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Climate Variability Since 1970 and Farmers' Observations in Northern Ghana

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Abstract

The study examines how farmers' observations of climate variability and change correspond with 42 years (1970-2011) meteorological data of temperature and rainfall. It shows how farmers in the Northern Region of Ghana adjust to the changing climate and explore the various obstacles that hinder the implementation of their adaptation strategies. With the help of an extension officer, 200 farmers from 20 communities were randomly selected based on their farming records. Temperatures over the last four decades (1970-2009) increased at a rate of 0.04 (± 0.41) ˚C and 0.3(± 0.13)˚C from 2010-2011 which is consistent to the farmers (82.5%) observations. Rainfall within the districts are characterised by inter-annual and monthly variability. It experienced an increased rate of 0.66 (± 8.30) mm from 1970-2009, which was inconsistent with the farmers (81.5%) observation. It however decreased from 2010-2011 at a huge rate of -22.49 (±15.90) mm which probably was the reason majority of the respondents claim rainfall was decreasing. Only 64.5% of the respondents had adjusted their farming activities because of climate variability and change. They apply fertilizers and pesticides, practice soil and water conservation, and irrigation for communities close to dams. Respondents desire to continue their current adaptation methods but may in the future consider changing crop variety, water-harvesting techniques, change crop production to livestock keeping, and possibly migrate to urban centers. Lack of climate change education, low access to credit and agricultural inputs are some militating factors crippling the farmers' effort to adapt to climate change.

Keywords: West Africa, climate change, precipitation, temperature, awareness, adaptation

1. Introduction

Climate change may have both positive and negative effects on farming, but there may be a more negative impact in the long run, which may lead to food insecurity if there are no immediate efforts to confront these problems. Agriculture is the major source of livelihood for the majority of West Africans. The sector employs 60% of the active labor force but contributes only 35% of gross domestic product (GDP). Climate variability poses a great threat to farmers in the West Africa region. Possible impacts include reduced yields, lower farm incomes, and reduced welfare (Jalloh, Nelson, Thomas, Zougmoré, & Roy-Macauley, 2013). In Ghana, most agriculture is rain-fed, with only 4% of its irrigation potential developed (Ministry of Food & Agriculture [MOFA], 2009). The sector employs over 50% of the country's workforce and supplies over 70% of the national food requirements. The potential impacts of unpredictable rainfall, increasing temperatures, and longer dry periods caused by global climate change add to the vulnerability of Ghanaian agricultural production systems (Jalloh et al., 2013). The agricultural sector in northern Ghana in particular is challenged by various factors, of which climate-related dry spells and floods are the major ones (Fosu-Mensah, Vlek, & McCarthy, 2012).

Adaptation is acknowledged as a vital component of any policy response to climate change. Studies show that without adaptation, climate change is generally detrimental to the agriculture sector; with adaptation, however, vulnerability can largely be reduced (Smith, 1996; Reilly & Schimmelpfennig, 1999; Smit & Skinner, 2002). The degree to which an agricultural system is affected by climate change depends on its adaptive capacity. Adaptive capacity is the ability of a social-ecological system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences

(Intergovernmental Panel on Climate Change [IPCC], 2001).The successful adoption of new agricultural and husbandry techniques depends to some extent on farmers' perception of environmental changes. The lack of knowledge about climate-change impact on agricultural production was identified as a setback to long-term sustainable agriculture in most developing countries, including Ghana (Kotei, Seidu, Tevor, & Mahama, 2007). In addition, a better understanding of how farmers think about on-going adaptation measures, and of the factors influencing the decision to adapt farming practices, is needed to craft policies and programs aimed at promoting successful adaptation of the agricultural sector (Bryan, Deressa, Gbetibouo, & Ringler, 2009).

Studies on temperature variability reveal that, with the advent of a changing climate, farming activities in northern Ghana are clearly affected. Some farmers have adjusted their farming activities in order to boost productivity in the face of a changing climate. However, not all adaptation measures or farming innovations can be generally linked to climate change. They may be motivated by other challenges, as in the case of new food storage and processing techniques or adaptive methods to fight local weeds (Tambo & Wünscher, 2014).

According to Juana, Kahaka and Okurut (2013), the design and implementation of any climate-change policy requires adequate knowledge about the local level of vulnerability; the existing knowledge the population has about the risks they are exposed to, the current adaptation practices, the existing capacity to adapt, and the perceived barriers to adaptation. Studies have shown that, one way of assessing farmers' perception of climate change and variability is by comparing meteorologically recorded data to the observations of farmers with regard to changes in temperature and rainfall. For example, Maddison (2006) used data for over 9 500 farmers from eleven African countries to compare the probability that the climate had changed, as revealed by an analysis of the statistical meteorological record, with the proportion of individuals who believed that such a change had occurred. Maddison (2006) reports that a significant number of farmers in the eleven African countries believed that the temperature had already increased and that precipitation had declined. Farmers with the greatest farming experience were more likely to notice changes in climatic conditions. Acquah-de Graft and Onumah (2011) analyzed information collected from 185 farmers in western Ghana. The majority of the respondents had observed an increase in temperature and a decreased precipitation; only 18% did not observe any climatic variability.

Eguavoen (2013) points out to the limitations of these comparative approaches, observing that while they are able to show divergence or coherence between meteorological datasets and individual observations, they are unable to reveal how respondents make sense of their observations and explain causes of environmental change. This paper, therefore, provides a comparison of meteorological data with farmers' observation but also reflects on the limitations of this methodological approach. Most of the farmers in sub-Saharan Africa are well aware of the local manifestations of climate change, especially changes in temperature and precipitation (Acquah-de Graft & Onumah, 2011; Deressa, Hassan, Ringler, Alemu, & Yesuf, 2008; Fosu-Mensah et al., 2012; Mandleni & Anim, 2011), though they often do not link them to climate change as such. This is because climate change is not a local concept and has therefore no local term in many African languages (Eguavoen, 2013; Bello, Salau, Galadima, & Ali, 2013).

After the documentation of the study area and methodology, the paper assesses the general awareness of climate change among farmers in the Northern Region. Afterwards, it compares historical data sets on temperature and precipitation with the reported observations by farmers. The paper then gives a brief overview of adaptation measures reported in the survey.

2. Material and Methods

2.1 Description of Study Area

The study was undertaken in farming communities in the two districts of Tolon and Kumbungu in the Northern Region of Ghana. The combined population of the two districts is 112 331 people in 2010 (Ghana Statistical Service [GSS], 2012). Most inhabitants are Dagomba (80% of the total population), who live on farming and livestock keeping, although other ethnic groups, such as Gonja and Ewe have settled in the area and live on fishing along the White Volta River. The standard of living is very low compared to the national average. Most people earn very little and cannot save to accumulate capital. The average household income per month is about GH¢20.20 (8.2 Euros in 2012). Tolon and Kumbungu are considered poor districts (Tolon/Kumbungu District Assembly, 2012).

The two districts lie between latitudes 09°15ˈ and 10° 02ˈN and longitudes 0°53ˈand 1°25ˈW. They cover a total landmass of 2,741km^2, forming about 3.9% of the entire land area of the Northern Region. The area has a unimodal rainfall pattern, with precipitation from April/May to September/October. The mean annual rainfall is 1,043mm. Temperature generally fluctuates between 15°C and 42°C, with mean annual temperature of 28.3°C.

The mean annual daily relative humidity is 54% (Savanna Agricultural Research Institute [SARI], 2006).

The vegetative cover is mainly Guinea Savanna. The soil is generally of the sandy loam type, except in the low lands, where alluvial deposits are found. Major tree species include the shea (*Vitellariaparadoxa*), neem (*Azadiractaindica*), dawadawa (*Parkiabiglobosa*), mango (*Mangiferaindica*), and cashew (*Anacardiumoccidentale*). Their crops form an integral part of local livelihoods. Cotton (*Gossypiumhirsutum*) and tobacco (*Nicotianatabacum*) are grown as cash crops but also for local consumption. The common grasses include guinea grass (*Panicum maximum*) and gamba grass (*Andropogongayanus*).

Subsistence agricultural production is the main economic activity in the districts and is highly seasonal, with a few people engaged in dry-season irrigation farming around the Bontaga, Kunkulum, and Golinga dams. Most people cultivate food crops like maize (*Zea mays*), sorghum (*Sorghum bicolor*), groundnut (*Arachishypogaea*), rice (*OryzaSativa*), yam (*Dioscoreaspp*), tomato (*Solanumlycopersicum*), okro (*Abelmoschusesculentus*), cowpea (*Vignaunguiculata*), and soybeans (*Glycine max*). According to the district statistics, the main crops cultivated per percentage of households are as follows: cereals 99.8%, legumes 88.3%, and tubers 80.6%. About 36% of the farming households cultivate vegetables, while 15.3% cultivate fruits. According to the same report, the main challenge for agriculture is the hazardous environment characterized by perennial flooding of farmlands, drought, erratic rainfall, perennial bush fires, and the decline of soil fertility (Tolon/Kumbungu District Assembly, 2012). In addition to agricultural activities, the population also engages in smock weaving (a traditional cotton dress) and the extraction of sheabutter and groundnut oil.

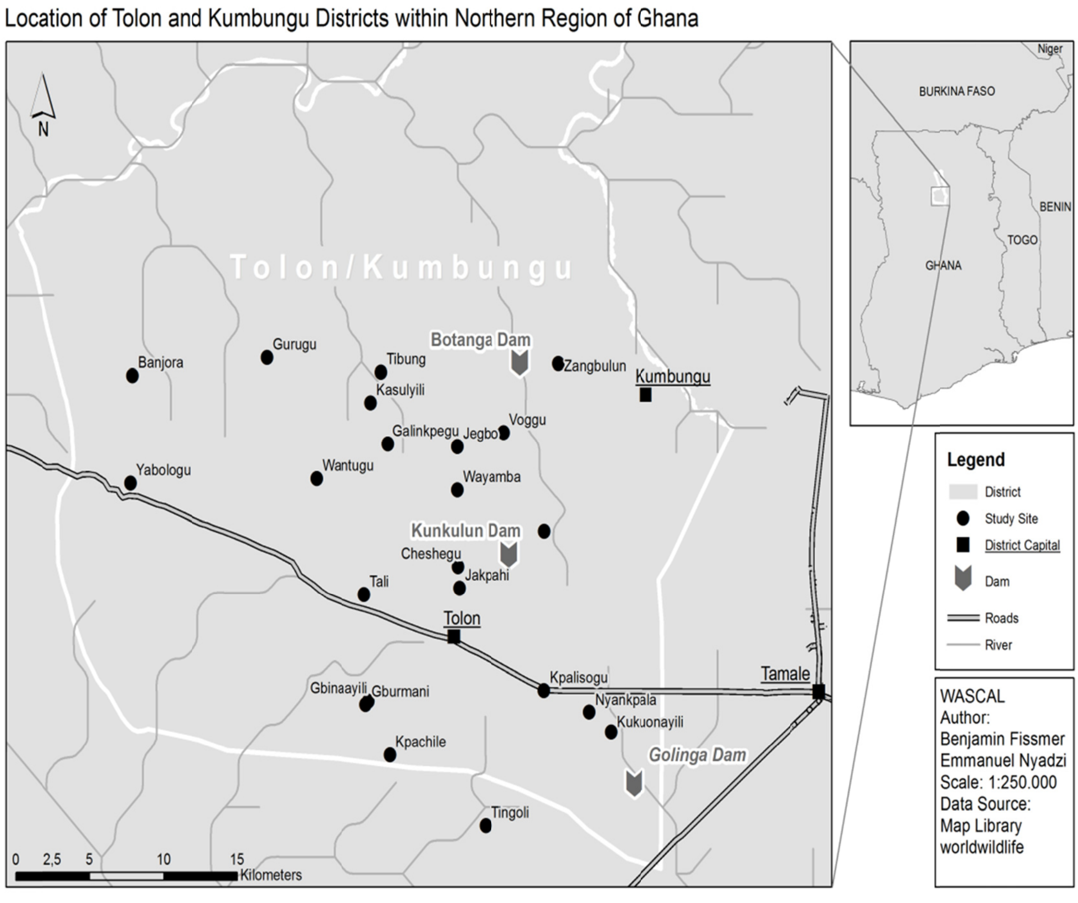


Figure 1. Map of study area

2.2 Sampling

A field survey was planned and carried out to collect a wide range of data about farmers' observations and adaptation measures in 2014. A total of two hundred (200) farmers were interviewed with one hundred (100) of them in each district. The questionnaires were designed in English, with both open-ended and closed questions, which were translated into the local language, Dagbani, during the interviews. With the support of an agricultural extension officer, 20 farming communities were selected based on their farming records, using a simple random technique for both districts (10 farming communities per district). Ten farmers were sampled in each community. As the perception literature indicated that observations by older farmers tended to be more precise (Maddison, 2006; Ozor, Urama, & Mwangi, 2012; Eguavoen, 2013), farmers from 40 to 70 years of age were purposefully selected as respondents. Farmers ranked four decades. 1970-1980, 1980-1990, 1990-2000, and 2000-2010. Ranking was done on a scale of 1- 4. 1 was assigned to the decade perceived to be the lowest and 4 to the highest. Farmers were encouraged to assign same score to any two or more decades they perceived to have same degree of hotness or wetness. The total score of each decade was compared to each other in percentages (Figures 5 and 10). The quantitative surveys were analyzed with SPSS while the qualitative information was noted down.

Meteorological data of monthly temperature and precipitation was obtained from Nyankpala weather station, run by the Savanna Agriculture Research Institute (SARI). The data was analyzed to obtain trends. The temperature and rainfall data covers a total period of 42 years, from January 1970 to December 2011.

3. Results

3.1 Sample Population

Out of the 200 respondents, the frequency of males sampled was 115, forming 57.5%, while that of females was 85, forming 42.5% of the total sample. Of the respondents, 34.5% were between 40 and 50 years of age, 39% were between 51 and 60 years of age, and 26.5% were between 61 and 70 years of age. The age distribution shows that the majority (73%) of the farmers sampled constitutes an active labor force and head households in the community. All respondents had extensive experience in farming. The survey showed that most of the respondents started farming at an early age, when they actively assisted their parents on the farm, undertaking various farm activities, such as land clearing, sowing, and harvesting. As many as 93% of them started farming between the ages of 5 and 10 years; 6% started between the ages of 10 and 15 years of age, and 1% began rather late, between 15 and 20 years of age.

In total, 89% of the respondents were farming on their own land, while the remaining 11% (mostly women) were farming on land that belonged to family and friends. None of the respondents was farming on rented land. The size of the farm holdings varied from farmer to farmer, with 64% owning between 1 and 3 acres, 31.5% between 4 and 7 acres, and 4.5% between 7 and 10 acres. Personal observation during the survey showed that females and males between the ages of 61 and 70 usually had smaller farms compared to those aged between 40 and 60. This can be related to the decreasing level of exuberance and energy possessed by this older group of farmers.

The major source of labor on the farms within the two districts was manual, except during the land clearing stage, when some of the farmers reported the use of tractors for ploughing the land. They indicated that fertilizer application and harvesting were also done manually. None of the respondents indicated their involvement in any off-farm activities, which means that the source of their income came entirely from the sales of their crops and livestock.

3.2 Awareness of Climate Change

Only four of the 200 respondents in the survey said they had heard of the term “climate change”, but they could not explain what the term meant. They had all heard it mentioned on the radio. This finding of extremely low awareness rates in parts of the rural population is consistent with other studies in West Africa and sub-Saharan Africa (Bello et al., 2013). Eguavoen (2013), for instance, reported that the majority of her respondents in rural northern Ghana had never heard of “climate change,” particularly the older respondents, who did not understand many of the English programs. In her field site (Kassena Nankana district), some public speeches in the local language used the English term “climate change” without further explanation. However, all farmers were familiar with a Nankani expression meaning “changes in the weather,” which was not equivalent in meaning to “climate change.” Almost all farmers in the Tolon and Kumbungu study (n=196) said that they had not received any information about why the temperature and rainfall patterns had changed. Only four of the respondents confirmed to have received some climate-change education. They could not remember who gave them such information, however. This finding is also validated by other studies about low climate-change awareness and public education in Ghana (Etwire, 2012).

However, 14% of the farmers (n=28) had individual views on why rainfall and temperature were changing. As causes, they mentioned deforestation, burning, the excessive use of fertilizers, and even morality (e.g., some conservative farmers said that the changes were a punishment for their wickedness. One farmer told the surveyor, “Our greediness and unwillingness to share food with those who don’t have any is the cause of the changes.”

Another farmer explained, “God is punishing us because of envy and rampant sexual promiscuity in our village today.” These moral transgression arguments were exceptional responses, however. Most of the farmers (n=172) did not tell the surveyor why the changes they had observed were occurring (Note 1).

3.3 Trends in Temperature

Mean annual temperatures from 1970 to 2011 varied from 25ºC to 31ºC (Figure 2). Temperatures over the last four decades (1970-2009) had increased at a rate of 0.04 (± 0.41) ˚C while from 2010-2011 it recorded an increased rate of 0.3 (± 0.13) ˚C. For the first decade, there was little variation in temperature except from 1971, when higher temperatures of 31ºC and a minimum of 26ºC were recorded. In the second decade (1980 to1989), a mean annual temperature of 28ºC was recorded from 1980 to 1983 and in 1988. The temperature variation became a bit wider, from 25.5ºC to 29ºC, toward the end of the 1980s. From 1990 to 1999 (the third decade), measured temperatures showed little variation, as well as a decrease in 1991 and a slight rise during the years 1996 and 1998. From 2000 to 2011, the temperature ranged between 28ºC and 29.3ºC, with a continuous rise from 2008 onwards. On average, 2000-2009 recorded the highest temperature, of 28.0ºC, followed by1990-1999 and 1970-1979, with a temperature of 27.9ºC. The decade from 1980 to 1989 recorded the lowest mean temperature, of 27.5ºC. The average temperature of 2010 and 2011was 28.9ºC, which clearly gives us an idea of how temperatures have continued to rise in recent years. Compared to the baseline annual mean annual temperature of 28.3°C (SARI, 2006) for the two districts, the years 2002, 2005, 2007, 2009, and 2011were warmer than earlier years (except 1971 which recorded 31°C).

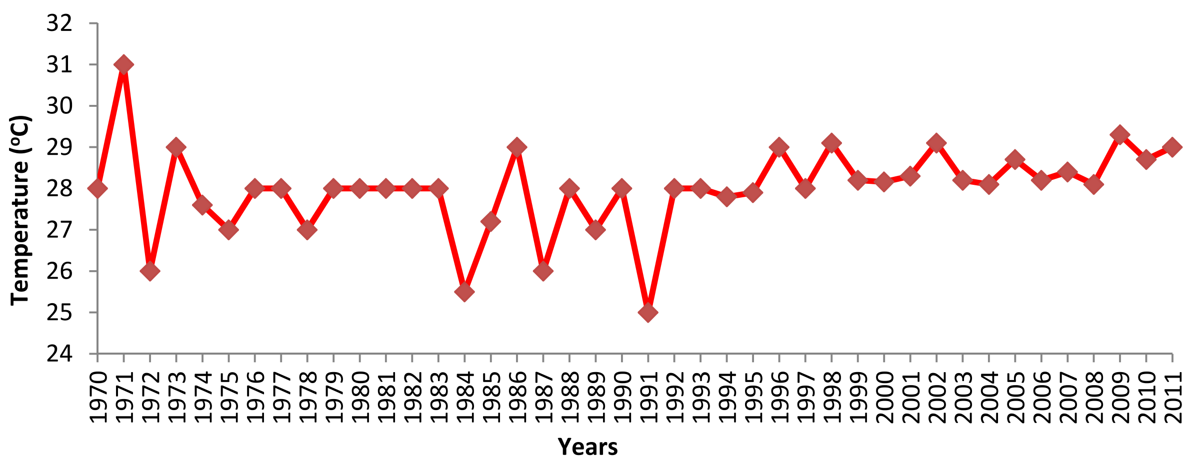
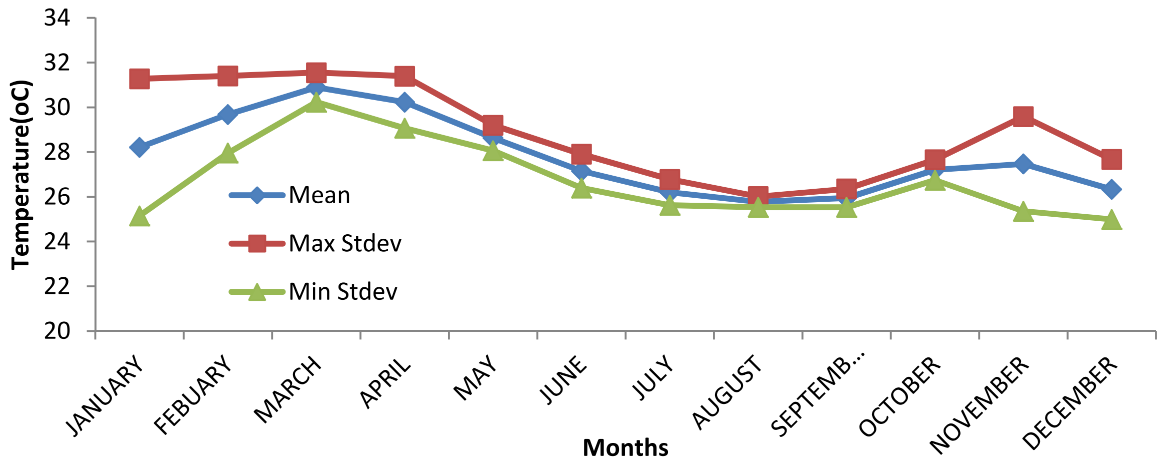


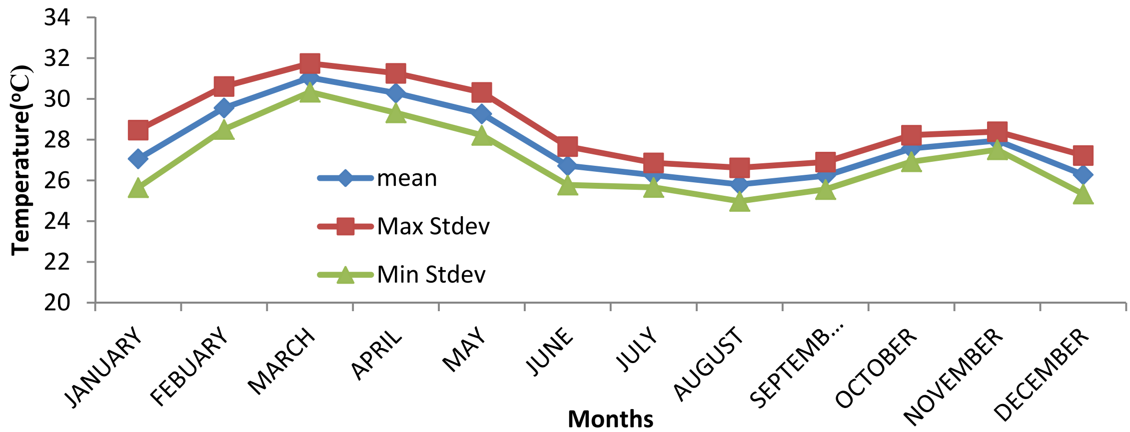
Figure 2. Mean annual temperatures in Tolon and Kumbungu (1970-2011)

Figure 3 depicts the mean monthly temperature variation that has occurred for the last four decades (1970-2011). The mean annual minimum temperature ranged from 20ºC in 1971 to 25ºC in 1989, and the maximum ranged from 25.5ºC in 1984 to 35.6ºC in 2009. The monthly mean temperature variation in Figure 3 reveals that temperatures are generally high in February to March, with March usually recording the peak, and then decrease slightly in April and May. The lowest temperatures of the year are usually recorded from June to September and December to January, while October and November record slightly higher temperatures.

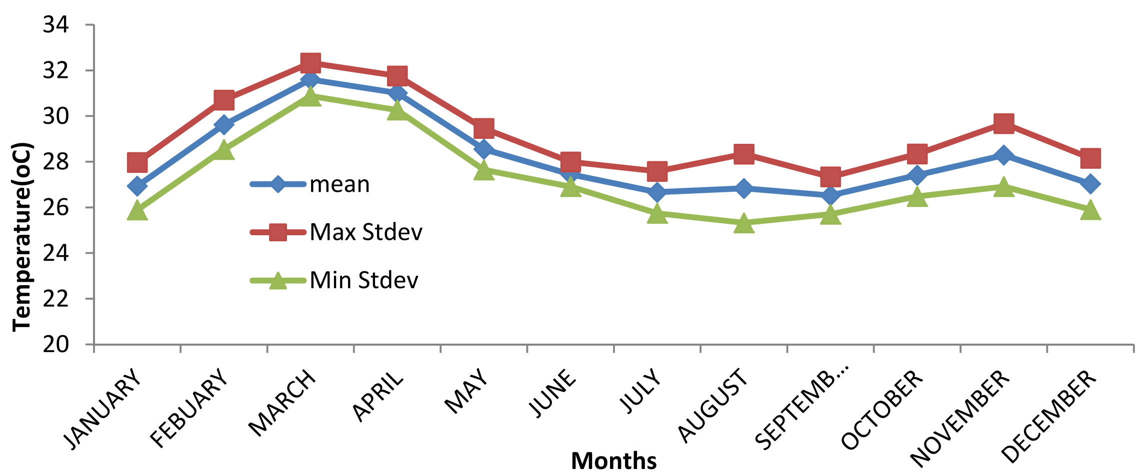
1970-1979



1980-1989



1990-1999



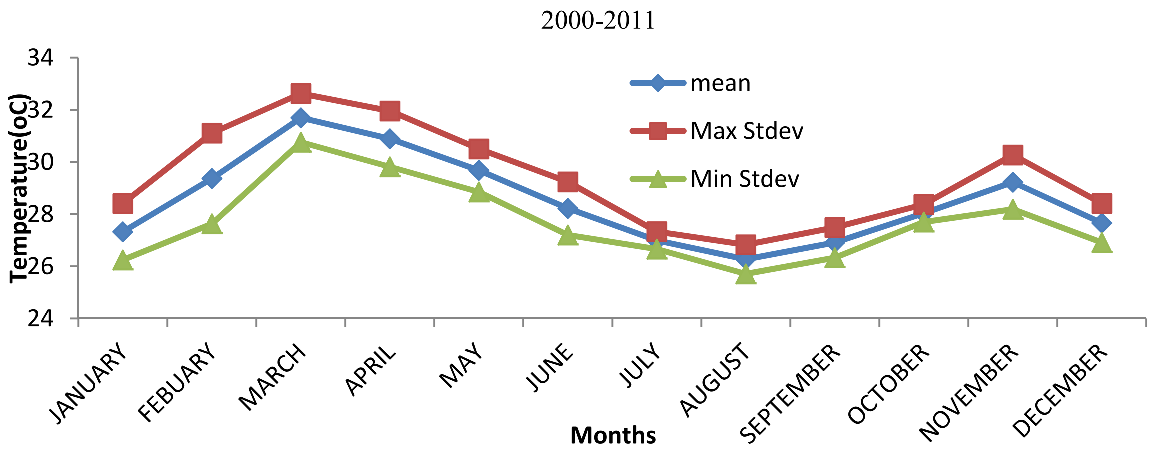


Figure 3.Variation in monthly mean temperature for four decades in Tolon and Kumbungu

3.4 Farmers Observe Increased Temperatures

Figure 4 show that, 165 farmers (82.5%) believed that temperatures had increased while nine farmers (4.5%) expressed the opposite view, believing that a decrease had taken place. Sixteen farmers (8%) said temperatures had been erratic. Eight farmers (4%) said they had noticed no change, while two farmers (1%) said they didn't know. These is consistent with other studies that have shown a general consensus among farmers across sub-Saharan Africa that temperatures have increased over the years (Acquah-de Graft & Onumah, 2011; Fosu-Mensah et al., 2012; Mandleni & Anim, 2011; Gandure, Walker, & Botha, 2012).

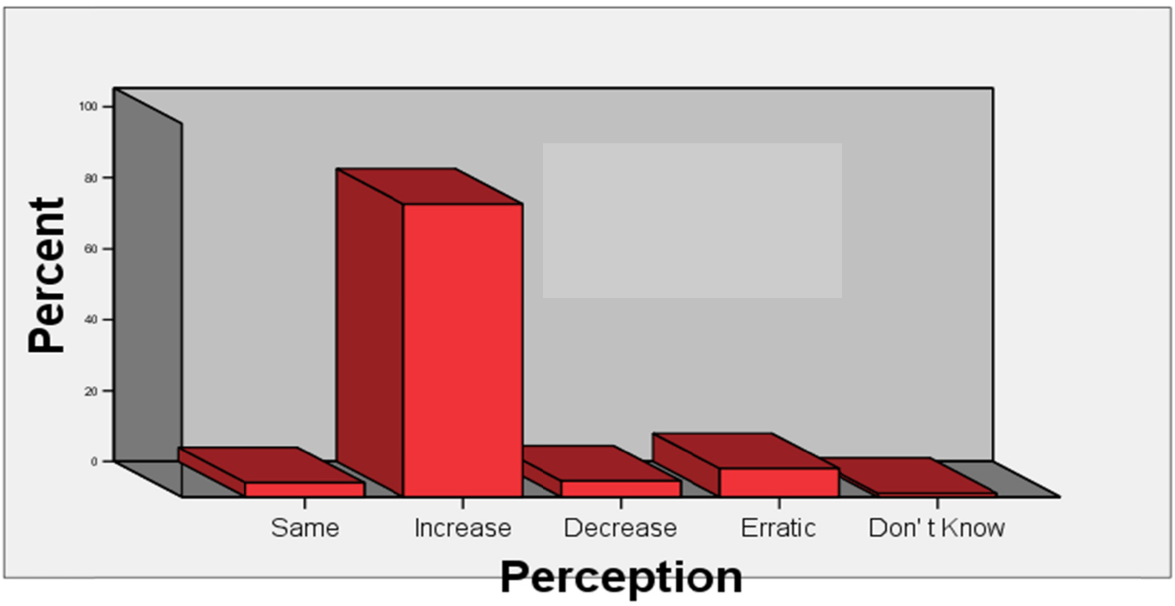


Figure 4. Farmers' observations of changes in temperature in Tolon and Kumbungu

The overall score of the ranking (Figure 5) was 1893 scores. Out of this, the period 2000-2010 was ranked as the driest decade, with the highest total score of 754; 1990-2000 was ranked second, with a total score of 511, followed by 1980-1990 with a total score of 372, while 1970-1980 was ranked as the decade with the least dryness, recording a total score of 256.

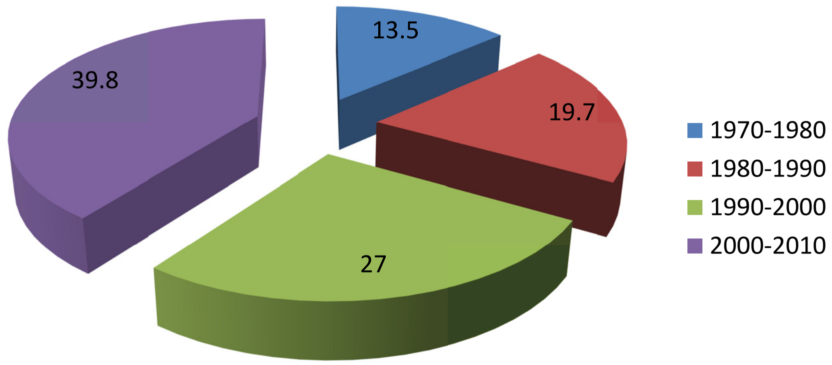


Figure 5. Farmers' percentage ranking of Hotness per Decade

We need to be careful with the overall argument because observations of temperature changes are rather indirect and usually based on observations of crop behavior and may be influenced by general narratives rather than an outcome of individual sensitivity to slight temperature changes over a long period. Perceived higher temperatures can also have other causes, such as the reduction of shaded areas and a change in construction technologies for local houses. It is worth mentioning that, the presented data has limitations because it does not indicate how people observe the rise of temperatures, including, inter alia, what observable indicators they have used to decide whether the temperature has changed over the past decades. There may be a dominant narrative or discourse in the study region that underlines the trend for a warmer and dryer climate that might be identified in future research projects.

3.5 Trends in Precipitation

Figure 6 illustrates the variation in mean annual rainfall of Tolon and Kumbungu districts from 1970 to 2011. The annual mean rainfall ranged from 745.2 to 1897.7 mm. Rainfall over the last four decades (1970-2009) was observed to having increased at a rate of 0.66 (± 8.30) mm meanwhile, it recorded a huge decrease of -22.49(±15.90) mm for 2010-2011. On the average, the decade mean of annual rainfall shows that, the decade 1970-1979 recorded the highest rainfall (1014mm), followed by 1990-1999 (1117mm), 1980-1989 (1035mm), and 2000-2009 (1016mm). This trend confirms the ranking of respondents for the period 1990-2000 been wet than 1980-1990. The trend in rainfall however did not substantiate their observation of a decrease in rainfall over previous decades except from 2010 to 2011.

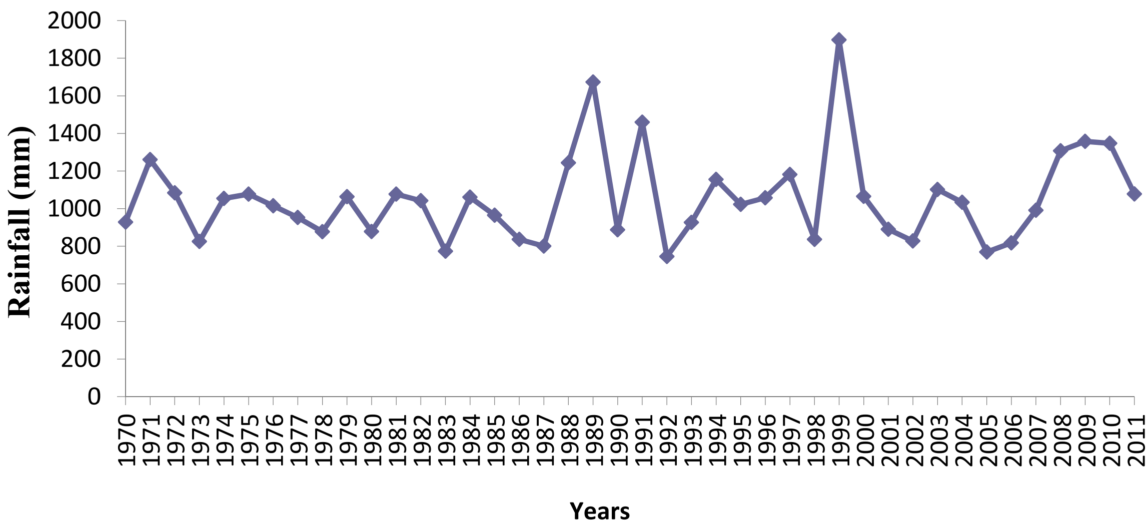
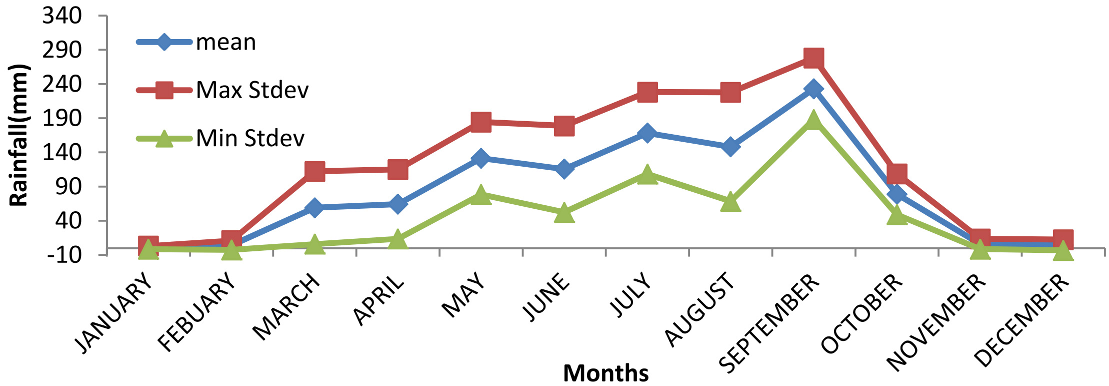


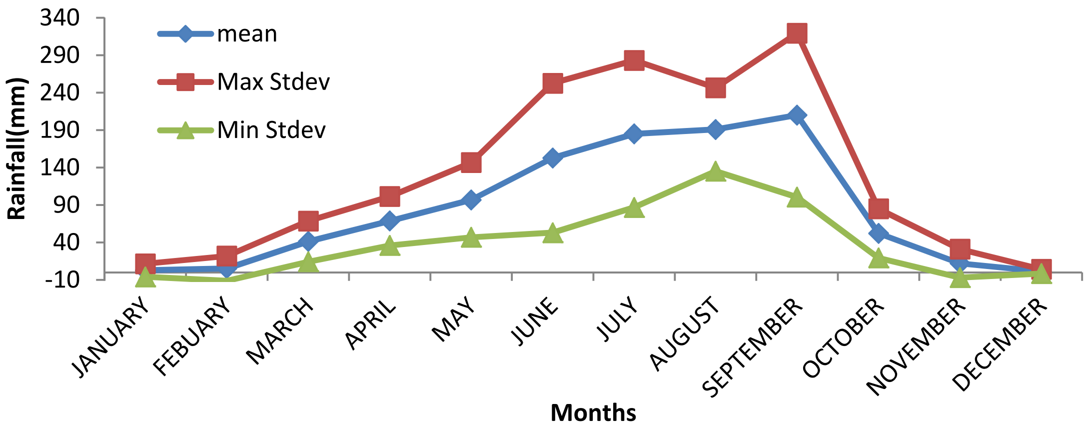
Figure 6. The mean annual precipitation in Tolon and Kumbungu (1970–2011)

Based on the results illustrated in Figures7, rainfall was observed to be very low from November to March. April and May records show few rainfall events while June to September account for the highest rainfall, with July usually seen as the peak.Interestingly, observation of the rainfall pattern over the past four decades shows that the amount of rain recorded in April and May from 1980 to 2011 has decreased compared to 1970 to 1979.

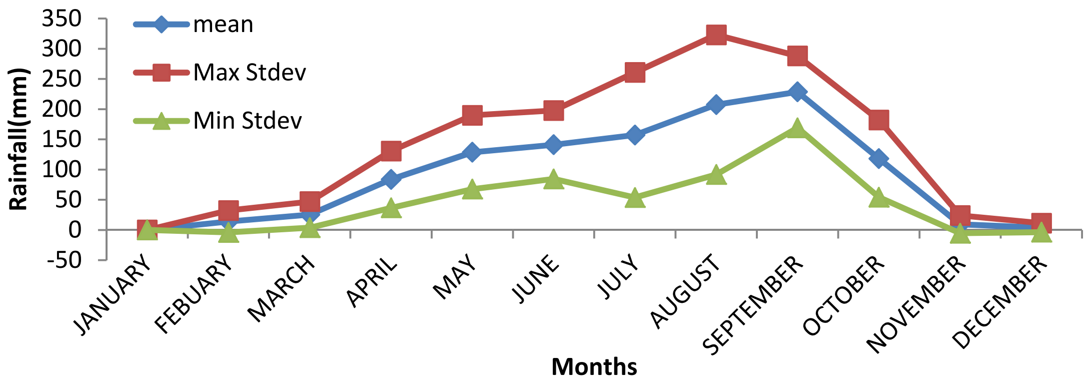
1970-1979



1970-1979



1990-1999



1990-1999

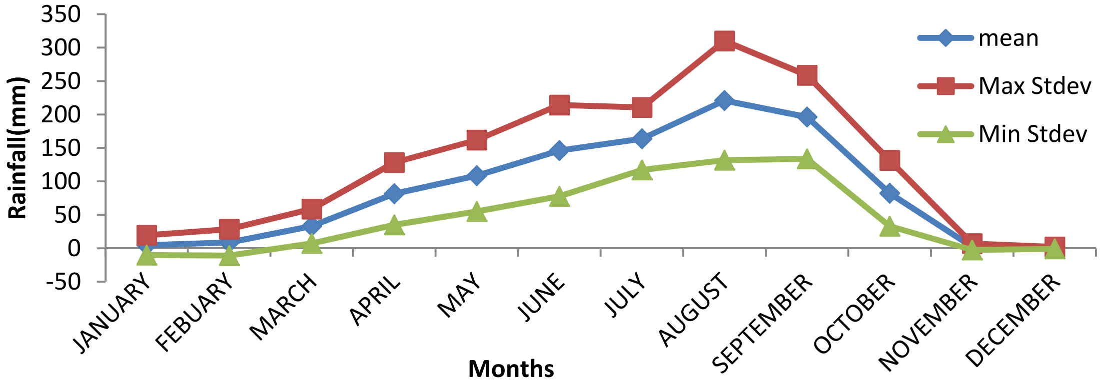


Figure 7. Variation in monthly mean precipitation in Tolon and Kumbungu

3.6 Farmers Observe Increased Variability and a Decrease Rainfall

When asked if the length of the rainy season had changed, 91% of the respondents said the rainy season still started in April and ended in October, though the rainy days and amount of rain had decreased drastically. However, 9% of the farmers indicated that the length of the rainy season had changed. They said the rain now starts in May and ends in September.

In West Africa, including Ghana, farmers have reported that they have experienced delayed rainfall and early cessation, as well as excessive rain and strong winds, sometimes leading to flooding (Acquah-de Graft & Onumah, 2011; Mertz, Mbow, Reenberg, & Diouf, 2009). Farmers in Osun State in Nigeria have reported increased temperature and precipitation, and have confirmed changes in the rainfall pattern which includes delayed rains, intensive and excessive downpour during the crop-growing season, and early cessation (Sofoluwe, Tijani, & Baruwa, 2011). Figure 9 shows that, 81.5% of the farmers were convinced rainfall over the period had decreased drastically, while 1.5% held a contrary view, claiming rainfall had increased, 11.0% perceived the rainfall to have had an erratic pattern, 2.5% said they didn't know, and 3.5% were of the view that there had not been any changes in the rainfall trend.

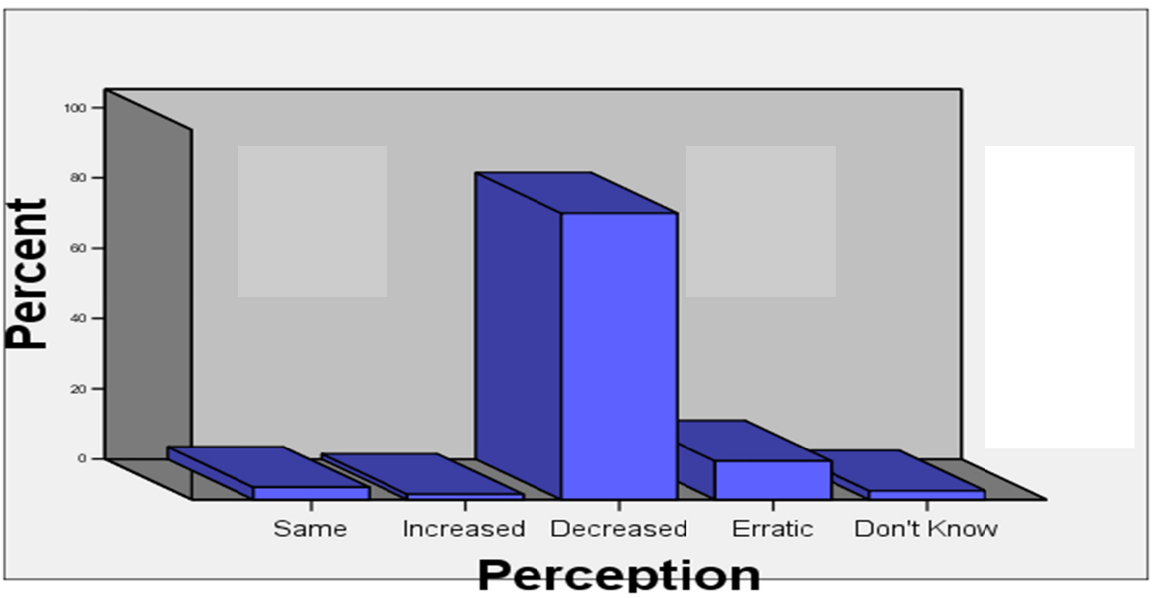


Figure 9. Farmers' observations of change in rainfall in Tolon and Kumbungu

Variation in wetness (Figure 10) for the last four decades as perceived by farmers, revealed an interesting result. Out of the 1561 overall decade score,1970-1980 was ranked as the wettest decade, with a total score of 773 of the overall ranking, 1990-2000 followed with 312, 1980-1990 had a total score of 256, while 2000-2010 was ranked last in terms of wetness for the last four decades with 220. Some of the farmers who ranked 1990-2000 ahead of 1980-1990 used the severe drought, bush fire, and famine situation in the country as the basis of their decision.

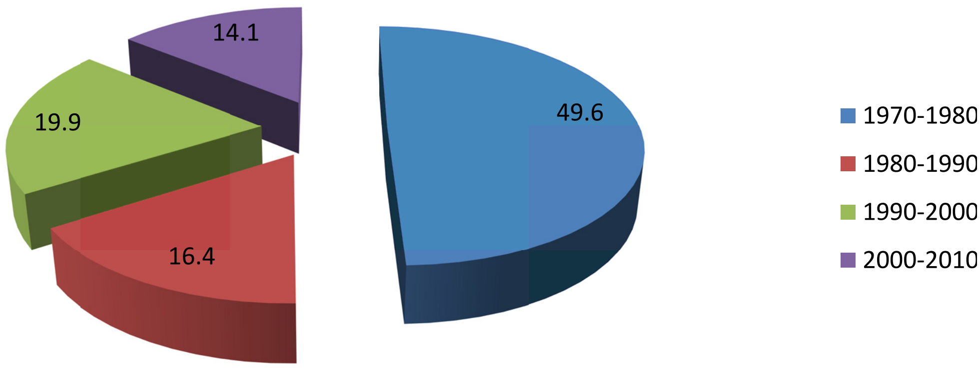


Figure 10. Farmers' percentage ranking of wetness

3.7 Adaptation Measures and Barriers

Adaptation helps farmers to achieve their food, income, and livelihood security objectives in the face of changing environmental and socioeconomic conditions, including climate variability; extreme weather conditions, such as droughts and floods; and volatile short-term changes in local and large-scale markets (Kandlinkar & Risbey, 2000). Farmers in the survey were provided with a list of adaptation measures and obstacles from which to select. They were also asked to state whether there were other measures and obstacles that were not captured in the questionnaire yet practiced and faced by them. In spite of the farmers' observed changes in temperature and rainfall only 64.5% of the respondents adjusted their farming activities. The remaining 35.5% of respondents had not engaged in any adaptation measures despite the varying and changing climatic and environmental conditions.

Most of the farmers do not consider the changing climate to be a major motivation for adopting the use of fertilizer and herbicide applications, but the depletion of soil nutrients because of continuous cropping. The use was rather motivated by the need to stabilize and increase yields and make agriculture more profitable than by climate change. Generally, adaptation initiatives are part of the larger context characterized by variability of rainfall and temperature. Maddison (2006) and Nhemachena and Hassan (2008), reported that the adaptation measures adopted by farmers are mostly driven by the aim to increase profit rather than dealing with climate change impacts. Despite their observations, these authors still mention that farmers' actions were driven by climatic factors.

The major adaptation measures identified in the study community are soil and water conservation techniques, changing the cropping system, use of fertilizers and pesticides, changing planting dates, changing crop varieties, and crop diversification. Only sampled farmers in Golinga engaged in dry-season irrigation with water from the Golinga Dam. Table 1shows the adaptation measures that farmers practice and would either continue with or consider in the near future, in light of the trends in temperature and rainfall.

Table 1. Farmers' adaptation measures

Adaptation measure	YES (%)	NO (%)	Don't know (%)
Change crop variety	92	7	1
Change planting date	66	28	6
Use of fertilizers and pesticides	96	4	0
Build a water-harvesting mechanism	57	38	5
Implement soil and water conservation techniques	96	4	0
Plant trees for shading	23	76	1
Irrigation	89	11	0
Change from crop to livestock	63	37	0
Migrate to urban area	31	53	16
Find off-farm job	86	11	3
Lease out land	94	4	2

About 96% of the farmers confirmed the existence of barriers to the implementation of their adaptive measures, while 4% said they do not face any barriers. The obstacles include a lack of information about climate change and appropriate adaptation measures, lack of credit, shortages of labor, the land tenure system, insufficient access to input, high cost of adaptation measures, gender, age, and land disputes and insecurity (Table 2).

Table 2. Obstacles to climate variability and change adaptation in Tolon and Kumbungu

Barrier	**Yes (%)**	**No (%)**
Any barriers	96	4
High cost of adaptation measures	91	9
Shortage of labor	33	67
Land tenure system	66	34
Insufficient access to input	88	12
Lack of credit (LC)	98	2
Gender	71	29
Age	62	38
Land disputes and insecurity	37	63

With respect to lack of climate change information, the farmers generally lamented the fact that extension officers do not visit their farms as often as they do to those in other villages located in other districts. Though they did not deny seeing the extension officers in their communities, they were quick to remark that, the extension officers often visited the larger farms, usually owned by affluent farmers.

Farmers mentioned that the high cost of farming inputs such as fertilizer, improved seeds, and herbicides often deterred them from their use despite the adverse effect on production. They also indicated that, NGOs, officials from political parties, private micro loans and savings operators, and rural banks (Bonzali rural bank) occasionally come to the villages to pledge their support and educate them about the essence of forming co-operative groups. They were told these initiatives would ease their access to financial support. They complained that despite the formation of such groups the people have failed to fulfill their promises. Some of the farmers who had tried to obtain credit from rural banks said they could not meet the requirements and thus could not access funds. Other farmers said they were denied financial support without any reasons being given; they were simply told they could not be supported.

Gender and age is a serious issue affecting climate change adaptation decision-making in the districts. When it comes to obstacles militating against climate variability and change, female farmers mentioned domestic chores, such as fetching water from places miles away from their homes and caring for sick children, as major challenges that hindered them from adopting adaptation measures. Some also expressed concern about the fact that they were unable to expand their farms like their male counterparts because they are not as strong as they are and do not have financial resources to hire tractors or buy fertilizers to compensate their strength. Older farmers (between 65 and 70 years of age) admitted that they were no longer strong enough to undertake some of the farming activities.

Some of the farmers mentioned land tenure and land disputes within and between the two districts as emerging obstacles to farming. They claimed most of the fallow lands, though fertile yet are not used for farming because of chieftaincy dispute over land between Tolon and Kumbungu districts. They admitted that some of these disputes also existed between families and individuals. According to most of the farmers, the background to these land disputes is the current economic advancement in districts that have attracted many immigrants and some affluent persons who have bought and developed the lands for settlement in the district.

These obstacles are similar to those identified by other authors, though in different study areas. Jalloh et al. (2013) reported that the majority of farmers in West Africa are resource poor. In addition to biophysical constraints to their farming pursuits, a lack of access to funds and markets severely limits their ability to break out of the vicious circle of poverty. In view of their scale of production, targeted subsidies coupled with micro credit with practical and reasonable collateral requirements will go a long way toward enabling small-scale farmers to acquire the vital inputs required for boosting production. Nhemachena and Hassan (2008), Advancing Capacity to Support Climate Change Adaptation [ACCCA] (2010), and Acquah-de Graft and Onumah (2011) have reported that access to credit was an important factor for the adoption of new agricultural technologies. Access to affordable credit increases financial resources of farmers and their ability to meet transaction costs associated with various adaptations. Mandleni and Anim (2011), Mengistu (2011), and Nyanga, Johnsen, Aune, & Kahinda (2011) have identified the high cost of adaptation measures, insecure property rights (and land disputes), and land fragmentation caused by population growth in parts of Africa where land is inherited as factors affecting effective adaptation.

Deressa et al. (2008) and Gbetibuou (2009) also reported that farmers expressed the view that among many of the sources of information, agricultural extension is the most important for analyzing the adoption decisions of adaptive measures. Accordingly, it is hypothesized that farmers who have significant extension contacts have better chances of being aware of changing climatic conditions and adaptation measures in response to the changes in these conditions.

4. Discussion and Reflexions

Majority of the farmers in Tolon and Kumbungu districts have observed that the climate is getting warmer and that rainfall has been decreasing over the past four decades. Although their observation on temperature is consistent with the trends in meteorologically recorded temperature, their observed decreased in rainfall was inconsistent with the meteorological rainfall data from 1970-2009 that indicated an increase in rainfall. Data from 2010 to 2011 however observed a huge decrease in rainfall, which probably might be the reason for their claim. Temperatures over the last four decades (1970-2009) increased at a rate of 0.04 (± 0.41) ˚C and 0.3 (± 0.13) ˚C from 2010-2011. Rainfall within the districts are characterised by inter-annual and monthly variability. It experienced an increased rate of 0.66 (± 8.30) mm from 1970-2009 and a huge decreasing rate of -22.49 (± 15.90) mm 2010-2011.

Despite the observed changes in temperature and rainfall, about one third (35.5%) do not engage in any adaptation measure to reduce their vulnerable to climate change. These farmers therefore need to be encouraged to adjust their agricultural practices to ensure that they reduce the impacts of climate variability and change. Majority (65.5%) of farmers are already engaged in some important adaptation practices, including soil and water conservation techniques, changing the cropping system, changing planting dates, changing crop variety, and crop diversification.

A majority (96%) of the farmers in the study districts face constraints that inhibit the implementation of their adaptation measures, thus making them more vulnerable to climate change. High cost of adaptation measures, shortages of labor, land tenure system, insufficient access to inputs, lack of credit, and land disputes were the main adaptation obstacles identified in this study. In particular, insufficient access to credit and agricultural inputs, as well as the high cost of adaptation measures were top on the list of the respondents (88%) possible adaptation obstacles.

At the policy level, the Ghanaian government should be central in providing appropriate information, as well as support rural farmers with credit and inputs. Research institutions needs to be properly equipped to develop more and better heat and drought-resistant crops that will help achieve current and future food demands. Policies should lay down reliable procedures to be followed in encouraging farmers to avoid monoculture and engage in growing a variety of crops that are capable of thriving in the changing climate. If droughts and heat increases with climate change, vulnerability of their agriculture system will increase. One adaptation option for farmers is therefore to plant a wider variety of crops to reduce the risks of crop failure.

Climate change education should not be exempted from such policies. Extension officers should be properly trained in matters relating to climate change and its adaptation measures so they can effectively and practically disseminate information on the subject. There is also the urgent need for non-governmental organizations to assist in the policy implementation process by investing in projects that will boost farmers' level of resilience and reduce their vulnerability and exposure. Such projects can include the construction of more dams and dugouts to supply water for irrigation purposes. This will help farmers shift from rain-fed farming, which is seasonal, irregular, and produces low yield, to farming all year round, which is highly productive.

In addition, further research across different parts of the country is necessary to improve our knowledge about how farmers observe and perceive climate variability and change and what challenges they are facing in adapting to them. It must also be noted that the generation of further similar studies that limits their methodology to surveys and thus provides limited empirical insight seems unhelpful in the long term because there is already sufficient evidence that farmers are good observers of change in their environment. One of the important findings hints at the information gap and lack of educational efforts to help people fully understand the global phenomenon and its local manifestations. Therefore, we would strongly recommend the addition of approaches that are better able to illuminate local knowledge systems and the inflow of information to communities in future research designs. This would help us understand how farmers explain the causes of environmental changes as well as their decisions and priorities in detail.

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Notes

Note 1. This low percentage may have something to do with the methodology. Surveys with structured questionnaires do not allow for much unstructured speech and priority setting by the respondents. Anthropological data collection techniques, such as consensus analysis and listing result, are more fruitful in this regard (compare Eguavoen, 2013; Eguavoen et al., 2013).

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