



# **Climate-Smart Agriculture (CSA) Adaptation Strategies of Farmers against Climate Change in Lawra Municipality, Upper West Region, Ghana**

**Ransford Teng-viel Karbo<sup>1\*</sup> and Aba Obrumah Crentsil<sup>2</sup>**

<sup>1</sup>CSIR-Science and Technology Policy Research Institute, CT519, Cantonments-Accra, Ghana.

<sup>2</sup>Institute of Statistical, Social and Economic Research (ISSER), University of Ghana, LG74, Legon-Accra, Ghana.

## **Authors' contributions**

*This work was carried out in collaboration between both authors. Author RTVK designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author AOC proofread the draft and edited the draft manuscript. All authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/JSRR/2021/v27i230355

### Editor(s):

(1) Dr. Rahul Kumar Jaiswal, National Institute of Hydrology, India.

### Reviewers:

(1) Yu Zhu, Henan Polytechnic University, China.

(2) Hasan Faruque, University of Dhaka, Bangladesh.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/65973>

**Received 30 December 2020**

**Accepted 08 March 2021**

**Published 19 March 2021**

**Original Research Article**

## **ABSTRACT**

Climate-Change is real and has daunting effects on various economic sectors. Agriculture is one of the hardest hit. The sector is the main source of livelihood for rural areas and risk being endangered. Concrete steps are needed to adapt to the situation. Climate-Smart Agriculture (CSA) practices are robust coping mechanisms against climate change and the effects on agriculture. Farmers in Lawra Municipal are encouraged to employ CSA practices in farming. The CSA adaptation strategies of farmers in Lawra against climate change are unclear. Specifically, the objective of the study is to identify CSA adaptation strategies of farmers in Lawra. The importance of this study is to strengthen the adaptation capacity of farmers towards protecting their primary livelihood source (agricultural) from the impact of climate change. Employing a qualitative approach and using a semi-structured questionnaire, the study conducted in-depth interviews with farmers, and a key informant each from the Municipal Agriculture Department and one local radio station. Quota, snowballing and purposive non-probability sampling techniques were employed to select 20 farmers with knowledge and experiences on CSA practices. Findings from the study suggest that,

\*Corresponding author: E-mail: [agentkarbo@yahoo.com](mailto:agentkarbo@yahoo.com);

farmers' CSA adaptation strategies included advice on crop management, new or improved crop varieties, climate change education and awareness, and the organization of field trips to demonstration sites. To improve farmers' adaptation strategies, the study recommends intensification of routine visits and monitoring by agriculture extension agents, encouraging farmers to frequently visit the Municipal Agriculture Department for assistance, and governments and the private sector must support farmers with logistics and credit pertaining to CSA practices.

*Keywords: Climate change; climate-smart agriculture; agriculture; Ghana.*

## 1. INTRODUCTION

The steady rise in the global population has triggered an increasing demand in agricultural output to feed the growing population [1]. There is a potential risk of inefficiently meeting the agricultural needs of the growing global population in the future, considering the effects of changing climatic conditions on agriculture [1,2]. Climate Change is taking a toll on farmers, particularly in sub-Sahara Africa. This is evident in occurrences of high temperatures and erratic rainfall patterns as well as extreme weather conditions including floods, droughts, heat inter alia [3]. Studies have reported experiences of changing climatic conditions in farming communities in the transition and coastal savannah zones of Ghana which has resulted in a decrease of the length of minor and major farming seasons [4,5].

In Ghana, smallholder agriculture is recognized as the backbone of the rural economy employing the majority of the rural population [6-8]. Production in agriculture is climate dependent (i.e. rain-fed), rendering the sector vulnerable to the vagaries of the weather [9]. According to [10], the over-reliance on rains for agricultural production has often resulted in low agricultural output and poor income for farmers. Considering the critical nature of the sector, climate change threatens a major source of livelihood for rural dwellers [11]. It is on this basis that, the adaptation capacity of farmers needs fortification to mitigate the impact of climate change [12]. Climate Smart Agricultural (CSA) practices are seen to be robust measures to mitigate or minimize the effects of climate change on agriculture [13]. The idea of "Climate-Smart Agriculture" was first recognized by the Food and Agriculture Organization (FAO) in 2010. CSA is developed on the tenets of three key objectives namely 1). sustainably increasing food security by increasing agricultural productivity and incomes, 2). building resilience and adapting to climate change and 3). developing opportunities

for reducing greenhouse gas emissions compared to expected trends [11]. CSA promotes greater awareness on climate change impact of agriculture and food system production, and the need for farmers to employ sustainable agronomic practices to maximize output even with limited resources [14].

Generally, scores of studies have reported diverse climate change adaptation strategies of farmers [15,16]. In Ghana, farmers' climate change adaptation strategies are fundamentally hinged on practices related to land management, crop management, and alternative economic opportunities inter alia [17]. Farmers in Lawra are encouraged to employ CSA practices to adapt to prevailing unfavorable climatic conditions. However, the CSA adaptation strategies of farmers in Lawra are unclear. For that matter, the objective of this study was to identify the CSA adaptation strategies of farmers against climate change in Lawra. Essentially, this study is seeking to strengthen the adaptation capacity of farmers against the effects of climate change on agriculture.

## 2. LITERATURE

### 2.1 Climate Change

Climate Change is the variation in weather conditions induced by natural or man-made actions over a while as a result of altering the morphology of the environment [18]. Climate scenarios for Ghana postulate that by 2020, 2050 and 2080 temperatures are likely to rise by 0.6°C, 2.0°C, and 3.9°C respectively [19]. The effects of climate change have led to variation in precipitation resulting in shorter rainfalls and some cases delay in rainfall. Formerly, farmers in Northern Ghana enjoyed rains between April to September or possibly October. Presently, the rains are shorter and can barely last up to 6 months, (i.e., June/July to September/October) [20,21,22] reported that in 2007, the rains delayed and did not fall as expected around

April. In the aftermath of this delay, there were a series of heavy rainfall causing floods and devastation to crops and livestock farms. This resulted in famine across parts of the Upper East and Upper West regions. In response to the climate change conundrum in Ghana, the National Climate Change Policy (NCCP) (2014) was implemented. The key objectives of the NCCP are effective adaptation, social development, and mitigation. Complementarily, a National Climate-Smart Agriculture and Food Security Action Plan accompanied the implementation of the NCCP to effectively operationalize the policy.

## 2.2 Agriculture

In Ghana, agriculture remains a critical contributor to the greater economy despite the decreasing rate in contributions from about 39% to 21% from 1990 to 2015 respectively [23]. The sector is predominantly occupied by smallholder farmers mainly in rural areas. Typically, smallholder farmers cultivate on land sizes of two or fewer hectares with simple manual farm tools, family labor, and limited mechanization [24]. Agriculture is the backbone of rural economies as it is the major source of employment for rural populations [6-8]. Agricultural activities for smallholder farmers are climate dependent (i.e. rain-fed), thereby rendering their source of livelihood prone to the effects of climate change [25]. According to [26], the sensitivity of agriculture is left to the mercy of floods and droughts that are destructive to the sector. Aside from the challenge of climate change affecting the agricultural sector, other notable challenges include lack of formal access to credit and insurance markets by smallholder farmers, limited integration with commercial marketing channels, limited technology adoption by farmers inter alia [27]. Given the full potential of agriculture, it is often argued that the sector can be a critical means for eradicating poverty in rural areas hence, the need for unbridled attention and investments to promote sustainable production practices [28].

## 2.3 Climate-Smart Agriculture (CSA)

'Climate-Smart Agriculture' as coined by the Food and Agriculture Organization (FAO) in 2010 is subject to three principal objectives including 1). sustainably increasing food security by increasing agricultural productivity and incomes, 2). building resilience and adapting to climate

change and 3). developing opportunities for reducing greenhouse gas emissions compared to expected trends [11]. In definition terms, [14] and [29] note that CSA is a combination of practices that best enable farmers ability at the local level to adapt adequately to weather variability to boost production capacity through the minimization of carbon emissions. The intended outcome of CSA is to strengthen food security for today and the future. The underlying principle of CSA is in its approach where the practices are not developed and implemented commonly. Rather, CSA practices capture the peculiarity of a respective area [11, 30]. CSA practices are not entirely new but propagation of appropriate agronomic practices that are resistible to climate change in the context of specific localities.

## 2.4 Adaptation Capacity

Adaptation as expressed in the National Climate Change Policy (2013) is defined as "*Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*" [19]. Changing climatic conditions have resulted in the need to develop adaptation strategies to counter the adverse effects on agriculture [3]. According to [41,42,43] adaptation strategies are regarded as autonomous or planned (policy-driven). Autonomous adaptation is when adaptation strategies are traditionally or locally engineered at the farmer level. Planned adaptation constitutes strategies that have been influenced by institutions (e.g., governments, non-governmental organizations, etc). Typically, adaptation strategies consider access and affordability of critical inputs, adoption of appropriate management practices, access to research and extension services, and enactment of enabling policies by government and stakeholders. [44] further add that consistency of technology, information and communication flow are critical in building robust adaptation capacity of farmers. To that effect, the robust adaptation capacity of farmers is subject to resistance against any adversity or vulnerability.

## 3. METHODOLOGY

The study employed a qualitative research method, using a semi-structured questionnaire to conducted in-depth interviews with farmers, and a key informant each from the Municipal Agriculture Department and a local radio station.

**Table 1. Examples of Climate-Smart Agriculture (CSA) practices**

<b>Practice</b>	<b>Definition</b>	<b>Justification</b>	<b>Reference</b>
Composting	Collection and heaping of organic waste materials such as food scraps, crop residues or livestock manure in a pit, pile or other structure to allow for decomposition and later application to cropland soil.	Adaptation: compensation for declining soil fertility Mitigation: emissions reduction avoidance animal application; improve soil carbon sequestration Food security: increase productivity; lower input requirements.	[31, 32]
New/Improved Crop Varieties	Use of genetically improved germplasm specifically bred for traits such as increased yield, stress tolerance and/or disease resistance.	Adaptation: stress tolerance and disease resistance; early maturing to avoid crop loss from shorter growing seasons or unreliable rains Food security: higher productivity; decreased risk of crop failure.	[33, 34]
Mulching	Covering the soil surface with a layer of organic residues (leaves, straw, stems, cut grasses) and allowing for eventual decomposition with the aim of stifling weed growth and evaporation of soil water content.	Adaptation: reduction in soil temperatures to compensate for higher air temperatures; improve moisture retention to compensate for drought and reduced rainfall. Mitigation: reduce emissions from exposed soil surface. Food Security: improve productivity; reduce risk of crop loss.	[35]
Intercropping	Planting of two different, though complementary, crops on the same plot of land, either in a mixed, row, or strip intercropping system.	Adaptation: reduce risk of total crop failure Food security: diversification of production.	[36, 37]
Stone bunds	Piling or mounding stones either across contours to create terraces in slope areas, or in a continuous line along contours to slow the flow of rainwater and allow the accumulation of plant debris and fine soil particles.	Adaptation: improve water absorption and retention for drought or low rainfall conditions Mitigation: reduce emissions from soil erosion; soil carbon sequestration. Food security: productivity maintenance through avoidance of soil erosion and degradation.	[38]
Contour and Ridge Planting	Construction of continuous lines of mounded dirt upon which crops are planted. Ridges are constructed along the contours of cropland to prevent run-off of rainwater.	Adaptation: increase water retention to compensate for drought & reduced rainfall; increase nutrient absorption Food Security: increase productivity on sloping marginal lands or compacted soils.	[14, 39]
Erosion Control	Use of one or more of a suite of practices that reduce runoff by slowing the flow of water over the soil's surface or improving infiltration speed, including ridge-building, bunding, and tree planting.	Mitigation: improve soil structure; soil carbon sequestration Food Security: improved/sustained yields through prevention of soil degradation.	[34, 40]

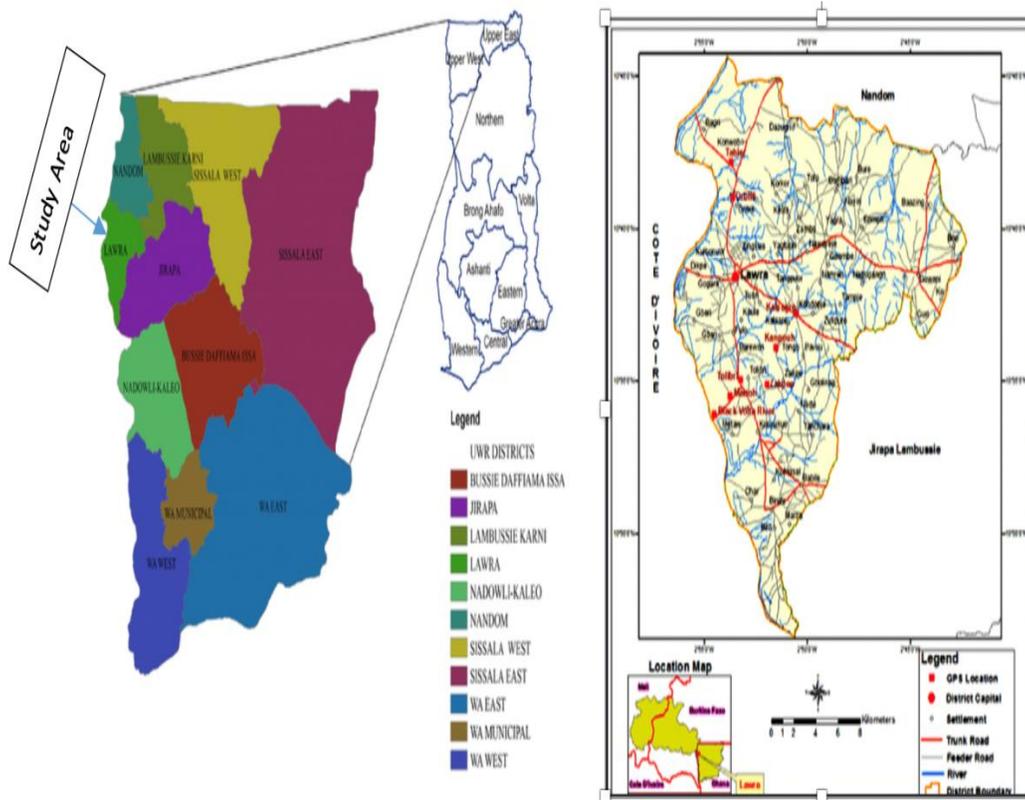
Source: [14]

In consultation with the Municipal Agriculture Department, farmers were selected from a list of beneficiaries from extension services, government and non-governmental led programmes. The farmers were drawn from the four administrative of Lawra Municipal namely, Lawra Town Council area, Babile area, Eremon area area and Zambo area. Due to data saturation, 20 farmers (5 from each administrative area) were sampled for the in-depth interviews using quota, snowballing, and purposive non-probability sampling techniques [45]. These sampling techniques were employed to select farmers with knowledge and experiences in CSA practices. The data was analyzed using deductive thematic analysis.

situated in the north-western corner of the region and draws its boundary line from Nandom Municipal to the north, Lambussie-Karni District to the east, and the Republic of Burkina Faso to the south-west and west [47]. Agriculture is the main economic activity in the area with about 84 percent of households deriving livelihood(s) from the sector [47]. Agricultural production is predominantly on a subsistence basis. Major crops cultivated include Maize, Millet, Groundnuts, Soybean, and Cowpea. Livestock reared include Pigs, Goats, Cattle and Guinea Fowl. Challenges affecting agriculture in Lawra include depletion of soil fertility, erratic rainfall pattern, prolonged dry season, limited capital and skill, pest and diseases, inadequate access to extension services, low access to ready markets inter alia [48]. These challenges inherently affect productivity that poses a potential threat to household food security. This has dire implications to compound the existing high incidence of poverty in the area and the region at large [49].

### 3.1 Profile of Study Area (Lawra Municipal)

Lawra Municipal is one of the eleven Municipalities/Districts in the upper west region of Ghana. The Municipality is geographically



**Fig. 1. Location of the study area**  
 Source: [46]; Lawra municipal assembly

## 4. RESULTS AND DISCUSSION

### 4.1 Socio-demographic Characteristics of Farmers Interviewed

About 95 percent of the farmers interviewed were male and 5 percent female (Table 2). This implied that agriculture in the area is dominated by men. Also, males are heads of the household, thereby overseeing associated assets including land. The average age, farm size and farming experience of the farmers were 49 years, 6 acres and 40 years, respectively (Table 3). About 85 percent of farmers had no formal education (Table 4). Majority of farmers (95 percent) engaged in farming primarily for food (Table 5). All farmers practiced mixed farming, thus cultivated crops and reared livestock. Essentially, livestock was reared to serve as a coping mechanism to any event of crop failure. In such events, livestock was sold to earn income to buy food for the household.

Climate change has become a major concern to farmers in Lawra hence the eagerness to find coping mechanisms to adapt to the situation since agriculture, their major source of livelihood is endangered. Climate-Smart Agriculture (CSA) practices are considered coping mechanisms for farmers against climate change. This study finds diverse CSA adaptation strategies of farmers in Lawra against climate change. These include advice on crop management, new crop varieties, climate change education and awareness, and the organization of field trips to demonstration sites.

Mainly, farmers disclosed that advice on crop management was a widely resorted CSA adaptation strategy against climate change. This strategy entails farmers receiving relevant tips from agricultural extension officers of the Municipal Agriculture Department about crop management. Farmers are advised on diversifying crops cultivated as part of coping mechanisms to adapt to climate change. One potential benefit farmers can derive from this

adaptation strategy is the improvement in soil fertility by intercropping food crops with legumes or cover crops. Depletion of soil fertility in Lawra is a challenge that is affecting agriculture productivity, thereby, stressing the essence of this adaptation strategy. The importance of this adaptation strategy is articulated by one farmer stating that *“though I have indigenous knowledge about farming, which we learned from our fathers, the advice given to me by the agricultural officers is helping me, particularly in this era of changing climatic conditions”*. [50] in a study, make similar findings, where farmers in Northern Nigeria adopted the practice of cultivating a mix of crops in rotation on a piece of land as part of CSA practices.

Another CSA adaptation strategy against climate change that is common among farmers in Lawra is the use of new and improved crop varieties. Given the circumstances of erratic rainfall patterns and spells of drought, improved crop varieties with drought tolerance, form part of the CSA adaptation strategies against climate change. The traditional crop varieties are regarded as less resilient against the prevailing harsh climatic conditions hence, the imploration on farmers not to rely on such crop varieties. However, this adaptation strategy appears not to be easily adhered to by farmers. The reason being that some farming practices have traditional values as a result, conservative farmers are adamant to accept this form of adjustment. Additionally, farmers consider the cost of new or improved crop varieties higher than traditional varieties thereby affecting the use of this adaptation strategy as a coping mechanism against climate change. A farmer disclosed that *“if we had loans to acquire more farm inputs like the seeds, they say we should buy so we can effectively cope with the effects of climate change”*. The use of improved crop varieties is also found in a study by [50], where farmers in Northern Nigeria adopted the cultivation of early maturing and drought resilient crop varieties to mitigate the negative impact of climate change on farming.

**Table 2. Gender of farmers**

		Farmer Gender			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	19	95.0	95.0	95.0
	Female	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

**Table 3. Age, farming experience and farm size of farmers**

	Descriptive Statistics				
	N	Minimum	Maximum	Mean	Std. Deviation
Age of farmer	20	33	63	48.60	7.014
Years of farming	20	30	55	39.75	5.730
Size of farm in acres	20	3	10	6.20	2.331
Valid N (listwise)	20				

**Table 4. Education level of farmers**

		Level of education			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No education	17	85.0	85.0	85.0
	Basic education	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

**Table 5. Farmer purpose for farming**

		Purpose for farming			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food	19	95.0	95.0	95.0
	Income	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Education and awareness creation through media on climate change is another CSA adaptation strategy for farmers in Lawra to cope with climate change. Information about climate change education and awareness is conveyed through the local radio station. This implies the vital role the media (local radio) is contributing to measures combatting the impact of climate change on agriculture. In Lawra, radio education and awareness on CSA practices are disseminated in the local dialect (Daagara) through announcements and panel discussions. Usually, there is a collaboration with The Climate Change, Agriculture, and Food Security (CCAFS) platform in Lawra to educate and create awareness on CSA practices. This adaptation strategy is enabling farmers in Lawra have access to information on climate change and potential solutions. [51] in a study, found radio to play an essential role in educating farmers on sustainable agronomic methods. Additionally, the study found that farmers’ perceived mass media as a means of channeling out relevant agricultural information.

The organization of field trips to demonstration sites is yet another CSA adaptation strategy for farmers in Lawra against climate change. Farmers are routinely organized into groups to embark on field visits where CSA practices are demonstrated. This exercise enables farmers to comprehensively observe the beginning and results of certain CSA practices (i.e., experiment

with new/improved crop varieties). During such exercises, farmers can seek clarity on CSA practices by observing and participating. The (CCAFS) platform routinely take farmers to a demonstration site at Tongokampore, where CSA practices are piloted. This adaptation strategy for farmers in Lawra goes to dispel some cultural and religious reasons that hinder the adoption of CSA practices. Many of the farmers are convinced and ready to adopt CSA practices after taking part in the field demonstration exercises. This adaptation strategy corroborates findings by [52], indicating field visits influenced farmer uptake of improved farming practices in Lesotho, forming part of strategies against climate change. [1] in a study also found that extensive and repeated demonstrations of CSA practices were likely to improve farmers’ adaptation capacity.

## 5. CONCLUSION AND RECOMMENDATION

Climate Change is impacting negatively on agriculture. Rural dwellers, mostly farmers in Lawra depend solely on agriculture as a source of livelihood. The effects of climate change endanger their main source of livelihood. Therefore, substantial efforts are required to address this impending danger. Climate-Smart Agriculture practices (CSA) are considered robust coping mechanisms farmers in Lawra can implement to adapt to climate change. This study

sought to find out the CSA adaptation strategies of farmers in Lawra against climate change.

Based on a qualitative study approach and using a semi-structured questionnaire to conduct in-depth interviews with farmers, and key informants from the Municipal Agriculture Department and a local radio station, advice on crop management, new and improved crop varieties, education and awareness creation on climate change, and the organization of field trips to demonstration sites were identified CSA adaptation strategies against climate change. This study recommends the intensification of routine visits and monitoring by agriculture extension agents to farmers to further strengthen farmers' adaptation strategy. Additionally, farmers should be encouraged to regularly visit the Municipal Agriculture Department for assistance on CSA practices. Finally, there is a need for the government and the private sector to support farmers with logistics and credit on CSA practices.

## CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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