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ECONOMIC IMPLICATION OF CLIMATE CHANGE ON FARMING IN KAILAHUN DISTRICT, SIERRA LEONE

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ABSTRACT

This study presents the economic implications of climate change on the farming system in Kailahun District of Sierra Leone. The country's economic and employment mainly depend on agricultural production. This research is to investigate the economic implications of climate change through examining the way climate change affects farmers and finding out the constraints that exacerbates vulnerability of the farming system. The study adopted administration of questionnaires and focus group discussion to present and analyse the information. This study reveals a good scientific understanding of climate change as well as coordinated actions at both the national and global levels. Human activities should be tailored in a more environmental friendly manner in coping with a changing climate as the research reveals the economic impacts on farming in Kailahun District. Poverty, financial insecurity, fall in GDP and change in rainfall pattern are the main factors affect farm products. Less crop yield in 2013 as compared to 2008 accounted for 65%. Fall in GDP" accounted for 55% while poverty stand out to be the main constrain that exacerbate climate vulnerability with 41%. Financial insecurity accounted for 22.5% as the main impact of climate change on farming in Kailahun District

KEYWORDS: *Climate Change, Farming, Economic implication, Green House Gases, Environment*

1. INTRODUCTION

There is strong nexus between agriculture and climate change. The phrase 'Climate Change' is often used interchangeably with the phrase 'Global Warming.' However, according to the National Academy of Sciences, USA the use of the phrase, 'Climate Change' is growing in preference over 'Global Warming' because it helps to convey the meaning of other issues related to climate change in addition to rising temperatures. Climate Change refers to any significant change in measures of climate (such as precipitation, temperature or wind) lasting for an extended period, a decade or longer[1]. Over the past three decades, evidences have come to

light that shows the global climate is changing and that anthropogenic greenhouse gases have been the main cause[2]. The unimpeded rise in greenhouse gas emissions has led to rise in the earth's temperature. In addition to this, world's rapid population growth, threatens food security and livelihoods for large numbers of people especially in developing countries like Sierra Leone. Many researchers believe agriculture is the most susceptible sector to climate change. This is attributed to the fact that climate change affects the two most important direct agricultural production inputs, precipitation and temperature[2]. Climate Change also affects agriculture indirectly through the emergence and

distribution of crop pests and livestock diseases. This has exacerbated the frequency and distribution of adverse weather conditions, reducing water supplies and irrigation, and enhancing severity of soil erosion[3].

2. CONCEPTUAL ISSUES ON CLIMATE CHANGE IMPACT

Climate Change is one of the biggest challenges the world faces today posing a threat to many populations around the globe. Studies show that many parts of world's agriculture will be affected by climate change, limiting food production and threatening food security[4]. Sub-Saharan African countries are among the most vulnerable to climate change having warm climate and lower socio-economic status that limits their capacity to adapt to the rapidly growing climate change effects[5]. As smallholder farmers in these countries continue to face an increasing threat from climate change, a growing body of literature is investigating to understand the potential impacts of climate change on the agriculture of this region. Findings from previous impact studies have indicated that agriculture will by and large be negatively affected in this region due to climate change[4]. However, most previous studies have either focused on assessing climate change impact on yield of individual crops or used aggregate models to assess economic impact[4, 5]. Assessing climate change impact on individual crops alone does not provide enough information for an understanding of the overall economic implications to the systems, where farms often simultaneously produce crops with varying degrees of sensitivity to climate change. Furthermore, the individual crop yield assessments mainly focus on evaluating the yield performance of crops in relation to future climatic conditions, other relevant socio-economic conditions that may change in the future are little considered in such studies. On the other hand, aggregate economic models do not adequately represent the heterogeneity of farming systems and conceal variability, which is of paramount importance to effective policy intervention. In previous climate change and technology[6] impact assessment studies on smallholder farming systems, a considerable amount of heterogeneity in terms of impact has been observed across households, which can be attributed to the spatial variability of the farms' physical environment, production activity and household characteristics[7]. This essential heterogeneity in agricultural systems is not adequately represented in earlier studies, though currently, studies that recognize the differential effects of climate change are emerging[5]. Overall, climate change impact studies that represent the direct yield response of the various crops grown in farms alongside future socio-economic changes and agro-ecological differences may provide useful information in understanding the overall implications of climate change. Climate change impact on productivity of crops is primarily due to the effects of

temperature, precipitation and rainfall on crop physiological activities and phenological development[8]. It can also impair crops production by altering pest incidence and plant-pest interaction[9]. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations Environmental Programme (UNEP) and the World Meteorological Organization (WMO) to assess the scientific, technical and socioeconomic information relevant for the understanding of human induced climate change, its potential impacts and options for mitigation and adaptation[9]. Its mission is to provide comprehensive scientific assessments of current scientific, technical and socio-economic information worldwide about the risk of climate change caused by human activity, its potential environmental and socio-economic consequences, and possible options for adapting to these consequences or mitigating the effects. Thousands of scientists and other experts contribute to writing and reviewing reports, which are reviewed by representatives from all the governments, with a summary for policymakers being subject to line-by-line approval by all participating governments[8]. The IPCC does not carry out its own original research, nor does it do the work of monitoring climate or related phenomena itself. A main activity of the IPCC is publishing special reports on topics relevant to the implementation of the United Nations Framework Convention on Climate Change (UNFCCC), an international treaty that acknowledges the possibility of harmful climate change[10]. Implementation of the UNFCCC led eventually to the Kyoto Protocol. The IPCC bases its assessment mainly on peer reviewed and published scientific literatures. Membership of the IPCC is open to all members of the WMO and UNEP[10]. The IPCC provides an internationally accepted authority on climate change, producing reports which have the agreement of leading climate scientists and the consensus of participating governments (over 120 countries)[5, 10]. It has provided authoritative policy advice with far-reaching implications for economics and lifestyles. Governments have been slow to implement the advice[6]. Major possible changes in atmospheric, soil and hydrological regimes were forecasted to occur with a direct impact on food supply and demand. Food security was the main issue in earlier 1990s[11] and the investigation was generally focused on regional or domestic agricultural impact[4].

However, several factors can determine the direction and magnitude of climate change impact on farms. First, as climate change manifests itself in different ways across regions, the impact may likewise vary depending on the specific local climatic changes. Secondly, even when areas experience a similar degree of climatic changes, the consequences will be detrimental, for example, in regions where temperatures are already near to physiological maxima[12]. Another important aspect is that

different crops do not respond to climate change in the same way owing to variation in their sensitivity to temperature, rainfall and carbon dioxide (CO₂) changes. The impacts of climate change may also vary from place to place and farm to farm due to differences in the capacity of agricultural systems and farms to adapt to climate change[3]. The recognitions of the global nature of climate change and the interdependencies between economies have led successively to various attempts to introduce international trade into the picture[13]. Farmers' response to the climate and natural environmental change was thus taken into account[13].

The recent crisis of rice all over the world showed a very good indication about the necessity of monitoring agricultural sustainability on regular basis. Due to this acute food crisis all over the world, many countries have been forced to reconsider the issue of agricultural sustainability and high rates of production, which have strong interactive impacts on climate change. This activity also forces nations to develop an appraisal system to monitor the state of sustainable economic system from time to time. Agricultural system affects the environment, but interestingly the agricultural system is also affected by the changes in environment and climate conditions[14]. Adding to this, a sudden natural disaster can have a severe negative impact on the overall agricultural sustainability. These disasters increase global demand for food and countries struggle to meet domestic food demands. International collaboration is essential in these situations. International collaboration is also required to be incorporated in sustainable agriculture system. Not only does the sustainable agriculture system address many environmental and social concerns, but it also may offer innovative and economically viable opportunities for farmers, labourers, consumers, policymakers and many others in the entire food system and the economic system. Farms in smallholder farming systems vary in terms of composition and intensity of production activity, household characteristics, use of agricultural technology and farm physical environment. This variation has an important implication for climate change impact. In environmental and other technological impact assessments, it is thus essential to recognize farm heterogeneity in such systems[15]. Another important aspect in climate change impact assessment is the socio-economic condition within which future agriculture is expected to work[14]. Potential changes, for example, in agricultural price and changes in land holdings that may happen in the future due to changes in various sectors of the economy, or changes in demand and supply, need to be taken into consideration in climate change impact studies.

Climate change will have far-reaching consequences for agriculture that will disproportionately affect the poor farmers. Greater losses of crops and livestock production are already

imposing economic losses and undermining food security and they are likely to get more severe as global warming continues[14, 15]. A climate change threat on agriculture is now unambiguous, but the exact magnitude is uncertain because of complex interactions and feedback process in the ecosystem and the economy[3, 5]. In parts of Africa, Asia and Central America, yields of rice, wheat and maize could decline by around 20 to 40 percent as temperature rises by 3°C to 4°C, as a result of climate change and other environmental factors like Carbon dioxide (CO₂), Nitrogen oxide (NO₂) emission and land degradation[1, 16]. This situation creates a 'domino effect' that receives less rain water, drop of water levels in reservoirs or rivers and less water for human consumption. The quality of the water is deteriorated, as sewage and industrial effluent becomes more concentrated and causes widespread of waterborne disease. With a lack of water, crops does not grow so livestock have less to graze on resulting to death[16]. The greatest concern about climate change is the damage caused to human and agriculture. Sierra Leone's economy, like that of many developing countries, is mainly based on farming and one of the major employment sectors of the country. More than 70% of the population relies on traditional and subsistence agriculture, the majority of which are dependent on rain-fed agriculture and pastures. Thus, the economy of Sierra Leone has been recently reported to be most vulnerable to slight changes in the weather. These changes may threaten many people's livelihoods and jobs[17].

3. MATERIAL AND METHODS

The study was conducted on smallholder farmers about the economic implication of climate change on agriculture in Kailahun District, the Eastern region of Sierra Leone. Agriculture in Kailahun District has been the main source of livelihood with more than 70% of the population contributing over 50% of the per capita income of the district. The per capita income growth has a nexus with rainfall variation in the past that shows the relationship between climate conditions and the agriculture based economy[18]. Sierra Leone has features of diverse agro-ecology and topography. Kailahun District is in the Eastern Province of Sierra Leone at latitude 8° 3' 40" North, longitude 10° 38' 49" West[17]. It borders Liberia to the east, Kenema to the west and Kono to the north. The total area of the Kailahun District is 3,939.5 km² and subdivided into fourteen chiefdoms. The main ethnic groups are Kissi and Mende. The main economic activity is small-scale farming and the district has an estimated population of 382,829. The annual rainfall is varied between 1000 mm and over 2500 mm during the past two decades. The average maximum and minimum temperatures during this period were about 28 °C and 17 °C.

This study is to present the assessment of climate change impact on farming economically in

Peje-West chiefdom in Kailahun District. The farm data used in this study is obtained from the farmers in Peje-West chiefdom, Kailahun District, Ministry of Agriculture, Forestry and Food Security (MAFFS) and the Climate Change Office in the Eastern Regional Headquarter of Kenema. The farmers' respondents were randomly selected to know the responses during June 2013 to September 2013. The food and economic production data on the various agricultural activities and household economic information in relation to farming output were obtained. The method used in the distribution of questionnaires was purely on the basis of careful purposive and relevance of data sources coupled with the size of the communities under review. A total of 80 respondents from five (5) towns (Masao kigbai, pejewa, Njama and Bunumbu) in the study area were interviewed and 10 respondents from the Ministry of Agriculture, Forestry and Food Security (MAFFS). Additional value data from 10 respondents were obtained from the Regional Climate office in Kenema City.

4. RESULTS AND DISCUSSIONS

In assessing financial assets and the degree of income and expenditure, it was found that majority of respondents do not have access to basic financial loan scheme from agricultural institutions. They do not

know the efficient way to manage the income and expenditure over extended periods during the planting season. This information was concluded after prolonged verbal discussions with the respondents. They were clearly unable to say what they earn and spend, while others stated that they spend more than they earn and are often in debt to informal loan providers.

The respondents in the study area believe that their incomes are insufficient to meet their expenditures. The respondents stated an approximated loss of Leone 1,600,000 (\$210) is spent as an unbudgeted sum. The money incurred at the year of the planting season is always less than the money spent and as such debt becomes the common reality for most respondents. It is difficult to believe that costs of living are consistently doubling at a rate of 200% within a year. The key explanation for the discrepancy is that a great proportion of the economy of this area is based on subsistence farming and the barter system as a form of trade as this is not solely a cash-driven economy. Farmers will store harvested rice for use and when austerity becomes friendly in the study area, barter system of trade take over and the majority of people live on the food they produced.

Table 1: The impact of climate change on farming

No.	Impacts of Climate Change on Farming	Respondents	
		Farmer	Percentage
1	Change in rainfall pattern	8	10
2	Occurrence of drought and flood	4	5
3	Crops failure	14	17.5
4	Loss of livelihood	4	5
5	Outbreak of pest and disease	4	5
7	Hunger	8	10
8	Financial insecurity	18	22.5
9	Change in temperature	12	15
10	Inundation of river areas	8	10
	Total	80	100

The Table 1 shows the impact of climate change on farming in Kailahun District. Financial insecurity representing 22.5% is the leading impact of climate change on farming in the study area. The income of farmers in the study area is not secured as the climate change leads to economic loss, thereby depriving the farmers from attending to their basic needs. The crops failure accounts for 17.5%, change

in rainfall pattern is 10%, change in temperature represent 15%, hunger is 10% and Inundating of river areas also account for 10%. These are all determinants for financial security which leads to poor living standard. While the occurrence of drought, loss of livelihood, outbreak of pet and diseases all accounted for 5%.

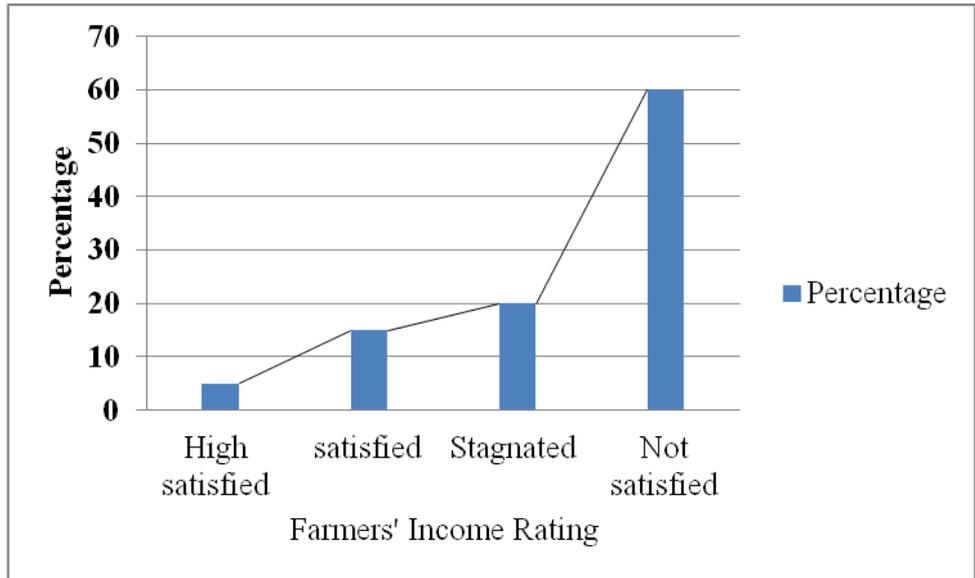


Figure 1: Income rating of farmers' farm output

The Figure 1 represents the rating of farmers' income in percentage. The result reflects the targeted respondents of smallholder farmers who rated their incomes after sales of farm products. Among the 100% respondents, 60% responded that climate change has profound effect on their incomes. They are not satisfactory as crops perished and some

plants are stunted in growth. The 20% of respondents have a stagnant income generated after sale of farm products. 15% of the respondents are satisfied with the income generated after the sale of farm output while 5% of the respondents are highly satisfied with the income generated from the sale of their farm outputs.

Table 2: Constraints/ challenges that exacerbate climate change vulnerability

No.	Constraints/ Challenges that exacerbate vulnerability	Respondents views			%
		Farmers	Climate Change Officers	MAFFS	
1	Lack of technical know how	6	0	1	7
2	Less access to alternative livelihood	4	0	1	5
3	Lack of knowledge on climate change	10	5	2	17
4	Lack of meteorological stations	15	2	1	18
5	Illiteracy	10	1	1	12
6	poverty	35	2	4	41
	Grand Total	80	10	10	100

Table 2 presents the constraints or challenges that exacerbating climate change vulnerability on agriculture. Agriculture is the major employment sector in Kailahun District and accounts for about 70% of all the employments. Food security remains everybody's desire as long as communities continue to increase in population size. From Table 2, poverty is the main challenge that exacerbates climate change vulnerability and it accounts for 41% of the

respondents. Lack of meteorological stations represent 18% while lack of knowledge on climate change accounted for 17% of the challenges that exacerbating climate change Vulnerability. Illiteracy and other challenges like less access to alternative livelihood and lack of technical know-how accounted for 12%, 5% and 7% respectively.

Table 3: Economic effects of climate change on farming in Sierra Leone

No	Economic effects of Climate Change	Respondents			Total	Percentage (%)
		Farmers	MAFFS	Clim. Change Officials		
1	Positive	0	0	1	1	1
2	Negative	50	8	7	65	65
3	Both	25	2	2	29	29
4	None	5	0	0	5	5
	Total	80	10	10	100	100

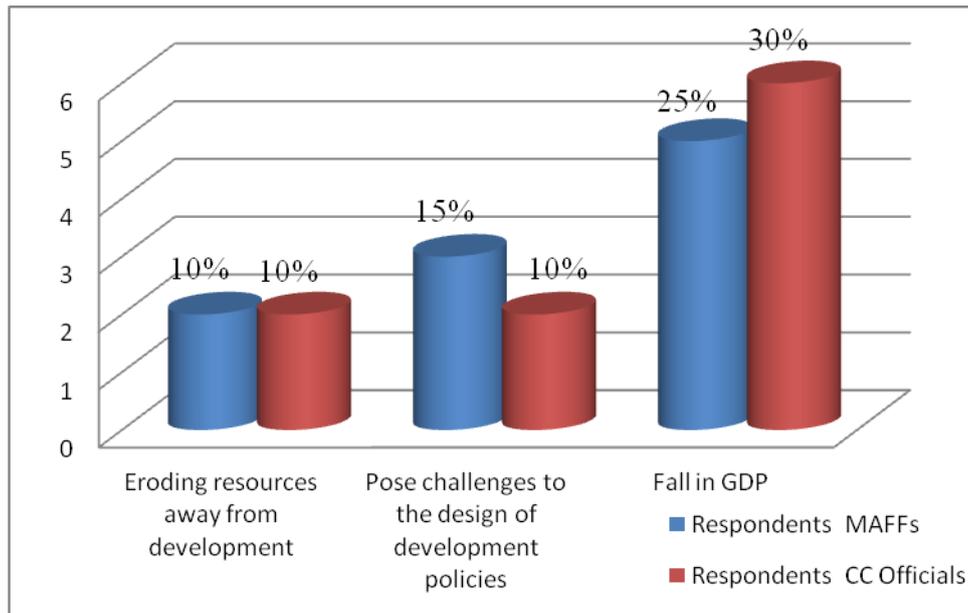


Figure 2: Consequences of climate change on Sierra Leone Economy

Table 3 and figure 2 present the economic effects and consequences of climate change on Sierra Leone’s economy. From table 3, the economic effect of climate change on farming in Sierra Leone is found to be mainly negative with 65%. While 29% of the respondents accounted for “both” in which the economic effect of climate change can be either negative or positive. The remaining accounted for positive and none economic effects with the proportion of 1% and 5% respectively.

Figure 2 presents the consequences of climate change on Sierra Leone’s economy. A total of twenty

(20) respondents were interviewed from both the MAFFS and Climate Change Office. This was to study the education background and their direct intermediary role played between government and the farmers. The Climate Change officials and MAFFS responded that, “Fall in Gross Domestic Product (GDP)” accounted for 55% as one of the main consequences on Sierra Leone economy. “Posing challenges to the design of development policies” accounted for 25% of the interviewees while 20% of the respondents represented “Eroding resources away from development.”

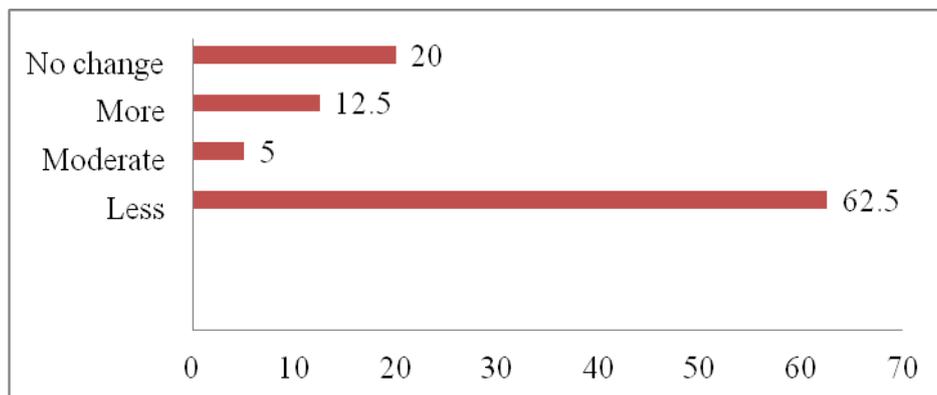


Figure 3: Comparing farm outputs over the last five years (2008-2013)

In Kailahun district, most of the farmers are engaged in subsistence farming by growing crops on small plots with rudimentary tools [18]. Figure 3 shows the comparison of farm outputs in past five years (2008 to 2013). 62.5% accounted for less farm outputs in 2013 when compared to 2008. The farmers also explained that, they were able to produce crops throughout the year even during the increased frequency of dry spells and unpredictable rainfall. The flooding and drowning of crops have become a daily problem in the study area. 5% of the respondents accounted for moderate farm output as compared to 2008, while 12.5% of the respondents found farm outputs in 2013 were greater than 2008. 20% of the respondents claimed that they did not notice “any changes” in farm outputs in 2013 when compared to 2008.

CONCLUSION

Like most developing countries, Sierra Leone depends mainly on agriculture. The effects of climate change on the agricultural sector are likely to threaten both the welfare of the population and the economic development of the country. This changing climate is particularly relevant for prudent implementation of agricultural policies. Agricultural policies such as changing crops, introducing irrigation or modifying farm management methods will influence farmers for successful adaptation to climate change. These changes in the form of policies can entail costly capital investments resulting to lower yield production from harvest as this low yield cannot compensate for the direct costs incurred. Thus, smallholder and subsistence farmers will suffer the impacts of climate change that will be locally specific and hard to predict.

It can be concluded that climate change has negative economic impacts on farming in Kailahun District. 65% accounted for less crop yield in 2013 when compared to 2008. Fall in Gross Domestic Product (GDP)’’ accounted for 55% while poverty stand out to be the main constraint that exacerbates climate vulnerability with 41%. Financial insecurity accounted for 22.5% as the main impact of climate change on farming in Kailahun District. As reported in the National Adaptation Programme of Action 2010 [18] climate change for Sierra Leone, poor communities have suffered most from the negative impact of climate change. This impact has been as a result of occurrence of extreme weather events including strong winds, thunderstorms, heat waves, etc. Subsistence farmers in the study area have also suffered from poor crop yields due to change in rainfall patterns which in turn threaten economic status and food security of the farmers in particular, and the country at large. Sierra Leone being a developing country is primarily dependent on climate sensitive factors like agriculture and forestry. These two economic elements are the major players of the country’s Gross Domestic Products (GDP). And because they have low financial adaptive

capacity, this makes the economic impact of climate change on farming in Kailahun District more vulnerable resulting to negative economy on Sierra Leone’s Gross Domestic Product.

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