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Climate Change Adaptation Strategies Adopted by Smallholder Farmers and Its Effects on Food Security at Anloga in the Volta Region of Ghana, West Africa

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Abstract:
Agriculture remains a significant part of the economies of countries around the world as it contributes to national gross domestic product (GDP), foreign exchange earnings, and food security. However, despite these contributions, the agricultural sector globally especially in Sub-Saharan Africa, is besieged with many challenges, paramount among them being climate change-related factors such as irregular rainfall patterns, increasing temperature, the incidence of droughts, and decreasing soil fertility. These problems have been found to have led to a fall in agricultural production globally including in developing countries like Ghana. On this premise, the present study sought to access the climate change adaptation strategies employed by smallholder farmers and its effects on food security at Anloga in the Volta Region of Ghana. The population for the study was crop farmers in the Anloga District who were selected using convenience sampling under non-probability sampling methods. The data collected was analyzed using Microsoft Excel and SPSS version 20. The study results revealed the farmers in the study area are aware of the negative effects of climate change on agricultural production and therefore adopt adaptation strategies such as using resistant crop varieties, crop diversification, intercropping/mixed cropping, changing cropping calendar and using irrigation with irrigating being stated to be widely used and most effective adaptation strategy. Based on the results it was recommended that farmers at Anloga and other communities within the District and the Region at large be educated on the importance of using adaptation strategies that are suitable for their climate to enhance their crop production.

Keywords: *Climate change, adaptation strategies, droughts, irrigation, soil fertility, agricultural production*

1. Introduction and Background

Agriculture remains a significant part of the economies of countries around the world as it contributes to national gross domestic product (GDP), foreign exchange earnings, and food security. However, despite these contributions, the agricultural sector globally, especially in Sub-Saharan Africa, is besieged with many challenges, paramount among them being climate change-related factors such as irregular rainfall patterns, increasing temperature, the incidence of droughts, and decreasing soil fertility. Further changes are expected in agricultural production, prices, and infrastructure due to climate change which may, in turn, limit the amount and quality of food produced. In line with nutrition in a family, inappropriate or too little food could adversely affect the health of people and maybe attributed to additional changes in global climate such as increasing temperature, floods or droughts which are threatening human physical and psychological circumstances. In the end, the poor in society especially those in the Least Developed Countries are likely to have little access to healthy, nutritious food which would lead to poor health status and lower labor productivity. These two factors according to a 2005 report by the FAO contributes to a continuous vicious cycle of poverty and malnutrition (FAO 2005).

The Intergovernmental Panel on Climate Change, IPCC (2007) defined climate change as 'any change in climate over time which arises as a result of both human activity and natural variability'. Its impacts are being felt by many people and ecosystems and have the potential to cripple the drive for sustainable growth and development globally (World Bank, 2008). Climate change according to Adger et al., (2003) is evident in increased temperatures, reduced precipitation, frequent droughts and scarcity of water. According to IPCC (2007), Africa is expected to experience the highest levels of warming with some countries, Ghana inclusive, also experiencing a decline in rainfall. These are expected to have adverse effects on agricultural production.

The Food and Agriculture Organization (FAO)of the United Nations (UN) defined food security at the World Food Summit in 1996 as 'when all people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'. Components of food security according to the FAO include ample food production, the socioeconomic issues surrounding food availability, or the ability to translate hunger into an economic demand for food and to have access to nutritious effectively, safe and culturally preferred foods. Therefore, on both the supply side in terms of production and the demand side in terms of being able to trade for food, the stability of food systems is important. Food security includes the production of food, trading of food, the nutritive value of food, and also how individuals and countries maintain access to food overtime periods in the face of challenges. This

makes the link between climate change and food security complex. This is because other aspects of food security such as access to food, availability of food, the stability of the food, and utilization of food have not been given much attention though much attention has been given to the effects of climate change on food production. As a result, some impacts of climate change on food security such as an increase in the prices of food and malnutrition may be underestimated.

In Ghana, agriculture remains the mainstay of the country's economy with more than fifty percent of the active labor force being employed by the agricultural sector which supplies the majority of the food requirements for citizens (FAO, 2015). According to Stanturf et al., (2011), projections on climate change across Ghana point to temperatures increasing across all the ecological zones with dry season temperatures expected to increase by about 3 ◦C by 2080. Projected changes in rainfall during the wet season are also not certain. As a result, these changes in the projection of rainfall variations and increases in extreme climatic events may affect agricultural activities negatively and also the gains expected to be made in terms of food security and rural development since food production activities are highly dependent on rainfall (Nelson et al., 2010).

Von Braun (2007) averred that world food demand is projected to increase in the next decades as it is presently being redefined by new driving forces. He added by stating income growth, climate change, high energy prices, globalization, and urbanization are transforming food production, consumption, and markets. In Sub-Saharan Africa, a 2010 report by the FAO revealed that countries within the region form the bulk of a prolonged food crisis. Meanwhile, in Sub- Saharan Africa, agriculture is the most significant sector and experiences the major impacts of climate change according to various authors (e.g. Kurukulasuriya et al., 2006; Moussa &Amadou, 2006; Hassan &Nhemachena, 2008; and Molua, 2006). While climate change could affect the agricultural sectors of different nations in diverse ways, it is expected that these changes would result in major losses in the welfare of citizens especially smallholder farmers to whom agriculture is their major source of livelihood. To buttress the above, according to Afful (2016), climate change and its variability negatively impact crop production. He explained this view by stating that, in areas with insufficient irrigation facilities, crops normally wither and die, resulting in a reduction in crop yields. A fall in crop yields would further the problem of poverty, especially among rural smallholder farmers.

Senaratne and Scarborough (2011) in their study additionally stated that the livelihoods of residents of farming communities that are mostly dependents on the weather and climate for their farming activities are highly altered due to climate change and its variability. For example, climate change negatively affects land use and livestock management by changing crop, forage and livestock growth and yield (Mu &McCarl, 2011). Kumasi, Antwi-Agyei, and Obiri-Danso (2019) in their study found about 82% of sampled respondents stated they had experienced a reduction in crop yields as a result of worsening climatic conditions such as drought. According to FAO, the basic elements of food production (soil, water, and biodiversity) are also affected negatively by climate change (FAO, 2009). Climate change has also been found to affect crops by spreading new types of diseases that do not exist in the past (Cohen et al. 2008). The control of such diseases and pests may be difficult since they are new to farming systems and may lack registered pest control remedies. Such instances would lead to a fall in food production, in so doing increasing the problem of food security globally especially in developing countries like Ghana. For this reason, there is a need for smallholder farmers to modify their farming practices to enable them to adapt better to the changing climate to enhance food security. Also, urgent measures need to be undertaken to improve the resilience of African communities, especially those in rural areas, to enable them to better adapt to climate change and other constraints to food production.

2. Brief Literature Review: Climate Change Adaptation Strategies Adopted by Smallholder Farmers

Due to the negative effects of climate change and variability on the agricultural sector, various adaptation strategies have been adopted by smallholder farmers to reduce its negative effects as a means of promoting food security.Climate change adaptation was defined by the Intergovernmental Panel on Climate Change (IPCC, 2014) as a 'process of adjustment to actual or expected climate and its effects'. This implies adaptation seeks to put in place measures to address the negative effects of climate change as and when it occurs as well as take advantage of positive outcomes that may be presented to farmers. This involves medium to long term modifications in socio-ecological systems as stated by Smit and Pilifisiva (2001).Climate change adaptation could also be said to mean measures instituted by individuals, society, and countries at large to enable them to adjust to climate change as it occurs. In so doing, these groups of people are able to minimize their exposure to risk associated with climate change, develop their capacity to cope with the damages that may occur due to climate change and its variability, as also exploit new opportunities that may be made available to them due to climate change.

In the agricultural sector, according to the Food and Agriculture Organisation of the United Nations (FAO, 2006), the adaptation strategies are normally adopted by farming households to enable them to manage climate change and its variability and its effects on their farming activities. Climate change adaptation strategies may be traditionally based on indigenous knowledge of farmers, strategies that may be available to farmers through the support of government and other international donor agencies, strategies based on advanced and innovative technologies, among others. However, this study will mostly concentrate on traditional adaptation strategies available to farmers.According to Snidvongs (2006), one method of adapting to climate change by smallholder farmers is when they use climate-resistant crop varieties. Some of these crop varieties may have shorter growth periods while others may be resilient to climate change and its effects (e.g. droughts). By using crop varieties with shorter maturity periods, farmers may be able to have more than a single crop season per year which could help reduce losses. Also, using drought-resistant varieties would help farmers and could help them reduce crop loss when there is less rainfall.Ngigi (2009) in his study stated that smallholder farmers in Nigeria, Senegal, Ghana, and Burkina Faso have tried using drought-resistant crop varieties as an adaptation methodto climate

change and have been more effective in reducing crop loss due to drought as compared to planting local varieties. Crop diversification could help safeguard smallholder agribusinesses from total crop failure because various crops respond differently to rainfall disparities and related climatic events, and changes in farm management practices may reduce yield losses.

Similarly, farmers reduce the negative effects of climate change by intercropping. This involves growing two, three or more crops together in the same field. Study results arrived at by Mendelsohn et al. (2000) on analyzing adaptations made in Africa revealed that all African counties excluding Cameroon and South Africa deem mixed cropping to be one of the major climate change adaptation strategies in agriculture. In mixed cropping, farmers normally plant different types of crops such as legumes, cereals, roots, and tubers, etc. together since all these types of crops have different characteristics in terms of the maturity period, drought tolerance, input requirements and the end-use of the product. Hence, at every point in time, a farmer who cultivates different varieties of food crops stand to receive more benefits than those who cultivate a single crop per cropping season. Farmers may equally change their cropping pattern which involves introducing new crops to replace or add up to existing crops being cultivated as a means of adapting to climate change. In line with the above, according to a 2008 Action Aid report, in the semi-arid zones of Brazil, farmers in the drought-prone areas incorporated varieties of bean, maize, sorghum and other crops in addition to existing crops being cultivated to help them boost their harvest potential amidst climate change pressures on crop production. Farmers in the Northern parts of the Philippines who experience divergent dry and wet seasons also moved from the cultivation of rice with irrigation to tobacco and other vegetable plants that are drought tolerant.

Further at the farm level, farmers can change their cropping calendar to suit the changes in climate. For example, different crops could be planted in sequence at different times of the year to ensure farmers would be able to harvest different types of crops at different times of the year. This is to help reduce losses incurred by planting one type of crop which may not do well all year round (Lasco& Boer 2006). In addition, since it is expected that climate change could result in a decline in the availability of both surface and ground freshwater and also reduced soil moisture during the dry season, farmers may resort to enhanced irrigation practices. This is necessary since the demand for crop water is expected to increase due to increased evapotranspiration triggered by climate change and the incessant introduction of high-yielding varieties and intensive agriculture (Selvaraju et al., 2006). Engaging in irrigation will, therefore, serve as insurance for farmers against rainfall variability and fluctuations and resultant crop failures.

In the Ghanaian context, in the Northern parts of the country, smallholder farmers adopt strategies such as using manure, farm residue management, stone/grass bundling, and tree planting to conserve soil moisture andfertility. Other climate change adaptation strategies that may be employed by smallholder farmers in their agricultural activities include changes in farm management practices, planting of early maturing, drought and pest-resistant varieties, intercropping, crop rotation, exploring alternative crops and testing them under drought conditions, conservation farming practices, more efficient use of water, renewable energy farm planning, and monitoring of plant and soil changes (Davies, 2014). Increased use of irrigation, increased use of water and soil moisture conservation techniques, and diversification to non-farm activities have also been employed as adaptation measures. Despite the benefits smallholder farmers may derive from adopting adaptive strategies for climate change variability, farmers must be cautious as the coping and adaptation strategies might put more pressure on the ability of farming households to withstand future vulnerabilities which may lead to maladaptation (Brown et al., 2007).

3. The Effectiveness of Climate Change Adaptation Strategies and Food Security

Climate change adaptation strategies have helped improve food security through increasing food production, opening access to markets and resources for farmers, reducing disaster risks, among others. This implies that, climate change adaptation strategies when effective in the agricultural sector may help ensure food production, thereby contributing to food security and sustainable livelihoods especially in developing economies. Some studies over the years have presented evidence that farmers in some parts of the world are already adapting to observed climate changes particularly by altering cultivation and sowing times and alternating crop cultivars and species. For instance,Passioura and Angus (2010) in their study found that changing cropping patterns could increase crop yields by three to seventeen percent though there may be some variations in yield in different parts of the world. The use of short duration cultivars was also found by Orlandini et al. (2008) to reduce crop exposure to droughts and high temperatures resulting from climate change. By the same token, the optimization of crop varieties and planting calendars according to Deressa et al., (2009) seems to be an effective adaptation strategy, leading to a twenty-three percent increase in yield. Therefore, altering planting dates and varieties to suit seasonal conditions may possibly be vital in the face of current climate change conditions.

Concerning diversification activities, findings from a study by Reidsma and Ewert (2008) revealed regional farm diversity decreases current risks associated with unfavorable climate conditionsin Europe. Further on diversity in agricultural production, a report by the FAO (2015c) stated that increasing the diversity in the production system is another important climate change adaptation strategy that may help increase agricultural production globally. Diversification in this sense could mean 'combining varied types of production (crop, forest, fish and animal) in diverse ways, increasing the number of different species, populations, varieties or breeds, and also increasing the use of materials that are genetically diverse such as crop multiline' (FAO, 2015c).Making changes in farm management practices such as employing novel tillage practices may help minimize exposure of the topsoil to air, and this reduces evaporation, improves soil moisture characteristics and reduces the sensitivity of crops to heat and drought.Villoria et al., (2016) also found that adaptive changes in crop management practices have led to an increase in the crop by about seven percent to fifteen

percent averagely, though theresults are highly dependent on the type of crop being considered and region. Also, the problem of increasing drought conditions and water scarcity has been addressed by enhanced water management practices such as water storage and improved access to irrigation water, improved irrigation technologies and techniques such as water harvesting (HLPE, 2015).

With regard to the effectiveness of climate change adaptation strategies employed by Ghanaian farmers,Bawakyillenuo, Yaro and Teye, (2016) found that farmers implemented changes in tillage practices and intensified irrigation to reduce the adverse effects of inconsistencies in rainfall and temperature on their crop production activities in northeastern Ghana.In addition, Fosu-Mensah, Vlek, and MacCarthy (2012) added that farmers in Southern parts of the country engaged in diversified income generation activities during the dry season and altered their planting and harvesting dates as a means of decreasing the negative effects of climate change. These were found to help improve food security in areas where they were being practiced.

4. Methodology

The study was undertaken at Anloga, a farming community in the newly created Anloga District in the Volta Region of Ghana.The District was carved out of the Keta Municipality. The town lies east of the Volta River and just South of the Keta Lagoon. In terms of population, Anloga is the 47th most populous town in Ghana with a population of 35,933 people. Residents of Anloga are notable for shallot farming which started around the 1930s when individual farmers at Anloga embarked on an intensive filling and reclamation of marshy depressions left by the sea and on the edges of the Keta lagoon, converting them into vegetable farms, and specializing in the production of shallots when there were high demands for vegetables across the country. To date, the majority of farmers in the area are into shallot farming with others venturing into the production of other food crops like cassava, maize, okra, and beans. The study used the descriptive research design to enable the researcher to describe and interpret the relationship between climate change adaptation strategies used by farmers in the study area and how it contributes to food security. Using the descriptive design also helped in collecting data relevant to the study in order to answer questions with regard to the present status of climate change and food security in the study area.

The population for the study was crop farmers in the Anloga District who were selected using convenience sampling under non-probability sampling methods. This aided in reaching farmers in the community who were present at the time of data collection. Their consent was sought as to whether they were willing to participate in the study. The data collected was analyzed using Microsoft Excel and SPSS version 20.

5. Results

From the results, information was collected from 138 farmers where 91 (66%) were male and 47 (34%) were female. Twenty-five (18%) of the respondents had been farming between 6-10 years and 113 (82%) had been into farming for more than 10 years. The farmers were into the cultivation of various crops such as cereals, roots and tubers, vegetables and legumes. With regard to the climate change adaptation strategies adopted by smallholder farmers include using resistant crop varieties (98.6%), crop diversification (98.6%), intercropping/mixed cropping (100%), changing crop calendar (100%), and using irrigation (138%). The majority of the respondents, however, stated they do not plant trees to conserve soil moisture and fertility as an adopted climate change adaptation strategy. This trend of results is consistent with the findings of authors such as Ngigi (2009), Snidvongs (2006), Davies (2014) among others as cited in the literature. This shows that the farmers in the area are well aware of climate change and its negative implications and have therefore put in measures to address the challenges which is an important step towards ensuring food security.

Adaptation Strategies	Yes	No
Using resistant crop varieties	136 (98.6%)	2 (1.4%)
Crop diversification	136 (98.6%)	2 (1.4%)
Intercropping/Mixed cropping	138 (100%)	-
Changing cropping calendar	138 (100%)	-
Using irrigation	138 (100%)	-
Planting trees to conserve soil moisture and fertility	2 (1.4%)	136 (98.6%)

Table 1: Climate Change Adaptation Strategies Adopted by Smallholder Farmers
Source: Field Data, 2019

Results on the effectiveness of climate change adaptation strategies and food security show that different adaptation strategies have been employed by smallholder farmers at Anloga as a means of promoting food security. The use of irrigation (98.6%) was identified by farmers as the major adaptation strategy used to address the negative effects of climate change on food crop production. This was followed by changing cropping calendar (69.6%), intercropping/mixed cropping (59.4%) among others.The views stated by the farmerson the effectiveness of the various adaptation strategies

have also been found by some researchers (e.g. Passioura& Angus, 2010;Fosu-Mensah, Vlek&MacCarthy, 2012, Muller & Elliot, 2015; Bawakyillenuo, Yaro&Teye, 2016, etc.). This is an indication that the farmers are concerned with the issue of food security as climate change has led to a change in their crop yields. Hence, to enable them to contribute to reducing the problem of food shortages, they use different strategies that may help enhance their crop production since they can no longer rely on natural weather conditions as they previously do.

Adaptation Strategies	Responses		
	Not Effective	Effective	Very Effective
Using resistant crop varieties	-	76 (55.1%)	62 (44.9%)
Crop diversification	-	69 (50%)	69 (50%)
Intercropping/Mixed cropping	-	56 (40.6%)	82 (59.4%)
Changing cropping calendar	-	42 (30.4%)	96 (69.6%)
Using irrigation	-	2(1.4%)	136 (98.6%)
Planting trees to conserve soil moisture and fertility	138(100%)	-	-

Table 2: The Effectiveness of Climate Change Adaptation Strategies and Food Security
Source: Field Study, 2019

6. Conclusions and Recommendations

From the study, it is concluded that the farmers are aware of climate change and its negative effects on crop production in the study area. These have led to them employing various adaptation strategies to enable them to continue food production in order to reduce the problems of food shortages. These adopted strategies according to the farmers were effective in addressing climate change problems in crop production in the study area especially the use of irrigation which was stated to be widely used and said to be very effective by the majority of the respondents.

For this reason, it is recommended that farmers at Anloga and other communities within the District and the Region at large be educated on the importance of using adaptation strategies that are suitable for their climate to enhance their crop production. This may be achieved by intensifying extension education especially in communities that are difficult to reach as they normally lack information on contemporary farming practices. Irrigation facilitiescan also be subsidized to enable farmers to purchase them. This may go a long way in increasing the use of irrigation for farming since smallholder farmers normally do not have adequate capital to purchase such farming inputs. In addition, to ensure food security, farmers must be educated on the need to enhance their postharvest management practices to help reduce losses incurred by farmers after harvesting their food crops. A reduction in postharvest losses, therefore, may help make food available all year round as well as increase the income farmers derive from their farming activities, thereby bringing about improvements in their livelihoods.

7.Disclaimer

The views expressed in this publication are those of the author and do not represent those of the United Nations Development Programme (UNDP) or United Nations (UN).

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