THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

Exploration of the Indigenous Farming Practices Used by Local Farmers for Adaptation to Climate Change in Lower Nyakach Division

Ochola Sylvance Onyango
Department of Sociology and Anthropology, Maseno University, Private Bag, Maseno, Kenya
Fred Ikanda
Department of Sociology and Anthropology, Maseno University, Private Bag, Maseno, Kenya

Abstract:
Adaptive strategies have been employed by farmers in developed countries to mitigate effects of climate change and to enhance food security. Most households in rural areas of Kenya still face food insecurity and there is no evidence that local farmers have adopted appropriate farming practices to cope with climate change effects. The general objective of the study was to explore the indigenous farming practices for adaptation to climate change in Lower Nyakach Division. Specific objectives were to: examine the level of awareness of climate change; explore the indigenous farming practices, and to assess the effectiveness of the indigenous farming practices in adaptation to climate change effects. Descriptive cross-sectional design was used on a target population of 2504 household stratified in 4 sub locations. The sample size comprised 10% of the target population as recommended by Gay & Diehl (1992), representing 250 households. Data was collected using structured questionnaire from household heads. It was found that farmers were aware of common short and inconsistent patterns of rainfall, and floods in the recent past accompanied with strange diseases like Miguna Miguna and invasion of army worms. Multi cropping, intensive weeding, planting early maturing crops, and applying manure on the farms are some of the indigenous farming practices engaged in for adaptation to climate change. These practices have not helped the farmers much in adaptation to climate change, leading to losses in farm produce. It is recommended that extension officers should use village barazas to disseminate climate change information, and that capital support be availed to farmers to enhance their capabilities. Further studies should be done on contribution of radio broadcasts on adaptation to climate change, and effect of climate information flow on adaptation practices to climate change.

Keywords*: Adaptation; outcome; climate change; indigenous farming practices; awareness: lower nyakach division*

1. Introduction

Dependence on climate-sensitive natural resource base like rain-fed subsistence agriculture continues to expose developing countries like Kenya to food insecurity. Consequently, this hinders the attainment of the sustainable development goals (SDGs) number one and two which aims to end poverty in all its forms everywhere and end hunger, achieve food security and improved nutrition and promote sustainable agriculture by 2030 respectively (United Nations Sustainable Development Summit, 2015). Deressa, Hassan, Alemu, Yesuf and Ringler (2008) assert that globally, the earth has over the years observed a significant increase in temperature but decreased precipitation. A broad consensus exist that climate change impacts may lead to serious ecological, economic and social impacts across globe, with some regions and sectors more deeply affected than others, according to the European Environmental Agency (EEA, 2012). Although appropriate adaptation can reduce these impacts and, in some cases, yield benefits and business opportunities, there are limited information with regard to such practices as employed by rural farmers in Kenya.

Adaptation is the adjustment of natural or human systems in response to current or expected climate change (or to its effects), to moderate negative consequences and take advantage of any opportunities (Mansanet-Bataller, 2010). On the other hand, Mabe, Sarpong, and Osei-Asare (2012) defines climate change as a significant shift in the average weather condition especially average temperature and precipitation of an area, and it is predicted that most land areas will have warmer and fewer cold days and nights. Similarly, Intergovernmental Panel on Climate Change Working Group (IPCCWG II, 2007: 30) states that climate change is a change in the climate that persists for decades or longer, arising from either natural causes or human activity. In their view, Antwi-Agyei, Dougill and Stringer (2013) suggest that Africa is particularly vulnerable to climate change due to the continent's high poverty levels, low adaptive capacity, its dependence on rain-fed agriculture as well as its limited economic and institutional capacity. However, indigenous farming practices adopted by rural farmers in parts of Kenya

in response to changes in climate seem to have received minimum attention. This is in disregard of the fact agricultural production in these areas continues to reduce each year.

In Kenya, farmers have continued to link reduction in agricultural production to climate shifts for the last 3 decades. Voluntary Service Overseas Evaluation Report (VSO, 2012) estimated that 53.4% of people in Kisumu County (Kenya) live below the food poverty line, compared to 8.4% in Nairobi. In Lower Nyakach Division in Kisumu County where households rely on maize crop as staple food, there are often poor harvests every season, with an approximate two to three bags yields to feed a household of five persons annually (Obuoyo, Ochola & Ogindo, 2016). Ochieng (2014) asserts that 65.0 percent of the residents of the division are food insecure due to infestation of maize farms by striga, declining soil fertility due to overuse and soil erosion. This therefore queriesthe farming practices employed by the farming households in ensuring adaptation to changes in climatic conditions. Records from Nyakach Sub County Agricultural Office (2016) indicate that between 2012 and 2015, Lower Nyakach Division with four administrative locations has realised a steady decline in maize crop production. Table 1.1 presents the trend of maize crop production in the area.

	2012	**2013**	**2014**	**2015**	**No of Households**
Jimo East	4585	4467	4412	4362	917
Rarieda	2120	2052	1992	1968	424
Gem Nam	2155	2064	2008	1987	431
Moro	3670	3567	3501	3484	734
Total	**12530**	**12150**	**11913**	**11801**	**2504**

Table 1: Trends of Maize Crop Production in Lower Nyakach Division
Source: Nyakach Sub County Agricultural Office (2016)

Table 1 illustrates that between 2012 and 2015, there was a decline of 712 bags in maize production in Lower Nyakach Division. Between 2012 and 2013, the production declined by 380 bags; 220 bags between 2013 and 2014; and 112 bags between 2014 and 2015. With a population of 2504 household (Kenya Population Census Report, 2009), each household received approximately five bags of maize from their farms to feed an average of five persons per household (KPC, 2009). Similarly, in 2013, 2504 households were to feed on 12150 bags obtained from the farms: this translates to 4.9 bags per household; in 2014, the amount reduced to approximately 4.8 bags per household, while in 2015; it declined to approximately 4.7 bags. This therefore implied that in a household of five persons, each person consumed 0.94 bags (or 37.6 two kilograms tins) of maize in 2015. This is far below an average of 91 two-kilogram tins per year as recommended by the World Food Organization (FAO), International Fund for Agricultural Development (IFAD) and the World Food Programme (WFP) (FAO, IFAD & WFP, 2014). Furthermore, the report in Table 1 questions the effectiveness of indigenous farming practices employed for adaptation to climate change by farmers in Lower Nyakach Division.

1.1. Statement of the Problem

It is estimated that 53.4% of households in Kisumu County live below the food poverty line, compared to 8.4% in Nairobi. In Lower Nyakach Division, households comprising five persons seem to be relying on farm harvests of between four and five bags of maize annually. This is an indication of food deficiency. Owing to the fact that climate change is unique to each region, adaptation practices adopted by farmers for mitigation of climate change effects in each region needs to be enquired. In Kenya, little evidence is available concerning the level to which adaptation strategies to climate change have been investigated. Moreover, the level of awareness of climate change, the indigenous farming practices for adaptation to climate change as well as their effectiveness in enhancing adaptation to the same is hardly known. This seems to be true because several households in areas like Kisumu County have been facing reduced food crop production, ostensibly due to effects of climate change. This study therefore sought to answer the following research questions:

1.2. Research Questions

- What is the level of awareness of climate change by local farmers in Lower Nyakach Division?
- Which indigenous farming practices are used by local farmers for adaptation to climate change in Lower Nyakach Division?
- How effective are the indigenous farming practices for adaptation to climate change in Lower Nyakach Division?

1.3. General Objective of the Study

The general objective of the study was to explore the indigenous farming practices used by local farmers for adaptation to climate change in lower Nyakach Division

1.4. Theoretical Underpinnings

This study was informed by the capabilities theory advanced by Sen (1992, 1999, and 2004). The theory emphasizes on the distinction between the means and the ends of well-being and development, and that only the ends have intrinsic importance, whereas means are only instrumental in the achievement of well-being and development. According to Sen

(1992), major constituents of the capability approach are functionings and capabilities. Functionings are the "beings and doings" of a person, whereas a person's capability is "the various combinations of functionings that a person can achieve. Capability theory examines capacities necessary for people to lead functioning lives. In the view of Goerne (2010), functioning lives reflects the collection of 'beings' and 'doings' that can be viewed in various outcomes in one's achievements. A capability approach focuses on whether or not people possess capacities necessary to construct a fully functioning life. On the other hand, Nussbaum, (2011) considers capacities as natural systems that directly depend on a stable climate system.

Since changes in climatic conditions will affect what individuals are able to achieve with the resources that they have, capability theory was found suitable for the present study. Schlosberg (2011) asserts that capability approach provides a concept that can encompass the current framing of climate change in a way that is more applicable to the development of adaptation strategy. Since this approach addresses the basic requirements that are necessary for human life to function and flourish; it is important to align adaptation strategies with climate change for the purpose of protecting basic functioning of human communities. If climate change impedes agricultural practices, or/and undermines local infrastructure, then functioning will be limited. In that case, climate change is a barrier to functioning lives of individuals (Schlosberg, 2011: 19). Additionally, Nussbaum (2011) considered the potential mental health impacts, such as the increased stress of farmers who have been affected by climate change, and the overall anxiety of rapid climate change, as a barrier to capability of emotional health.

1.5. Literature Review

Adopting effective adaptation strategies to combat climate change can only be possible if small scale farmers understand the manifestations of climate variability (Clements, Haggar, Quezada and Torres (2011). Several studies have attested to understandings (of climate change and adaptation strategies) as the first step in mitigating vulnerability caused by variations in weather over time. Pidgeon and Lorenzoni (2006) reviewed major studies to analyse how climate is conceptualized among the public in Europe and the United States of America (USA). This was a comparative analysis using study finding from Europe (25 studies) and USA (30 studies). They found some shared perspectives among publics across the Atlantic (although not strictly comparable, general US findings are broadly in the range of the EU ones), supported by fifteen years of climate change perceptions research. Specifically, the analysis established widespread awareness and concern about environmental issues and climate change. Nonetheless, Pidgeon and Lorenzoni (2006) did not find out the adaptation strategies used to address vulnerabilities to climate change in their review. The need to address these areas necessitated the present study. The BBC World Service Trust (2010) conducted research to explore public awareness and understanding of climate change in Tanzania. The findings were that Tanzanians have noticed changes in the weather, seasons and drought but most have little understanding of the relationship between these issues and climate change; are unfamiliar with the concepts of climate change and global warming; believe that humans are to blame but point to local deforestation and local pollution as the primary causes of the drought and environmental degradation and hold themselves individually or collectively responsible for local changes.

Another study done in Tanzania to established people's indigenous knowledge on Climate Change & Variability and their adaptive capacity was by Mary and Majule (2009). This was done in two villages of Kamenyanga and Kintinku of Manyoni District, central Tanzania. Findings showed that local people perceived changes in rainfall and temperature to have affected crops and livestock in a number of ways resulting in reduced productivity. Kalungu, Filho, and Harris (2013) assessed smallholder farmers' perception of the impacts of climate change and variability on rain-fed agricultural practices in semi-arid and sub-humid regions of Kenya. It was found that more farmers at the drier sites reported having perceived more changes in the past 30 years than in the past 10 years in nearly all the selected agricultural practices. In addition, there was a strong association between the perceived changes and the regions (semi-arid and sub-humid) for the last 30 years. The study also showed that there was significant association between the observed changes in agricultural practices and household.

Although farmers have resorted to different farming practices like crop diversification, planting different crop varieties, changing planting and harvesting dates (among others), limited studies in the developing countries have established whether these are adaptation practices to climate change. Studies done in the USA, Europe, and other developed countries have however attested to this. Jackson, et al., (2011) examined adaptation strategies for agricultural sustainability in Yolo County in California, USA. They found that farmers concerned about climate change were more likely to implement water conservation practices, and adopt voluntary Green House Gas (GHG) mitigation practices.

Ramsey and Tarleton (2008) assessed farm-level adaptation to multiple risks in climate change and other concerns among farmers in the Parkland region of Manitoba, Canada. A change in crop hybrids was the only adaptation made by farmers that was related almost exclusively to climate. Another study by Below, Artner, Siebert and Sieber (2010) explored micro-level practices for adapting to climate change that are available to small-scale farmers of African origin all over the World. The study found 104 different practices relevant to climate change adaptation and organized them in five categories: farm management and technology; farm financial management; diversification on and beyond the farm; government interventions in infrastructure, health, and risk reduction; and knowledge management, networks, and governance.

Enete, Madu, Onyekuru, Onwubuya, and Eze (2011) aimed at promoting understanding of the most cost-effective and sustainable indigenous climate change adaptation practices in southeast Nigeria. They found that in the face of extreme weather events occasioned by climate change, and apparently because of its tolerance to these conditions, cassava, has become

the dominant food crop in the area.In Lesotho, African Technology Policy Studies, (ATPS, 2013) assessed the response of farmers to climate change in Ts'akholo and Kolo communities in Mafeteng District. The results revealed that the farmers reported experiencing drought, sporadic and heavy rainfall periods, soil erosion, declining yield, pests and disease infestation, and short growing season and this has led to them developing their own adaptation/coping strategies to climate change. Some of the adaptation strategies include water harvesting technologies, conservation tillage, use of keyhole and trench gardens, agro-forestry and application of traditional medicine to control pests and diseases.

A study done in Kenya by Oremo (2013) sought to identify small scale farmers' perception and adaptation measures to climate change in Kitui County. It was found that extension service, educational attainment, membership to social and economic group, and access to water were the major factors influencing adaptation uptake. Improving these factors will be important to enhance adaptive capacity at the household level. Ochieng (2014) sought to establish the factors that limit the adoption of Striga weed control mechanisms in Nyakach district in Kisumu County. Increase in access to credit by farmers increases their adoption of control methods of striga by 31%. An increase in the level of income of the respondents decreases their adoption of striga control methods by 0.0084%. Increase in the level of education increases the level of adoption of striga control methods by 68%. Increase in access to the extension services increases the adoption by 13%. A unitary increase in age of the farmer increases adoption increases by 2.4%. There is a positive relationship between gender and adoption: with every male farmer, adoption of striga control methods is likely to increase by 14%.

2. Materials and Methods

2.1. Study Area

Lower Nyakach is one of the three divisions that make up Nyakach Sub County in Kisumu County. It is bound to the north by Nyando division in Nyando Sub County, to the South by Upper Nyakach division, to the West by West Nyakach division and Lake Victoria to the North West. The divisions forming the Nyakach Sub County are Lower Nyakach, Upper Nyakach and west Nyakach divisions. The Division's total area is 182.6 Km^2 and total population of 58,789 according to Kenya Population Census Report (Republic of Kenya, 2009). The rivers that run through the area are River Awach and River Nyando, which often flood adjacent farms and villages during heavy downpour of rainfall, at times making it difficult for cultivation. The rest of the area, however remains dry and are nonproductive agriculturally. Maize and sorghum are the staple foods in the area. However, each household of five persons is only able to obtain approximately two bags of such produce to be consumed each year. Households in Lower Nyakach therefore rely on supplies from Upper Nyakach Division and Kericho County, although this is a stressor to household income.

2.2. Methodology

This was a descriptive cross-sectional survey design that employed both quantitative and qualitative data collection method and analysis. Study population comprised of household heads from four sub-locations in Lower Nyakach Division, namely Jimo East, Moro, Gem-Nam, and Rarieda, totaling 2504 in number. According to Gay & Diehl (1992; cited in Mungure, 2015: 21), the number of respondents acceptable for a study depends upon the type of research involved: descriptive, correlational or experimental. Gay and Diehl (1992) contend that for descriptive research, the sample should be 10% for a large (more than 2000) population, and 20% for a small (less than 1500) population (Hill, 1998: 6; Akyina & Alubokin, 2016: 42). Therefore 10% of the targeted heads of households were selected as the sample size, making up 250 households. To ensure proportional representation of each sub location according to the population of each unit, proportional stratified random sampling technique was employed, where each individual sub location served as a stratum. This enabled the researcher to select a sample in accordance with proportional percentage of the population of each sub group (stratum) or each sub location (Paton, 2002). For example, Jimo East, with a population of 917 households, had a proportional representation calculated as:

$$\frac{917}{2504} \times 100 = 36.6\%$$

Therefore, 36.6% of 250 households equal 92 households from Jimo East sub location. The same proportional calculation was applied to other sub groups. The sample size and sampling procedure is as shown in Table 2.

Sub location	Target Population	Sample size	Percent
Jimo East	917	92	36.6
Rarieda	424	42	16.9
Gem Nam	431	43	17.2
Moro	734	73	29.3
TOTAL	**2504**	**250**	**100**

Table 2: Sample Size

Source: adopted from Kenya Population Census Report (KPC, 2009)

The study used questionnaire method to collect data from randomly selected 250 household heads from the 4 locations sampled by the researcher. The questionnaire was administered in person by the researcher. The significance of this method is that it enabled the researcher to draw short simple questions, which were closed ended, and which also required short and precise answers from the respondents, (Tsai, Lin, & Sai, 2001).

3. Research findings

3.1. Biographical Profile of Respondent

Table 3 and 4 presents a summary of demographic profile of the sampled household heads.

Profile	Measurement	Frequency	Percentage
Return Rate of Questionnaires			
Gender	Male	96	38.4
	Female	154	61.6
	Total	**250**	**100**
Age	Below 30	23	9.2
	31 - 35	51	20.4
	36 - 40	35	14
	41 - 45	28	11.2
	46 - 50	37	14.8
	51 and above	76	30.4
	Total	**250**	**100**
Education Level	None	12	00
	Primary	123	49.2
	Secondary	105	8.70
	Tertiary	10	91.3
	Total	**250**	**100**
Approximate farm size	Less than 1 ha	46	18.4
	1 – 2 ha	121	48.4
	3 – 4 ha	58	23.2
	More than 4 ha	25	10
	Total	**250**	**100**
Family Size	1 – 3 Members	49	19.6
	4 – 6 Members	125	50
	7 – 9 Members	58	23.2
	10 – 12 Members	12	4.8
	13 and above	6	2.1
	Total	**250**	**100**

Table 3: Demographic Profile of Head Teachers and Teachers

Table 3 illustrates that majority most (61.6%) of the sampled household heads were females, while 38.4% were males. This suggests that among rural households which commonly engage in small scale or subsistence farming, women form the majority. This finding seems to indicate that most rural households engaging in small scale farming activities are headed by females. The Table further indicates that that most (30.4%) of the sampled household heads were aging 51 years and above, while 20.4% of the household heads were between 31 and 35 years of age. On the other hand, 14.8% of the respondents were of between 46 – 50 years of age; 14% of the sampled household heads aged between 36 and 40 years; 11.2% of the respondents being between 41 and 45 years old; and the remaining 9.2% of the respondents were of below 30 years of age. Findings in the Table indicate that over 50% of the sampled household heads were 45 years and above, suggesting that they were adults who have been participating in food production for the benefit of households which they head.

The Table further illustrates that the highest number (49.2%) of the sampled household heads had primary level of education, while 42% of them had secondary level of education. Furthermore, 4.4% of the sampled respondents did not attend school entirely, and the remaining 0.4% of the respondents failed to indicate their education level. It has been revealed by the Table that the highest numbers of households were headed by adults whose education levels are up to primary schooling only. This suggests that awareness to climate change might prove difficult to these household heads, because most of climate change information is seldom relayed through local vernacular languages. With regard to the farm size, the highest number (48.4%) of the sampled households own between 1 and 2 hectares of land, while 23.2% of them own between 2 and 3 hectares of land. On the other hand, 18.4% of the households whose heads participated in the study own less than 1 hectare of land and 10% of them were found to own more than 3 hectares of farm size. This finding indicates that more than 66% of the respondents own

below 2 hectares of land. This suggests that farmers in Lower Nyakach Division have limited options for crop diversification owing to farm size.

Concerning the size of the household, the table shows that the largest number (50%) of the sampled households had between 4 and 6 members, while 23.2% had between 7 and 9 members. Equally, 19.6% of the sampled households had between 1 and 3 members; 4.8% had between 10 and 12 members, and the remaining 1.2% of the sampled households had 13 and above members. However, 1.2% of the sampled household heads did not indicate the size of their families. This finding suggests that the average size of families in the study area is 5 members. Thus, households composed of 5 members and with less than 2 hectares of land would be expected to employ intensive farming inputs to adapt to climate change (Ndambiri, et al, 2012). This would call for high adaptive capacity or capability.

3.2. Level of Awareness of Climate Change

The first objective of the study sought to assess the level of awareness of local farmers on climate change. Using translated language to suit local dialect, the researcher presented statements related to the level of awareness in regard to shifts in climatic conditions, whereby the sampled household heads were requested to express their agreements as: **1**- Strongly Disagree; **2**- Disagree; **3**- Neither Agree nor Disagree; **4**- Agree **5**- Strongly Agree to the statements presented by the researcher. Table 4 presents the distribution of respondents by level of awareness of local farmers to climate change.

No	Items	1	2	3	4	5
1	We often receive weather information through *barazas*	9.6	29.6	28.4	32	4
2	Radio has been a common source of weather information	0.4	1.2	0.8	76.0	21.6
3	We've experienced decreased rainfall in recent past	00	11.2	0.8	87.6	0.4
4	We have received intense rainfall in recent past	00	30.4	6.4	62.4	0.8
5.	Prolonged draught has become common in the village	00	7.6	4.8	74.0	13.6
6	Floods have become common on arrival of rainy seasons	00	22.0	1.6	63.6	12.8
7.	Short and inconsistent patterns of rainfall are common	00	4.4	2.0	92.4	1.2
8.	Heavy rainfall has caused delay of land preparation	00	38.8	5.2	38.8	17.2
9	We receive weather information via extension officers	7.6	68.0	0.8	22.8	0.8
10	We rely on internet for weather information	18.8	78.4	0.8	1.6	0.4

Table 4: Distribution by Level of Awareness of Local Farmers

Table 4 illustrates that, with regard to level of awareness of shifts in climate change, 92.4% agreed that they were aware of common short and inconsistent patterns of rainfall; 87.6% agreed that there has been decreased rainfall in recent past; 76% of the sampled household heads also agreed that radio is a common source of weather information in the area; another 74% also agreed that there has been prolonged droughts in the village; while 63.6% of the sampled household heads agreed that there has been floods during rainy seasons. Equally, 62.4% of the sampled household heads agreed that instances of intense amounts of rainfall had been some shifts in climatic conditions in the area. On the other hand, the respondents disagreed that: they rely on internet for weather information (78.4%); and that they receive weather information from extension officers (68.0%). This therefore implies that rainfall patterns have become short, inconsistent and decreased in amount in Lower Nyakach Sub County. Moreover, radio has remained a common source of weather information in the area, while internet seems to be inaccessible due to low level of education and location of the area, being far away from urban centres.

Interviews held with the agricultural officers also produced an outstanding theme pointing to lack of information seeking from the side of the farmers, with the following statement emerging from one of the two Agricultural Officers:

Only a few farmers from this division do seek necessary weather information from the agricultural extension officers (A1).

Without seeking weather information from sources like agricultural officers (also referred to as extension officers), it is likely that by the virtue of being a common mass communication gadget, radio stands as a common source of information, including weather information, in the division. Additionally, owing to the fact that majority of the household heads who participate in small scale farming in the area are females with primary level of education, limitation in language of communication might suggest that vernacular radio stations are the only optional source of information. This finding resonates with that of The BBC World Service Trust (2010) when it conducted a research to explore public awareness and understanding of climate change in Tanzania. It found that although Tanzanians have noticed changes in the weather, seasons and drought, most of them have little understanding of the relationship between these issues and climate change due to lack of weather information from experts. It is therefore important to note that the capability of these farmers to access appropriate weather information seems to be limited in terms of lack adequate language for communication and knowledge of where to get such information.

With regard to weather information as held by farmers in the division, an outstanding theme emerging from two FGDs was soil degradation as well as emergence of pest and strange crop diseases such as *Miguna Miguna* (the yellowing of the entire maize crop) that have taken place in the recent past. A common theme derived by the researcher was:

There has been increase in land degradation, and soil erosion leading to formation of gullies. There has also been emergence of pests and diseases like "Miguna Miguna", yellowing of maize plants, affecting maize crops in the region; unpredictable weather patterns, and prolonged drought and floods (F3).

This excerpt from FGDs implies that the sampled farming household heads are aware of climate changes and the effects that this has had on crop production. Figure 1 presents a picture of a maize disease invasion in the study area.

Figure 1: Picture of strange disease invasion on Maize Crop

Figure 1 and 2 presents pictures of maize crop that have suffered from invasion of strange diseases. According to the farmers who participated in the FGDs, the developing cob is first attacked during flowering stage, and then the entire crop turns yellow. The type of attack shown in the second picture is the outcome of the stalk yellowing. This was another statement that emerged from the discussants:

(Ochondo mako bando te, ma gima inyalo ka en man nus mar bando) ..... the entire cob is consumed by the disease such that one can only get half of what was expected from the field (F5).

This statement indicates that the farmers lose almost half of what they were expected to harvest due to this invasion. This finding seems to concur with Mary and Majule's (2009) results in a study which established that changes in rainfall and temperature have affected crops and livestock production in a number of ways resulting in reduced productivity in Tanzania. Nevertheless, Pidgeon and Lorenzoni (2006) did not find any perceived negativity as well as threat attributable to changes in climate in a study among the public in Europe and the United States of America. This might have been due to contextual differences and individual capabilities in developed and developing countries. Perhaps the capabilities of farmers in Europe to adapt measures that mitigate effects of climate change enable them to realize uninterrupted crop production throughout farming periods. This is in line with Schlosberg (2009) assertion that changes in climate affects what individuals are able to do with the resources that they have. For instance, if climate change impedes agricultural practices, then functioning of lives becomes limited. In that case, climate change is a barrier to functioning of lives. Capabilities of farmers in places like Tanzania and Lower Nyakach Division to own sufficient resources to mitigate effects of climate change has therefore led to low production of food crops hence affecting functioning of lives of households.

3.3. Indigenous Farming Practices

The second objective of the study sought to establish the indigenous adaptation strategies used by local farmers in addressing climate change and to enhance crop production. To this end, the researcher presented statements related to indigenous farming practices adapted to combat shifts in climatic conditions, whereby the sampled household heads were requested to express their opinion to the presented statements as: **1**- Strongly Disagree; **2**- Disagree; **3**- Neither Agree nor Disagree; **4**- Agree**5**- Strongly Agree. Table 5 presents the distribution of respondents by level of awareness of local farmers to climate change.

No	Items	1	2	3	4	5
1	We often plant drought resistant hybrid seeds	1.2	23.2	11.2	64	00
2	We use tractors to plough our farms	6.4	71.6	2.8	19.2	00
3	Most of us plant early	2.0	64.4	2.0	31.6	00
4	We apply manure intensively in our farms	0.8	40.4	8.4	49.2	1.2
5.	Most of us use crop rotation in our farms	00	57.2	1.2	39.2	2.4
6	Multi cropping has become our only alternative	0.4	1.6	00	89.2	8.8
7.	Weeding is done more than once	00	0.4	00	83.6	16.0
8.	We normally plant early maturing crops	3.6	10.4	8.4	76.0	1.6

Table 5: Distribution by Indigenous Adaptation Strategies

Findings presented in Table 5 reveal that the sampled respondents agreed that: Multi cropping had become their only alternative (89.2%); weeding is done more than once (83.6%); they normally plant early maturing crops (76.0%); they often plant drought resistant hybrid seeds (64.0%); and that they apply manure intensively in their farms (49.2%) as some indigenous adaptation strategies that they have used to mitigate the effects of climate change. This implies that, to minimize risks associated with crop losses, farming household heads resort to planting more than one type of crops as well as weeding intensively, although this may require large parcels of farm sizes. Perhaps due to the small sizes of farms revealed in this study, food deficit has been rampant among most households in this area. The capability of the farming households to own large farms is low, hence limiting their choice for crop rotation among other practices.

Interviews conducted with KII alongside discussions held with discussants from the four sub locations revealed outstanding themes, one of which was related to improvement in soil fertility. Four key informants stated thus:

Farmers have adopted use of green manure and farmyard manure in the farms instead of commercial fertilizers (C2).

Some other KII stated that:

There has been a tendency of mulching and terracing to reduce flooding and soil erosion, while some farmers also plant short or fast – maturing seeds, as well as the use of disease-tolerant seeds(N1).

Results obtained from KII suggest that farmers in this area are more concerned with soil degradation as caused by changing climatic conditions. The African Technology Policy Studies, (ATPS, 2013) also established similar adaptation practices in its study on farmers responses to climate change in Lesotho. It established that farmers consider soil fertility to be more in conservation agriculture than other practices.

Similarly, discussants who participated in FGDs gave out statements which the researchers deciphered to an outstanding theme the use of composite manure for soil fertility conservation. For instance, some 5 discussants in two of the FGDs made the following statements:

We have resorted to the use of farmyard manure in the farms instead of commercial fertilizers for soil enrichments in our farms (F1).

Another 1 discussant in one of the FGDs asserted that:

We have decided to increase the usage of agro forestry practices, with seasonal crop patterns and rotation for soil enrichment in our farms (F3).

The farmers under study seem to be incapable of acquiring suitable resources to combat changes in climatic conditions, as explained by capability theory: their functionings are limited to the mentioned practices. This therefore implies that the need to control soil erosion and enhancing of soil fertility is a major concern of farmers in Lower Nyakach Division. Prevalence of soil erosion thus seems to drive the need to plant fast maturing crops among the farming household heads, given the fact that the ability of the farmers to employ appropriate technologies in harvesting the rain water seems limited. Additionally, the level of education held by the farming household heads (mostly primary level of education) tends to inhibit their acquisition of adequate knowledge for controlling unexpected floods or soil degradation.

On the other hand, farming household heads in this study were found not to use deep ploughing machines like tractors for farm preparation, plant early, and use crop rotation (71.6%; 64.4%; & 57.2%, respectively). This tends to suggest that more concern is placed on state of soil fertility than seeds or method of planting and farm preparation, although the capability to meet the cost of such farming practices seems to be beyond the farmers. Furthermore, the small sizes of farms among the households as revealed in this study compounds the ability to practice crop rotation. This finding, however, seems to contradict what Enete, et al (2011) found out that farmers in Nigeria have resorted to planting drought resistant crops like cassava to combat climate change effect.

Studies focusing adaptation practices in the developed world have revealed contrasting results. Jackson, et al., (2011) found when they examined adaptation strategies for agricultural sustainability in Yolo County in California, USA. They (Jackson, et al., 2011) found out that farmers in the particular area implement water conservation practices, and adopt voluntary Green House Gas (GHG) mitigation practices. Similarly, the findings also seem to contradict what Ramsey and Tarleton (2008) found that farmers use crop rotation frequently as a farm level adaptation to multiple risks in climate change among farmers in Canada. Another study done in Kenya by Oremo (2013) also produced results which contradict those shown in Table 5. In an attempt to identify small scale farmers' perception and adaptation measures to climate change in Kitui County, Oremo (2013) found that the farmers rely on extension service, educational attainment, membership to social and economic group. The present study therefore reveals that in Lower Nyakach Division, farmers have adapted soil conservation practices that involve control of soil erosion as well as application of farm yard manure and mulching. This situation is probably explained by capability theory in that the ability of local farmers to adapt practices which can enhance their food security is limited to the mentioned practices.

3.4. Effectiveness of Indigenous Farming Practices

Using field visits and group discussions, the researcher was able to evaluate the effectiveness of the indigenous farming practices in adaptation to climate change. It was revealed that flush floods often wash away crops in the farms and all plants plus organic deposits, leaving behind bare grounds exposed to extreme heat during dry spells. Plates 4.2; and 4.3 present pictures of such extreme weather conditions.

Figure 2: Picture of flooded farms in the study areas

Figure 2 presents a picture of flooded farms: farms that have been entirely submerged in flood water during unexpected flash rains. Entire farms are washed away with the floods, including crops and organic substance on the farms. This implies that the dependency on rain fed agriculture for crop production using indigenous farming practices has proved ineffective in this area. Similar findings were also established by Balaam, et al (2013) in a study in Kilombero District Tanzania: it established that local farmers with low adaptive capacity are thought to be more vulnerable to adverse effects of climate change, which contributes to the loss of their farm produce. Oluoko-Odingo (2006) also established in a study done in Nyando District (Kenya) that six months of flooding resulted into total crop failure. Obuoyo, et al (2016) revealed in a study carried out in Lower Nyakach that flooding and drought are particular climate chance factors that escalate incidents of food insecurity. Intense floods often leave the farmlands exposed to the scotch of the sun in the proceeding period as shown in Figure 3.

Figure 3: Pictures of dry farms that have been heavily eroded during floods

Figure 3 presents dried farmlands that have been washed bare by the floods during unexpected rains. Statements from the FGDs suggested that it takes time for such farms to regain their nutrients. One statement attributed to one of the discussants was that:

(Koth pore bang'e ka cham dwa chako golo wino seche moko mathoth matamo wang'. Pi yweyo puodho ma weyo ka owango cham te) ..... the rains at times come unexpectedly just when the crops are about to flower. Such rains cause floods that consequently wash away everything (F2).

This finding implies that most farms are damaged by unexpected rains to an extent that crops are lost, and the cultivated farms are left bare. Indigenous farming practices like mulching and soil erosion control measures seem not to be helpful to farmers. African Technology Policy Studies, (ATPS, 2013) also revealed in a study done in Lesotho that sporadic rainfall and soil erosion often lead to crop loses. This happen despite use of adaptation strategies like water harvesting technologies, conservation tillage, use of keyhole and trench gardens, agro-forestry and application of traditional medicine to control pests and diseases.

4. Conclusion

Based upon the study findings, it is concluded that indigenous farming practices by farmers in Lower Nyakach Division are not enhancing adaptation to climate change among the farming households. In the area, floods continue to wash away crops, leaving the firms bare and resulting into exposed dry earth unfit for crop production. Additionally, there is lack of awareness of weather information by the farmers, further rendering unprepared for the climatic changes. This is worsened by their lack of capability in adopting appropriate climate change measures to mitigate effects of climate change.

5. Acknowledgements

This research paper appreciates the contribution of all household heads who participated in the study. The information they provided enable analysis of data and consequently the findings of the study. In addition, the representative of the county commissioner of Lower Nyakach Divisionis appreciated for the role they played in providing permission for data

collection from the sampled households under study. Finally, the study appreciates the contribution made by everybody towards this work.

6. References

i. Akyina, K.O. and Alubokin, B. (2016). Extent of educational, vocational and personal-social guidance needs of some selected prison inmates in Ghana. *British Journal of Education 4*, (2), 37-50.

ii. Antwi-Agyei, P., Dougill, A.J., and Stringer, C. L. (2013) *Barriers to Climate Change Adaptation in Sub-Saharan Africa*: *Evidence from Northeast Ghana.* Systematic Literature Review. Accra, Ghana.

iii. African Technology Policy Studies, (ATPS, 2013): *Farmers' Response and their Adaptation Strategies to Climate Change in Mafeteng District, Lesotho*, [Sekaleli T.S.T, Sebusi K.] ATPS Research Paper No. 26.

iv. BBC World Service Trust (2010), *Tanzania Talks Climate: the public understanding of climate change*, Research Report, British Council, www.afr icatalksclimate.com: Accessed 12/01/2017.

v. Below, T., Artner, A., Siebert, R. and Sieber, S. (2010) Micro – level Practices to Adapt to Climate Change for Small-Scale Farmers. IFPRI Discussion Paper 00953.http://www.ifpri.org/publications/results/taxonomy%3A468. Accessed on 25theDecember, 2017.

vi. Clements, R., Haggar, J., Quezada, A., and Torres, J. (2011) Technologies for Climate Change Adaptation in the Agriculture Sector. Zhu, X. ed. Roskilde, UNEP Risø Centre.

vii. Deressa, T., Hassan, R.M., Alemu, T., Yesuf, M. and Ringler, C. (2008). *Analyzing the*

viii. *Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia*. IFPRI Discussion Paper 00798. Environment and Production Technology Division, Ethiopia.

ix. Enete, A.A., Madu, J.C., Onyekuru, A.N., Onwubuya, E.A., and Eze, F. (2011) *Indigenous Agricultural Adaptation to Climate Change: Study of Imo and Enugu States in Southeast Nigeria*. African Technology Policy Studies Network, Nairobi Kenya.

x. European Environment Agency (2012), *Climate change, impacts and vulnerability in Europe 2012: An indicator-based report*. EEA Report No. 12/2012. Copenhagen: EEA.

xi. FAO, IFAD and WFP. (2014). *The State of Food Insecurity in the World: Strengthening the enabling environment for food security and nutrition*. Rome, FAO.

xii. Gay, L. R., & Diehl, P. L. (1992). *Research Methods for Business and Management*. New York: Macmillan.

xiii. Goerne A. (2010). *The Capability Approach in social policy analysis. Yet another concept?* Working Papers on the Reconciliation of Work and Welfare in Europe RECWOWE Publication, Dissemination and Dialogue Centre, Edinburgh.

xiv. Hill, R. (1998). What sample size is "enough" in internetsurvey research?*IPCT-J 6*(3-4) 1 – 10.

xv. IPCCWGII (2007) – *Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the IPCC on Climate Change*, Cambridge University Press, Cambridge, UK, 2007. M.L. Parry, O.F. Canziani,

xvi. Jackson, L., Haden, V.R., Hollander, A.D., Lee, H., Lubell, M., Mehta, V.K., O'Geen, T., et al. (2011) *Adaptation Strategies for Agricultural Sustainability in Yolo County, California.* California Energy Commission; Publication number: CEC-500-2012-032.

xvii. Kalungu, J.W., Filho, W.L., and Harris, D. (2013) Smallholder Farmers' Perception of the Impacts of Climate Change and Variability on Rain-fed Agricultural Practices in Semi-arid and Sub- humid Regions of Kenya. *Journal of Environment and Earth Science, 3* (7) 129 – 140.

xviii. Kenya Population Census report (KPC, 2009). *The National Household Survey in Kenya*. Government Press, Nairobi.

xix. Lorenzoni, I., Pidgeon, N.F., (2006). Public views on climate change: European and USA perspectives. *Climatic Change 77*, 73–95.

xx. Mansanet-Bataller, M (2010). *The challenges of adapting to climate change.* Climate Report No. 21April 2010.

xxi. Mary, A. L. and Majule, A. E. (2009) Impacts of climate change, variability and adaptation strategies on agriculture in semi arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. *African Journal of Environmental Science and Technology 3* (8) 206-218.

xxii. Mungure, S.E. (2015). *The impact of tourism activities to the local communities: A case of Mto Wa Mbu ward in Monduli District*. A dissertation submitted the Open University of Tanzania.

xxiii. Nassbaum M. C. (2011). *Capabilities, Entitlements, Rights: Supplementation and Critique*. In: *Journal of Human Development and Capabilities, 12*. 23-37.

xxiv. Obuoyo, J. A., Ochola, C. O. & Ogindo, H. O. (2016). Livestock for Household Food Security- A Case Study of Small-Scale Mixed Farmers in Semi-Arid Nyakach, Kenya. *International Journal of Livestock Research*, 6 (1) 57-67.

xxv. Ochieng, K., O. (2014). *Report on factors limiting the adoption of the control mechanisms of Striga weed in Nyakach District of Kisumu County*. Unpublished report submitted to the University.

xxvi. Oremo, F. O. (2013) *Small-Scale Farmers' Perceptions and Adaptation Measures to Climate Change in Kitui County, Kenya*. Unpublished Thesis submitted to the Centre for Advanced Studies in Environmental Law and Policy (CASELAP), University of Nairobi.

xxvii. Patton, M. Q. (2002).*Qualitative research and evaluation methods (3rd ed.).* Thousand Oaks, CA: Sage.

xxviii. Ramsey, D. and Tarleton, M. (2008) Farm-Level Adaptation to Multiple Risks: Climate Change and Other Concerns. *Journal of Rural and Community Development 3*, (2) 47–63.
xxix. Tsai, C., Lin, S.S & Sai, M.J. (2001). Developing an Internet Altitude Scale for High School Students; *Computers and Education* (37), (45-51).
xxx. Schlosberg, D.(2011). "Capacity and Capabilities: A Response to the Greenhouse Development Rights Framework." Ethics, Place and Environment 12, (3): 287-290
xxxi. Sen, A. (1992). *Inequality Re-examined*. Oxford: Clarendon Press.
xxxii. Sen, A. (1999). *Development as Freedom*. New York: Knopf.
xxxiii. Sen, A, (2004). "Dialogue. Capabilities, Lists, and Public Reason: Continuing the
xxxiv. Conversation", *Feminist Economics*, 10-3, 77-80.