes a great danger to the health of majority of the continent's countryside communities (Juana, *et al.,* 2013). Studies done in USA show that average yield of barley and wheat could follow from 17% to 3% worldwide (*Quan et al*., 2019).

Most of the smallholder famers in Sub-Saharan Africa (SSA) are found in Arid and Semi-Arid Areas (ASALs) and 70% depend highly on agriculture as the greatest source of income (Asayehegn, 2017). Adequate food supply ensures a healthy nation and its citizen do not suffer from malnutrition, diseases and the importation of food (Omoyo *et al.,* 2015). In addition, Omoyo *et al* . (2015) records that for any country to develop, food security should be guaranteed. In the stressed regions of SSA, the main natural resources like water are getting scarce thus having a negative implication on economic and social activities in rural and urban areas (Mwenda *et al.,* 2019). Global heating is expected to change pests and disease outbreaks, and increased floods and drought which will result to low or poor yields, livestock mortality and crop failure (Harvey, 2014).

Climate shifts have not only affected smallholder farmers' income but also the country's economy (Milkalista, 2015; Campbell, *et al.,* 2016). Therefore, climate change presents major threats in achieving the sustainable developmental goals (SDGs) especially SDG number 1 no poverty, SDG number 2 zero hunger and the thirteenth on climate change. These SDGs aims to support growth through changing socio-economic situations, thus getting rid of poverty and hunger, hence encouraging environmental sustainability (UN, 2015). The global community has realized agriculture as the power that moves growth and poverty elevation in countries where it is the main activity for the poor. Studies conducted in Ethiopia indicate that about 57. 8% of families are food secure whereas 42.2% of the families are food insecure (Woldeamanual & Simane, 2017).

IPCC predicts that by 2020 there will be 50 % decline in rainfall. This will result into decline of agricultural yields of major staple foods and 90 % drop in net revenue. In addition, the IPCC predicts that by 2050 there will be a decline from 8% to 22% in groundnuts, millet, cassava, sorghum and millet output which has resulted because of global crisis (Muema e*t al.,* 2018). According to IPPC 4th African assessment report, 75-250 million inhabitants of SSA would face heightened water stress by 2020. Crops from rain fed agriculture will decline in yield by 50%, unless deliberate efforts are made to adapt to climate change (Chete, 2018). IPCC`s fifth assessment raised concerns that pests and diseases on livestock and crops were likely to rise due to global heating (Niang *et al.,* 2015). Studies predict loss of 2% to 7% of GDP by 2100 in parts of Sub-saharan Africa, 2-4% in West Africa and 0.4-1.3% in Central Africa (Juan *et al.,* 2016).

Agriculture is the backbone of the Kenya's wealth and contributes at least 25%of the country's gross domestic product (GDP). Over the years, the country's GDP has been reducing from 40 % in 1963, 33% in the 1980's to 27% in 2014 (KNBS, 2015). The agriculture sector accounts for about 70% of the foreign exchange in the country and this has contributed to development of the country (Asayehegn *et al.,* 2017). According to (UN, 2015), over 75% of the Kenyans population earns their living from agriculture either directly or indirectly and therefore, for any development to occur there should be sustainable agriculture. Smallholder farmers play key role in agriculture Kenya has set a record of twenty-eight major droughts in the past 100 years (World Bank, 2016). This can be accredited to climate change and variability over past years. Smallholder farmers` have suffered losses as result of these droughts. Climate change has caused rainfall variability, raise in temperature, prolonged drought and floods (Serdeczny *et al.,* 2016).

In 2010, Kenya developed national climate change response (NCCR), which recognize the importance of climate change impacts on the country development. In 2012, National climate change action plan (NCCAP) was developed which highlighted agricultural adaptation practices. In Kenya, ASALS cover nearly 80% of the Kenyan land and 25% of the population in Kenya rely on 75% of crop production and livestock rearing (Mutunga *et al.,* 2017).

The general objective of this study was to analyze smallholder farmers' perceptions, level of awareness and adaptation to climate change in Masinga Sub-County, Machakos County, Kenya. The specific objective of the study was to investigate smallholder farmers' adaptation strategies to climate change in Kithyoko, Kangonde and Masinga locations. This study sought to answer the question: What are the smallholder farmers' adaptation strategies to climate change in Kithyoko, Kangonde and Masinga locations?

2.0 Literature Review

TPB has wide application in the study of human actions and has been used strongly in various areas such as food consumption and behaviors connected to good health (Ajzen, 2015). There are three factors that makeup TPB, these are behavioral beliefs which are perceived with regards to behavior; normative beliefs which are subjective norms and control belief which is behavioral control (Masud, *et al.,* 2016). Lin (2013) indicates behavioral beliefs results to an adverse or beneficial attitude concerning behavior.

Normative beliefs lead to personalized standards or perceived social pressure to accomplish a behavior. Control beliefs results in conscious behavioral measure that is the viewed difficulty or ease of accomplishing the behavior (Ajzen, 2015). When these three factors are considered give rise to behavioral intentions. Studies that have been done in support of this theory because of its ability to predict intentions showing that changes in behavior could bring changes in one's behavior. This theory is very relevant to the present study as it develops and qualifies the second research objective on the investigating smallholder farmers' adaptation strategies to climate change. The theory will help understand and predict the level of smallholder farmers` to carry out adaptation practices after perceiving climate changes information.

Therefore, smallholder farmers' behavioral changes as regards to conversion and readiness to take actions to implement strategies are very crucial. On some occasions, smallholder farmers may be conscious of global heating and may not be willing to adopt strategies that will assist in counteracting the negative effects of the climate change.

Smallholder Farmers' Perception, Level of awareness and adaptation to climate change

Adaptation is an adjustment in human or natural systems in response to expected or actual climatic stimuli or their effects, which exploits beneficial opportunities or moderates harm (Onyango, 2019). In addition, Ndamani, F. and Watanabe, T, (2015), adaptations are amendments and interventions that occur to control the losses or maximize on the privileges presented by a fluctuating climate. Adaptation has been opted as the only immediate way for protecting

Quan, Li, Song, Zhang and Wang (2019) explored farm household's autonomous climate change adaptation strategies in rural China. a pre-tested questionnaire was used on 360 farm households situated on six acres. The research showed that households had several adaptation measures that were carrying out in wheat production. These were use of pesticides, chemical fertilizers, change of crop variety and irrigation.

Yamba, Appia and Siaw, (2019) conducted a survey of 152 smallholder farmers in Bosomotwe district in the southern rural of Ghana to assess the perception and adaptation strategies to avert effects of climate variability. The study adopted a mixed cross-sectional research approach. The results indicated that 93% of smallholder farmers had adapted to climate change while 7% claimed to have not. Adaptation strategies included change of crop type and variety, irrigation, agrochemicals, clearing of virgin forests for new farmland and expansion of farms. Irrigation was not commonly practiced due to lack of funds.

In Kenya, Evelyn, Charles and Patricia (2017) adopted descriptive survey design administering questionnaires on 177 randomly sampled smallholder farmers of Mikuyuni and Kaveta villages in Kitui county, to assess the perceptions of small-scale farmers and identified measures of adaptation that were being adopted in response to climate variability. Results revealed that 76% of respondents in Kaveta village and 88% of respondents in Mikuyuni were adopting. The adaptation practices were use of animal manure, pesticides, planting hybrid varieties and practicing mixed farming.

In a study conducted on the adaptation mechanisms of the Turkana in Kenya by Opiyo, Wasonga, Nyanyito, Schiling and Munang (2015), it was established that many of those who live adjacent to River Turkwell depend on the river for harnessing their livelihood needs through farming and harvesting sand. In fact, it was discovered that the communities had devised a wide array of mechanisms which supported their initiatives to struggle in order that they survive and better their social support capabilities

Perception is an important determinant for the adoption of adaptation measures. For adaptation to occur, variation in climate change has to be perceived to happen, therefore the role of perception as a precursor to adaptation plays a key role. If the role of perceptions is ignored in the adaptive decision of smallholder farmers` who are affected by climate variability, there is a likelihood of

counter productivity; this is because integration of human perceptions to the adaptation process could address the shortfalls of socio economic, technical and institutional determinants.

Pickson and Hege (2021) conducted a study in Chengedu China to asses smallholder farmers' perception and adaptation constraints to determine capacity of adaptation to climatic variation. Purposive and quota sampling technique were used in the study. Sample size was 46, 170, 56 and 111. Smallholder rice farmers from Pidu, Qionglai, Xinjin and Dayi were selected. The study revealed that households had realized that global warming had affected rice production, water sources were drying and occurrence of new diseases was being reported. In order for smallholder farmers to carry out adaptation strategies perception of climate variations is very key

In Kenya, Onyango *et al.* (2019) conducted a survey in two wards in Yatta sub-county namely Ikombe and Katangi. A semi-structured questionnaire was administered to 60 households randomly selected. The study revealed smallholder farmers were aware of climate change. Erratic and low rainfall, rising temperature and drought were reported to be known indicators. Deforestation was sited to be the main cause of the climate change in the area.

3.0 Research Methodology

This study was carried out in Masinga Sub-County, in Machakos county, Kenya. It has a population of 148,522 (KNBS, 2019). The study was specifically carried out in three locations, Kithyoko, Kangonde and Masinga. The study employed a combination of purposive, stratified and systematic sampling to select the study area and respondents. Masinga Sub-County was stratified into ten locations and then three locations purposively selected for the study based on the heterogenic nature of the study area. In each of the selected location. The study employed Krejcie and Morgan's (1970) formulae for calculating the sample size, according to the formulae, for a sample of 36,251, a sample size of 300 is appropriate. Based on this, therefore, the study targeted 300 households in three locations namely, Kithyoko, Kangonde and Masinga in Masinga Sub-County. In each location one hundred households were sampled. In addition, 30 key informants were targeted who includes chiefs, assistant chiefs, area managers, agricultural extension officers and non-governmental organizations. These individuals were targeted because they were directly or indirectly involved in farming, therefore they were able to giver relevant information.

The close and open-ended questionnaires and structured interview guide were used to collect data. The questionnaires were used to gather primary data from 300 households and interview guides were used to gather qualitative data from key informants. After collecting data, it was analyzed using descriptive statistics. Findings were expressed in frequencies and percentages as well as means and standard deviation before being presented in figures and tables. The permission to collect data was sought from St. Paul's University, NACOSTI and the local administration in each location.

4.0 Results And Discussions

Demographic characteristics of respondents

The demographic characteristics for the respondents are shown in Table 1. Majority of the respondents were male (54%) whereas 46% were females. The respondents sampled, 83% were adults (aged 36 years and above) meaning they had wide experience in agriculture and had observed climate variability for a long duration. Therefore, were deemed able to come up with adaptation strategies that will improvement farming in study area.

Table 1: General demographic characteristics of respondents

Demographic characteristics	Frequency	Percentage (%)
Gender		
Male	162	54
Female	138	46
Age Bracket in years		
Below 35	51	17
Between 36-45	113	37.7
Between 46-55	81	27.0
Over 55	55	18.3
Level of Education		
Primary	124	41.3
Secondary	86	28.7
Certificate	34	11.3
Diploma	26	8.7
Degree	12	4.0
Masters	1	0.3
Non-Formal	17	5.7
Marital Status		
Single	40	3.3
Married	222	74
Widowed	28	9.3
Separated	10	3.3
Farming Experience in Years		
Below 10	96	32
Between 11-20	130	43.3
Between 21-30	36	12
Above 31	38	12.7
Source of income		
Farming	216	72
Employed	47	15.7
Business	35	11.7
Other	2	9.7

The results showed that majority of the respondents sampled (41.3%) had attained primary education, followed by 28.7% with secondary education level. Therefore, the likelihood the smallholder farmers would be able to adopt adaptation strategies that will counter the effects of climate change. Majority of the respondents were married at 74% and 13.3% were single while 9.3% were widowed as shown in Table 1. The respondents had different duration of farming experiences with 32% having farmed for less than 10 years, 43.3% had been farming for 11 to 20 years and 12% had farmed for 21 to 30 years. The main source of income for majority of the respondents sampled was farming at 72%, followed by those employed at 15.7% and whose income was from business were 11.7%. Labor is one of the factors of production and therefore plays a very key role in determining how much households would spend on farming process. The source of labor for the different households surveyed showed that 64% of households depended on family members as their source of labor. This would mean that the households will spend less money on paying for labor, and thus positively influencing smallholder farmers in carrying out adaptation strategies. The study found that majority of the households owned farming land which had a mean of 4.81±3.592 hectares. These farms were mainly for growing crops like maize, beans, green grams and also keeping livestock. Since land sizes were small, households did agriculture for home consumption. The findings are consistent with studies conducted by Menike and Arachchi (2016), Mutunga *et al.* (2017) and Simotwo *et al.* (2015).

Types of crops and livestock kept by the households and factors influencing farming

The study sought to know the crops and livestock kept by households in the study area, adaptation practices adopted and their benefits. In addition, the study investigated the source of household income and its effects on climate change adaptation. The results indicated a total of 289 (96.3%) households were growing maize, 247(82.3%) were growing cow peas and 242 households represented by 80.7% were growing beans. The crops by households were suitable to the area of study. Findings also had an implication that household practiced diversification in their farming. Amongst the livestock kept, cattle were 77%, goats 76.3% and least was chicken represented by 22.3%. Maize was commonly grown and cattle was mostly kept. The factors that influenced the type of crops grown by different households are presented in Table 2.

Table 5: Factors influencing crops grown by respondents

Variable	Response	Frequency	Percent
Cultural Value	Yes	207	69.0
	No	93	31.0
Water Availability	Yes	71	23.7
	No	229	76.3
Soil Condition	Yes	238	79.3
	No	62	20.7
Market Availability	Yes	232	77.3
	No	68	22.7
Ability to resist Climate change	Yes	261	87.0
	No	39	13.0
Land Tenure	Yes	154	51.3
	No	146	48.7

The factor cited by majority of the households 261 (87%) was the ability to cope with climate change, followed soil condition with 238 households (79.3%). Availability of market had 77.3% while cultural value was represented by 69%. Land tenure was represented by 51.3% and lastly water availability was 23.7%. This implies that ability to resist climate change, soil conditions and availability of market were the most important factors influencing crops grown by the households in the study area.

This agrees with studies conducted by Ogalleh *et al*. (2013) and Nguyen and Kupika *et al. (*2019).

Adaptation practices to climate change

Findings showed that 90% of household carried out some adaptation practices whereas 10% had not adapted any strategies. The adaptations strategies practiced by farmers are presented in Table 3.

Table 3: Adaptation Strategies practiced by farmers

Adaptation strategies adopted by farmers	**Kithyoko n=100**	**Kangonde n=100**	**Masinga n=100**	**Overall percentage (%)n=300**
Irrigation agriculture	20	12	53	28.3
Improved crop variety	79	67	76	74
Drought resistant crops	76	95	73	83.3
Pasture preservation	69	46	51	30
Early planting dates	68	25	35	55.3
Agro forestry	48	16	44	36
Use of pesticides	59	84	71	71.3
Use of animal manure	68	73	80	73.7
Conservation practices	66	74	80	73.3
Use of inorganic fertilizers	42	24	56	40.7
Rainwater harvesting	47	28	50	41.7

Note: Multiple responses accepted

The research established that highest numbers of smallholder farmers in Masinga sub-county were implementing adaptation practices to counter impacts of climate shifts. Practices of adaptation were, growing of drought resistant crops (83.3%), improved crop variety (74%), conservation practices (73.3%) use of pesticides (71.3%), early planting dates (55.3%), Rain-water harvesting of (41.7%) use of organic fertilizers (40.7%), practicing agroforestry (36%), pasture preservation (30%) and irrigation agriculture (28.3%).

These included, practicing irrigation agriculture, planting of improved crop varieties like (Nduma, Pioneer) growing of drought resistant crops like (Green Grams, Katumani Maize and Cowpeas), pasture preservation carrying planting before onset of rainfall, planting of trees, control of pests and diseases by use of chemicals, use of animal manure like farm yard manure, practicing construction of terraces for conservation, uses of inorganic fertilizers and Harvesting of rain water by use of plastic tanks and earth dams. These results agree with the findings of,

Asayehegn, *et al.* (2017), Ndamani, F. and Watanabe, T. (2015) and Kupika, *et al.* (2019) who reported similar adaptation practices.

The findings from the key informants were that half of the smallholder farmers were carrying out adaptation strategies in their farms while others were still using traditional methods, cultural beliefs, ignorance and resistant to change where some of the factors that were hindering farmers from accepting adaptation practices. Some of the adaptation strategies carried out were diversification of crops, pasture preservation, cutting terraces, improved local adapted crops were planted these were katumani maize, pigeons yellow grams and sunflower.

A key informant said:

> "*Although smallholder farmers have been trying to carry out adaptation strategies in their farms the yields have been very low as a result of dry spells. These has been worsened by rigidity and ignorance of smallholder farmers not willing to change to traditional crop growing to crops that fetch high prices like watermelon and passion fruits.*"

These results agree with the findings of Asayehegn *et al (2017),* Ndamani, F. and Watanabe, T. *(2015) and* Kupika, *et al. (2019)* who reported similar adaptation practices.

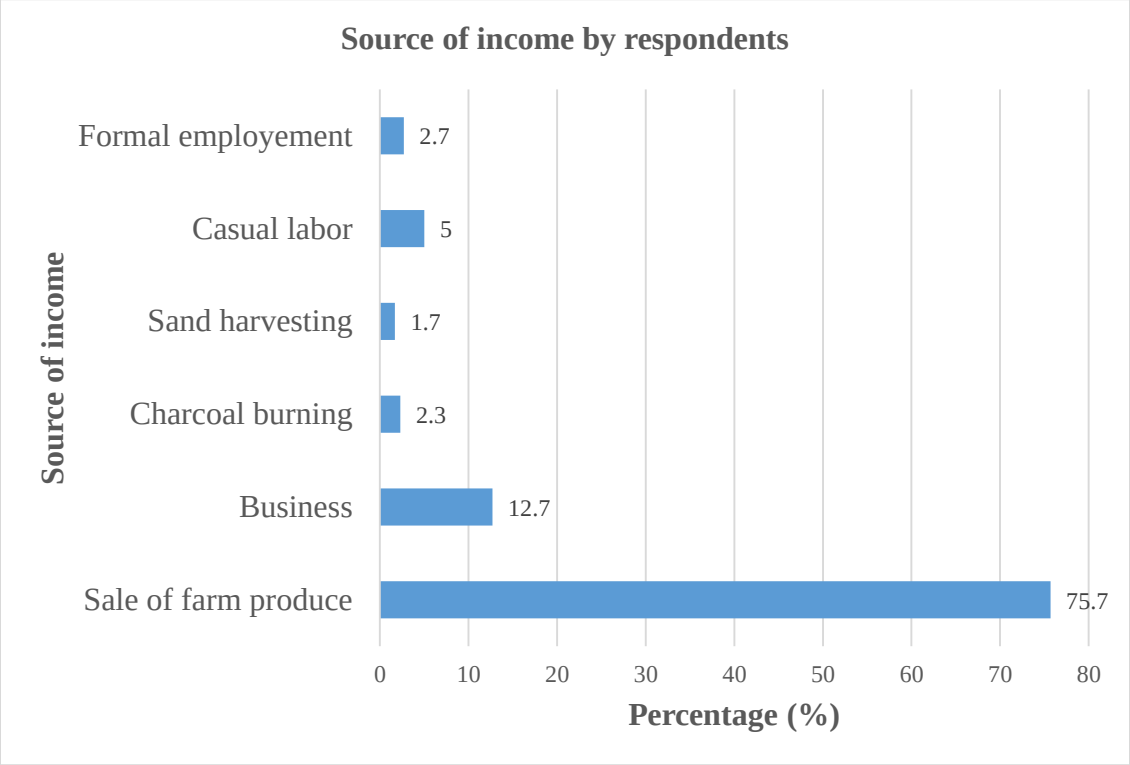

Figure 1: Source of income by respondents

A total of 277 (92.3%) of the household sampled, indicated that their source of income did not have any effects on climate change while 23 (7.7%) of household sampled, the source of income had negative effect on climate change. This included charcoal burning and sand harvesting

5.0 Conclusion and Recommendation

Conclusion

The study concludes that not all the households were aware of climate shifts. The seminars, extension officers, internet, peer farmers, Newspaper, Television, radio, formal education, self-help groups, Barazas and NGOs were mainly climate information sources.

Regarding smallholder farmers adaptation strategies, not all the households were carrying out adaptation practices. Adaptation practices implemented are: drought resistant crops, pasture preservation, improved crop variety, conservation practices, use of pesticides, early planting dates, rain-water harvesting, use of organic fertilizers, practicing agroforestry, pasture preservation and irrigation water.

The study concluded that the smallholder farmers were facing various constraints to adaptations strategies. These were: farm inputs cost was high, credit facilities access was inadequate, inadequate climate information, poor knowledge on modern farming systems, water for irrigation was insufficient, poor coverage of agricultural extension services, fluctuations of prices for farm produce, unavailability of improved seeds, weak agricultural policies and poor land ownership practices.

Recommendation

While the current research delimitated on household adaptation practices to climate change, the study proposes further studies on factors affecting choices of adaptation practices by the households. There is need to focus on other locations that is Ekalakala, Kivaa, Ndithini and Muthesya.

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