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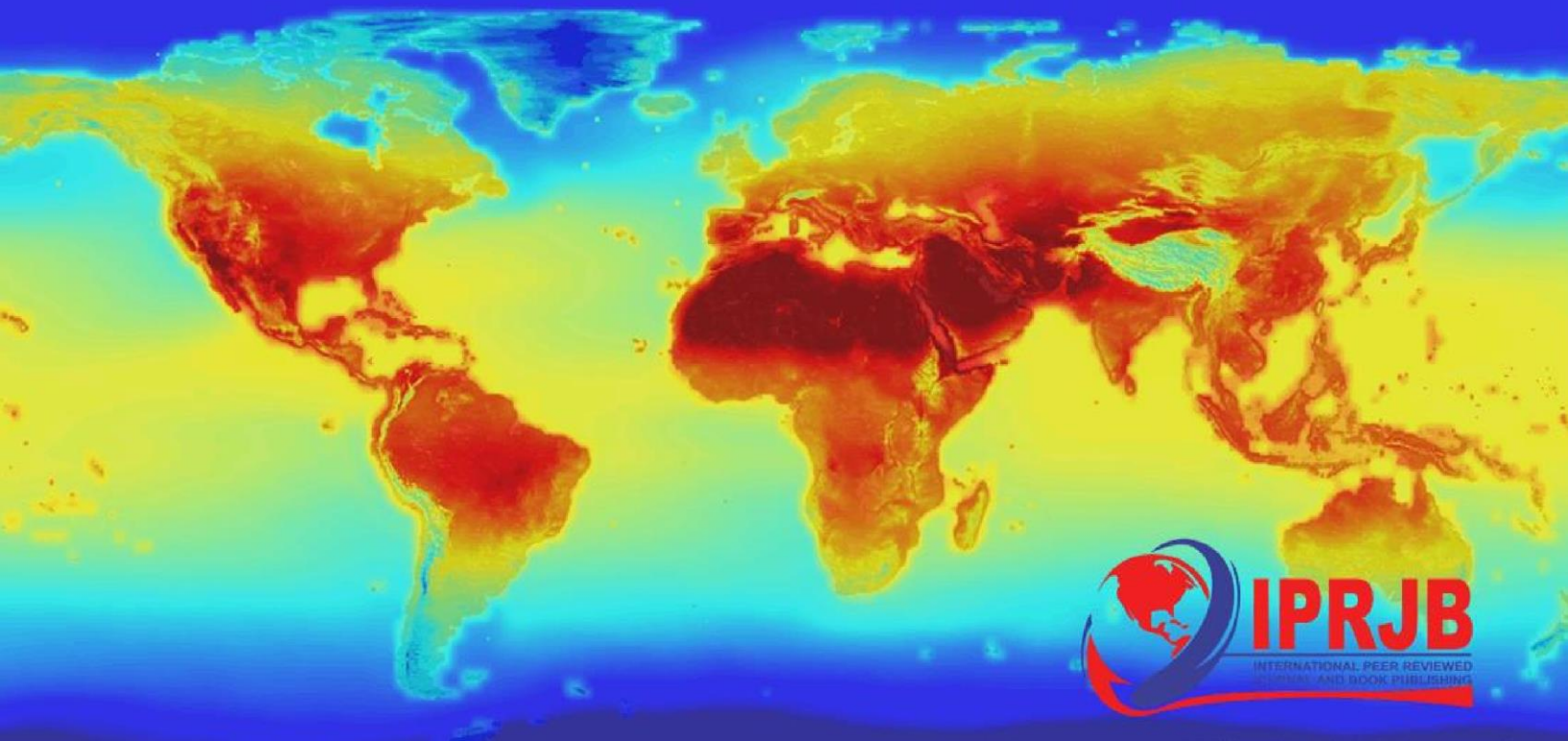

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ABSTRACT

Purpose: Climate change can disrupt food availability, reduce access to food, and affect food quality. Projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Increases in the frequency and severity extreme weather events can also interrupt food delivery, and resulting spikes in food prices after extreme events are expected to be more frequent in the future. Increasing temperatures can contribute to spoilage and contamination. The general objective of the study was to establish the effect of Adaptation practices to climate change and its impact on agricultural production by farming household.

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: The study found out the locals households prefer multiple adaptation strategies to counter the effects of climate variability and change. The current local adaptation strategies include crop, diversification, shifting planting dates, off farm jobs and diversifying from farm to non – farm activities. However majority of the respondents employ crop diversification as the main adaptation strategy. For the locals' crop diversification does, to an extent, guarantees good harvests although there are years in which farmers report total crop losses

Recommendations: The study recommends that policy efforts should be directed at enforcing adaptation measures of climate change in order to boost agricultural production

Keywords: *Adaptation, climate change, agricultural production, household*

INTRODUCTION 1.1 Background of the Study

It has been argued that the world's climate will continue to change at rates unprecedented in human history, and that all societies need to enhance their adaptive capacity to face subsequent present and future challenges (Adger et al., 2003). Climate change has thus become the most important topical development policy and global governance issue in the 21st century (African Development Bank, 2010). Despite agriculture being the most important sector in the Kenyan economy, contributing 24% of the annual Gross Domestic Product directly and another 27% indirectly, agricultural productivity has been on the decline at a rate of 21.41% annually (World Bank, 2016). Over 75% of the Kenyan population earns their living from agriculture, and the population is increasing. According to United Nations' projections, the population will grow by around one million people per year, hitting 95 million by 2050 (United Nations, 2015). Worse still, are the expected adverse effects of climate change in the future as global circulation models are predicting increased temperatures of about 4oC and variability in rainfall of up to 20% by the year 2030, leading to severe droughts and unreliable rainfall to cater for the predominant rain fed agriculture practices in the country. These changes will adversely affect agriculture in both the arid and semiarid areas and high potential areas (Kabubo- Mariara and Karanja, 2007)

Increased intensity and frequency of storms, drought and flooding, altered hydrological cycles and precipitation variance have implications for future food availability. The potential impacts on rain fed agriculture vis-à-vis irrigated systems are still not well understood. The developing world already contends with chronic food problems. Climate change presents yet another significant challenge to be met. While overall food production may not be threatened, those least able to cope will likely bear additional adverse impacts (Simberloff,2005). The estimate for Africa is that 25–42 percent of species habitats could be lost, affecting both food and non-food crops. Habitat change is already underway in some areas, leading to species range shifts, changes in plant diversity which includes indigenous foods and plant-based medicines (McClean, Colin et al., 2005). In developing countries, 11 percent of land could be affected by climate change, including a reduction of cereal production in up to 65 countries, about 16 percent of agricultural GDP (FAO Committee on Food Security, Report of 31st Session, 2005).

Changes in ocean circulation patterns, such as the Atlantic conveyer belt, may affect fish populations and the aquatic food web as species seek conditions suitable for their lifecycle. Higher ocean acidity (resulting from carbon dioxide absorption from the atmosphere) could affect the marine environment through deficiency in calcium carbonate, affecting shelled organisms and coral reefs.

Climate change impacts can be roughly divided into two groups:

biophysical impacts: Which is consistent of :physiological effects on crops, pasture, forests and livestock (quantity, quality);changes in land, soil and water resources (quantity, quality);increased weed and pest challenges; shifts in spatial and temporal distribution of impacts, sea level rise, changes to ocean salinity, sea temperature rise causing fish to inhabit different ranges and socioeconomic impacts which consist of decline in yields and production, reduced marginal GDP from agriculture, fluctuations in world market prices ,changes in geographical distribution of trade

regimes, increased number of people at risk of hunger and food insecurity, migration and civil unrest.

Two main types of adaptation are autonomous and planned adaptation. Autonomous adaptation is the reaction of, for example, a farmer to changing precipitation patterns, in that s/he changes crops or uses different harvest and planting/sowing dates. Planned adaptation measures are conscious policy options or response strategies, often multispectral in nature, aimed at altering the adaptive capacity of the agricultural system or facilitating specific adaptations. For example, deliberate crops selection and distribution strategies across different agriclimatic zones, substitution of new crops for old ones and resource substitution induced by scarcity (Easterling 1996).

Farm level analyses have shown that large reductions in adverse impacts from climate change are possible when adaptation is fully implemented (Mendelsohn and Dinar 1999). Short-term adjustments are seen as autonomous in the sense that no other sectors (e.g. policy, research etc.) are needed in their development and implementation. Long-term adaptations are major structural changes to overcome adversity such as changes in land-use to maximize yield under new conditions; application of new technologies; new land management techniques; and water-use efficiency related techniques. Reilly and Schimel pfennig (1999, p. 768ff.)major classes of adaptation include seasonal changes and sowing dates, different variety or species, water supply and irrigation system, other inputs (fertilizer, tillage methods, grain drying, other field operations),new crop varieties, forest fire management, promotion of agroforestry, adaptive management with suitable species and silvicultural practices (FAO, 2005).

1.2 Statement of the Problem

The reduced availability of resources (particularly food, energy and water) has positively changed the rural community's outlook towards the need to conserve the environment and resources resulting in an increasing need to achieve food security (FAO 2013). To achieve increased food production in this region, farmers would, therefore, have to cope and adapt to climate change. There is, however, little knowledge on how farmers perceive climate change and if they have formulated adaptation measures (Fosu-Mensah et al., 2012). Hence, this paper seeks to explore the effect of adaptation practices to climate change and its impact on agricultural production by farming household.

1.3 Objectives of the Study

The general objective of the study was to establish the effect of adaptation practices to climate change on agricultural production by farming household.

1.4 Justification and Significance of the Study

This study is justified in several ways. First, while using crop adaptation strategies are believed to minimize the negative impact of climate change on crop yields, the adaptive capacity of farming households is low. There are few studies done to effect of Adaptation practices to climate change and its impact on agricultural production. Therefore, analyzing effect of Adaptation practices to climate change and its impact on agricultural production is important to identify policy intervention areas in crop adaptation.

Moreover most of the recent studies analyze factors affecting crop adaptation strategies in aggregate crop adaptation in their analysis. Given that different factors may affect different crop adaptation strategies differently, studies need to be focused on effect of adaptation practices to climate change on agricultural production.

LITERATURE REVIEW 2.1 Theoretical review

Two theories were found to be relevant in establishing the effect of Adaptation practices to climate change and its impact on agricultural production by farming household the theories that were found to best inform the research constructs are the capability theory (Sen, 1999, 2004; Nussbaum, 2003, 2011) and random utility maximization theory (McFadden, 1974; Cascetta, 2009).

2.2 Capability theory

The theory examines capacities necessary for people to lead functioning lives. A person's functioning's reflect the collection of "beings" and "doings", and can be viewed as various outcomes a person may achieve (Goeme, 2010). The central argument of this theory is the need to judge just arrangements in distributive terms, and how they affect the ultimate well-being and functioning of people's lives. The central question about justice is what we are actually able to do and be - it is not about commodities or the total/average GDP, but how they enable us to function (Nussbaum, 2011). A capability approach focuses on whether or not people possess capacities necessary to construct a fully functioning life. Such capacities are supported by among others, natural systems that directly depend on a stable climate system.

Capabilities approach provides concepts that can encompass the current framing of climate justice, but in a way that is more applicable to the development of adaptation policy (Schlosberg, 2011). Since this approach addresses the basic requirements that are necessary for human life to function and flourish; it is important to align adaptation policies with climate justice that protects the basic functioning of human communities, including the environment.

Changes in climate will affect what individuals are able to do with the resources that they have. 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 (Schlosberg, 2009). Similarly, potential mental health impacts, such as the increased stress of those made climate refugees, and the overall anxiety of rapid climate change, could be seen as a barrier to capability of emotional health (Nussbaum, 2011).

Crucially, a capabilities-based approach to adaptation is not a top-down, expert-driven affair. Rather, communities need to be thoroughly involved in defining their own vulnerabilities and designing just adaptation policies that are planned to shield them from climate change that threatens their ability to function (Schlosberg, 2009; Ribot, 2010). Thus the approach offers a way of analyzing the particular needs of communities, of identifying gaps which hinder people to adapt to climate change, of directing adaptation policy toward preserving or rebuilding the specific capabilities under threat from climate change, and of measuring the success of implemented adaptation policies.

2.3 The Random Utility Maximization Theory

The decision to use any adaptation option falls under the frame-work of random utility theory.

According to this framework, people choose what they prefer, and where they do not is influenced by random factors (McFadden, 1973). Thus, the utility of a choice is comprised of deterministic and an error components. The error component is independent of the deterministic part and follows a predetermined distribution. This shows that it is not usually possible to predict with certainty the alternative that the decision-maker will select. However, it is possible to express probability that the perceived utility associated with a particular option is greater than other available alternatives (Luce, 1959; Cascetta, 2009).

The utility U that individual i gains from the consumption of a good j is made up of an observable deterministic component V (the utility function) and a random component e, and can therefore be defined as follows: Uij = VtJ + Eij (3.1)

According to Cascetta (2009), we assume that utility U depends on choices made from some set of j adaptation options. The individual is assumed to have a utility function of the form:

Ull = V(Xj,Zi) (3.2)

A rational farmer who seeks to maximize the present value of benefits of production over a specified period of time must choose among a set of j adaptation options. The farmer i will use j adaptation option if the perceived benefit from that option is greater than the utility from other option k if Uj > Uk. Utility derived from any adaptation option is assumed to depend on the attributes of the adaptation option itself Xj and the socio-economic characteristics of the farmer Zt (Cascetta, 2009). However, a farmer may not choose what seems to be the preferred adaptation option. To explain such variations in choice, a random element, e is included as a component of utility function. Equation 3.2 can then be re-written as: Uii = V(Xj,Zi) + s(Xj.Z,) (3.3)

The probability that farmer i will choose adaptation option j among the set of adaptation options k could be defined as follows:

Pr[i|C5] = Pr[Uj > Uk], V) e CS (3.4)

= Pr[(Vj + £j) > (Vk + £k)]

= Pr[(Vj - Vk) > £]

Where CS is the complete choice set of adaptation option. In order to estimate equation 3.4, assumptions must be made over the distributions of the error terms. A typical assumption is that the errors are Gumbel-distributed and independently and identically distributed (McFadden, 1973)

2.2 Empirical Review

Most impact and adaptation studies have been based on climate change scenarios that provide a limited set of possible future climates - invariably specified as average annual conditions such as temperature and precipitation (Wang, 2012). Yet the climate change-related stimuli for which adaptations are undertaken are not limited to changes in average annual conditions; they include

variability and associated extremes.Climatic conditions are inherently variable, from year to year and decade to decade. This study therefore incorporates vulnerability and adaptation to both climate variability and change.

Smithers and Smit (1997) comment that changes in climate are expected to have ecological and socio-economic impacts. Thus the extent to which ecosystem, food supplies, and sustainable development are vulnerable or "in danger" depends on exposure to changes in climate and on the ability of the impacted system to adapt' (IPCC, 2001b)

The capacity to adapt depends largely on the assets (natural resource, human and social, physical and financial capital) that one has or can access and how well these are utilized (Klein and Maclever, 1999). The adaptive capacity of human systems in Africa is generally considered to be low due to lack of economic resources and technology. Similarly, vulnerability is considered high due to the heavy reliance on rain-fed agriculture, frequent droughts and floods, and poverty in many African countries (Eriksen, 2000). According to Adger (2000), populations have developed a number of coping and adaptation strategies in order to live with climatic variations and uncertainty, such as diversification of crops and sources of income, migration, reliance on remittances and social networks of support. These adjustments largely take place within informal economic sectors and most poor people have little access to formal support or investments (Adger, 2000; Smithers, J, and Smit, 1997).

Maddison (2007) on the perception and adaptation to climate change in Africa reveals that the factors that affect the farmers' perception and adaptation to climate change are location, financial constraint, lack of appropriate seed, market accessibility, farming experience, access to free extension advice, level of education, farm size, tenure in the form of land borrowing, current climate. Being head of the household also increases the probability that the farmer can adapt, perhaps because he or she is in control of household resources. There is, however, no evidence that gender influences the probability of adaptation. With Regards to the adaptation options, this study found out that in all countries apart from Cameroon and South Africa the planting of different varieties of the same crop is considered to be one of the most important adaptation methods to climate change.

However a study conducted by Deressa et al., (2008) in Ethiopia found out that the level of education, age, sex and household size of farmers are the significant determinants of adaptation to climate change in the study area. Using cross-sectional data from a survey of farmers to illicit information on adaptation methods, the study found out that the adaptation methods currently in place in the study area are; changing planting dates, using different crop varieties, planting tree crops, irrigation, soil conservation and not adapting. The farmers reported that the use of different crop varieties was the most common adaptation method, while irrigation was the least common. They also reported that the reasons for not adapting are lack of information on climate change impacts and adaptation technologies, lack of financial resources, labour constraints and land shortages.

The socio-economic team of Advancing Capacity to support Climate Change Adaptations (ACCCA, 2010) employed a Multivariate Probit model to analyze data from a survey of 160 farm households in northern Ethiopia. The main aim of this study was to analyze the factors influencing the farmers' decision to adapt. The study revealed that Extension service, livestock ownership by

female farmers, access to climate change information and the observed change in temperature have positive and substantial impact on adaptation to climate change. The findings also indicated that the most common adaptation strategies include: use of different crop varieties, soil and water conservation, changing planting dates, use of external fertilizer, borrowing lost local crops from community, and using short duration crops.

Kurukulasuriya and Mendelson (2007) on the other hand used the Multinomial Logit Model to analyze crop and livestock choice as climate change adaptation options in Burkina Faso, Cameroon, Ghana, Niger, Senegal, Egypt, Ethiopia and Kenya, South Africa, Zambia and

Zimbabwe. The study on crop choice showed that crop choice is climate sensitive and farmers adapt to changes in climate by switching crops. The results of the choice models from the livestock study showed that farmers in warmer temperatures tend to choose goats and sheep as opposed to beef cattle and chicken. Goats and sheep can do better in dry and harsher conditions than beef cattle.

Research gaps

Methodological gap is the gap that is presented as a result in limitations in the methods and techniques used in the research (explains the situation as it is, avoids bias, positivism, etc.). Kurukulasuriya and Mendelson (2007) on the other hand used the Multinomial Logit Model to analyze crop and livestock choice as climate change adaptation options in Burkina Faso, Cameroon, Ghana, Niger, Senegal, Egypt, Ethiopia and Kenya, South Africa, Zambia and Zimbabwe while The socio-economic team of Advancing Capacity to support Climate Change Adaptations (ACCCA, 2010) employed a Multivariate Probit model to analyze data from a survey of 160 farm households.

Conceptual gap arises because of some difference between the user's mental model of the application and how the application actually works. A number of studies (Kurukulasuriya and Mendelson;2007; Derressa et al.,2008; ACCCA,2010; OBrein,2000) have been conducted in Sub Sahara Africa on climatic and weather variability, adaptation, crop production and household food security. However, most studies have concentrated on farmers' perception and adaptation strategy to the impacts of climate change production and less on vulnerability and factors that hinder effective adaptation. To bridge this gap, this study examined the to establish the effect of adaptation practices to climate change on agricultural production by farming household.

METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to effect of Adaptation practices to climate change and its impact on agricultural production by farming household. Three sorting stages were implemented on the subject under study in order to determine the viability of the subject for research. This is the first stage that comprised the initial identification of all articles that were based on adaptation practices to climate change and its impact on agricultural production from various data bases. The search was done generally by searching the articles in the Article title, abstract, keywords. A second search involved fully available publications on the subject of on adaptation practices to climate change and its impact on agricultural production. The third step involved the selection of fully

accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that related to on adaptation practices to climate change and its impact on agricultural production which was split into top key words. After an in-depth search into the top key words (adaptation, climate change, agricultural production), the researcher arrived at 12 articles that were suitable for analysis. The drawing and interpretation of research findings and sense which is not a quantitative impact evaluation, was important in this context, which implies that qualitative and thematic analysis was most suitable in this study

SUMMARY, CONCLUSION AND POLICY IMPLICATION FOR FURTHER STUDY

4.1 Summary

The study found out the locals households prefer multiple adaptation strategies to counter the effects of climate variability and change. The current local adaptation strategies include crop, diversification, shifting planting dates, off farm jobs and diversifying from farm to non – farm activities. However majority of the respondents employ crop diversification as the main adaptation strategy. For the locals' crop diversification does, to an extent, guarantees good harvests although there are years in which farmers report total crop losses. The cultivation of both short and long cycle crop varieties enables the households to take advantage of the different maturing times of crops, to strengthen their resilience to impacts associated with variable unpredictable rainfalls and drier conditions, in order to increase chances of having good harvest during the drier and wetter seasons.

4.2 Conclusion

Climate change and variability is already affecting the planet. Rural households are experiencing changing pattern of rainfall, increase in temperatures, changing time of cultivation of crops, changing behavior of animal among others. The production and productivity of the food grain as well as cash crops has been decreasing every year. Climate change and variability globally has a strong influence on the local's livelihood sources. For majority of countries especially African Continent the main source of income for residents is agriculture which is highly sensitive to climate variability. The households depend on rain-fed agriculture for their livelihoods,. Improvement on the food security status of the household therefore depends on a successful rainfall season. However, with current and future climate change and variability, this will increase vulnerability to food insecurity.

4.2 Recommendations

The results indicate that overall climate change will have an adverse effect on agricultural production in households and hence may also have an adverse effect on food security. This is noted because of the close relationship between food availability and food security .Therefore, policy efforts should be directed at enforcing adaptation measures of climate change in order to boost agricultural production.

One critical policy intervention would be raising awareness among households on climate change by providing climate change related information and adaptation measures to be used. It is estimated that only about 50% of farmers in Africa are aware of climate change and its impact on agriculture

but they don't have meager information on the adaptation measures they can take. Increasing awareness would require that the government actively monitors climate change, encourages research into climate change and sets up information dissemination channels to farmers (KabuboMariara, 2009).

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