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FARMERS' PERCEPTION OF CLIMATE CHANGE IN THE EJURA-SEKYEDUMASE DISTRICT OF GHANA

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ABSTRACT

Sustainable agriculture is embedded in the relationship between humans and climate, especially in attitudes towards climate change, the rates of change and the impact of such change on the entire agro-ecosystem, including soils, crops and animals. The adoption and successful implementation of new technology and husbandry practices and farmers' adaptation to changes in their ecosystems depend on their tendency to perceive and react favourably towards changes in climate and environment. The lack of sufficient knowledge about climate changes and the impact on agricultural production is a setback to long term sustainable agriculture in most developing countries, including Ghana. This paper presents the results of an investigation to determine perception of farmers about changes in climate in the Ejura-Sekyedumase District of Ghana, as part of a broader research that assessed farmers' adaptation to climate change in the district. The study compared farmers' perception on climate variability with the actual variations based on climatic data recorded from 1993 to 2009. A survey was conducted and considered interviews with farmers in six (6) of the nineteen (19) operational areas in the district. The targeted populations were adult farmers with at least 10 years of farming experience in the area. Data was collected on perceptions about temperature changes and variability in precipitation over a 10 year period. The results indicated that more than 80% of farmers believe that temperature in the district had become warmer and over 90% were of the opinion that rainfall timing had changed, resulting in increased frequency of drought.

Keywords: climate change, perception, farmers, Ejura-Sekyedumase, Ghana.

1. INTRODUCTION

Sustainable agriculture is embedded in the relationship between humans and climate, especially in attitudes towards climate change, the rates of change and the impact of such change on the entire agro ecosystem, including the soils, crops and animals. The adoption and successful implementation of new technology and husbandry practices and farmers' adaptation to changes in their ecosystems depend on their tendency to perceive and react favourably towards changes in climate and environment. The lack of sufficient knowledge about climate changes and the impact on agricultural production is a setback to long term sustainable agriculture in most developing countries, including Ghana (Kotei *et al.*, 2007).

Climate change and agriculture are interrelated processes, both of which take place on a global scale (Parry *et al.*, 2007). Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, precipitation and glacial run-off (Funk *et al.*, 2008; McCarthy *et al.*, 2001). These determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. Rising carbon dioxide levels would also have effects, both detrimental and beneficial, on crop yields. The overall effect of climate change on agriculture will depend on the balance of these effects (Fischer *et al.*, 2002). While overall food production may not be threatened, those least able to cope will likely bear additional adverse impacts (WRI, 2005). Studies indicate that Africa's agriculture will be negatively affected by climate change (Pearce *et al*., 1996; McCarthy *et al*., 2001; Dinar *et al*., 2008). The estimate for Africa is that 25-42% of species habitats could be lost, affecting both food and non-food crops. Habitat change has already been observed in some areas leading to species range shifts, changes in plant diversity including indigenous foods and plant-based medicines (McClean *et al*., 2005). In developing countries, 11% of arable land could be affected by climate change, including a reduction of cereal production in up to 65 countries, about 16% of agricultural GDP (FAO, 2005). A study conducted in Cape Coast in the Central region of Ghana found that yields of all major crops in the metropolis have been declining gradually over the past 16 years due to the gradual change in the pattern of the major climatic elements (Owusu-Sekyere *et al*., 2011).

A better understanding of how farmers' perceive climate change, ongoing adaptation measures, and the factors influencing the decision to adapt farming practices is needed to craft policies and programmes aimed at promoting successful adaptation of the agricultural sector (Bryan *et al*., 2009). For farmers to adapt effectively to climate change, they must have correct perceptions about the state of the climate and possible future trends. In practice, farmers take decisions in the context of their own environment, and differences may exist between perceived and real environments (Mather, 1992). Thus there is the need for knowledge of how interacting climatic factors will affect crop productivity and soil and water resources.

The evidence that global climate is changing is widely acknowledged (IPCC, 2007). People who live and work close to agriculture do experience these changes more since climate has a profound effect on production. Consequently, farmers and fishermen who work closely with agricultural fields and water bodies have a fairly good knowledge of the changing climate. A study by the World Bank (Maddison, 2007) in a number of African countries revealed that large numbers of agriculturalists already perceive that the climate has become hotter and the rains less predictable and shorter in duration. In many cases, the activities of farmers contribute to increases in greenhouse gases because of their farming practices, which affect climate change.

In general, most people's understanding of the underlying issues and causes of climate change varies a lot, with some taking a more scientific approach and others a more religious one. Some of the perceptions are unscientific, mainly because many subsistence farmers, who are by definition often poorly educated, resort to superstition to explain natural events because that is their only source of 'information'. A study of community perception of climate change in Bolivia by Christian Aid (Chaplin, 2007) summarised some of the perceptions of causes of climate change as lack of respect and carrying out of old rituals and customs. The people also perceived hailstorms as being a punishment from God, which tend to happen particularly where young women have aborted pregnancy and also thought that the world has 'turned over' and the sun is closer to the earth, having 'fallen' from its place in the sky (Chaplin, 2007). Another study conducted in the Sahel (Mertz *et al*., 2009) found that farmers are aware of climate variability. However, when questions on land use and livelihood change are not asked directly in a climate context, households and groups assign economic, political, and social rather than climate factors as the main reasons for change.

The adoption and successful implementation of new technology and husbandry practices and farmers' adaptation to changes in their ecosystems depend on their tendency to perceive and react favourably towards changes in climate and environment. The lack of sufficient knowledge about climate changes and the impact on agricultural production is a setback to long term sustainable agriculture in most developing countries, including Ghana. If farmers are to cooperate in devising mitigation and adaptation strategies, they should at least be aware of climate change and their causes and effects. This paper presents the results of a survey to determine farmers' perception of climate change in the Ejura-Sekyedumasi District in the Ashanti Region of Ghana, which can serve as a basis to carry out adaptation assessment and therefore formulate adaptation policies for the various agro-ecological zones in Ghana.

2. MATERIALS AND METHODS

2.1 Overview of the study area

This research was conducted in Ejura-Sekyedumase District, which is located within longitudes 1˚5' W and 1˚39' W and latitudes 7˚9' N and 7˚36' N (Ejura-Sekyedumase District Assembly, 2006). The district had a population of 88,753 as of 2006 and covers an area of 1,252 m^2 (Ejura-Sekyedumase District Assembly, 2006). It has 130 settlements of which only three are urban and the rest are rural. Sixty percent of the population live in the rural areas with farming as their main occupation (Ejura-Sekyedumase District Assembly, 2006). Figure-1 shows the map of Ejura-Sekyedumase district showing the agricultural operational areas and the survey areas. The agricultural sector in the district employs about 68.2% of its population which is above the national average of 60% (Ejura-Sekyedumase District Assembly, 2006). The types of cropping system in the district are mixed farming, mixed cropping and mono-cropping. Farming is mainly rain-fed and cultivation is normally under subsistence, with few commercial base farms (Ejura-Sekyedumase District Assembly, 2006).

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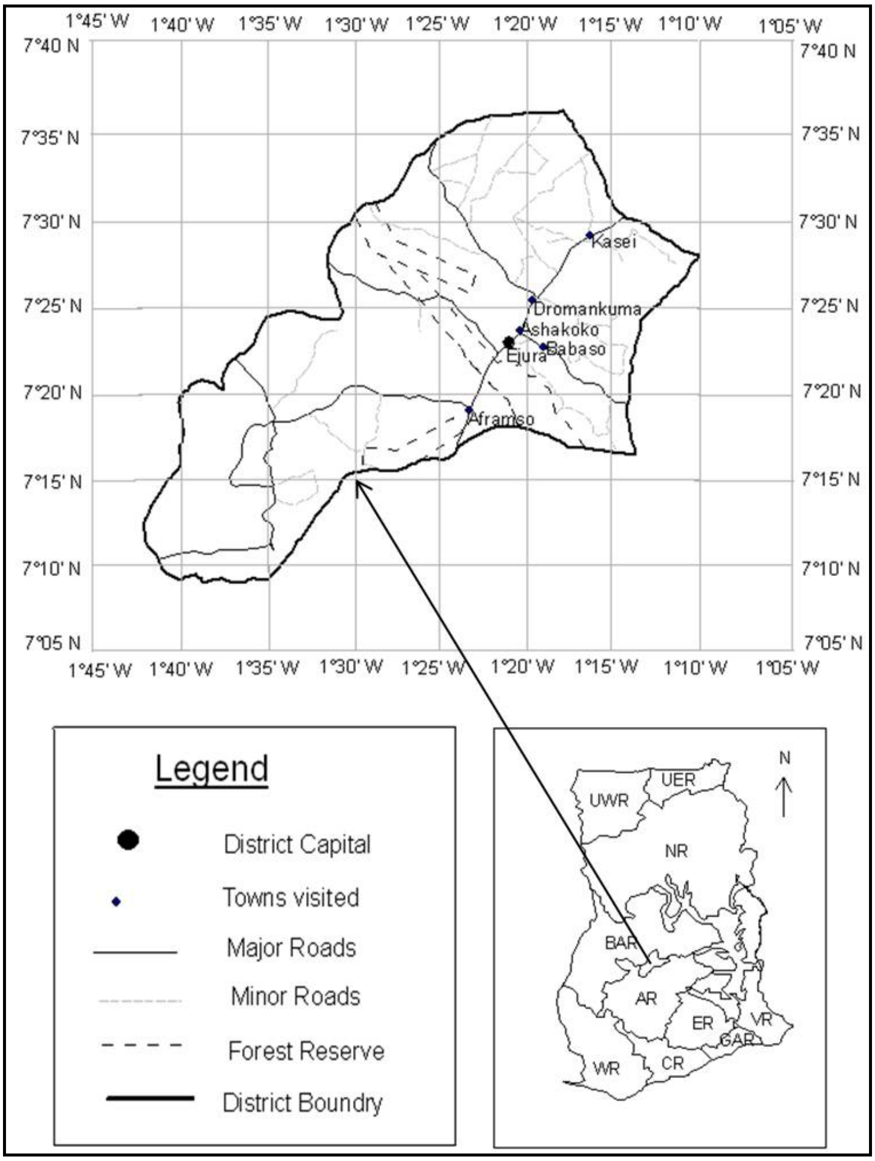

Figure-1. A map of Ejura-Sekyedumase District depicting locations of towns where questionnaires were administered.

2.2 Target areas and sampling

The survey was conducted with Agricultural Extension Officers of the Ministry of Food and Agriculture (MOFA) in the Ejura-Sekyedumase District. The District is divided into 19 agricultural operational areas with one Agricultural Extension Officer assigned to each of them. Each operational area has a number of communities under it. This research only considered interviews with farmers in six of the operational areas, which are in close proximity to the Volta River particularly from the central to the eastern part of the district. They include Babaso, Kasei, Ashakoko and Dromankuma in the eastern part and Aframso and Ejura, which are in-between central and eastern. Farmers within each area constitute a farmers' group who share ideas and resources. One hundred and fifty farmers' households were randomly selected among the six operational areas and interviewed using structured questionnaires. Farmers' group meeting preceded the interview. To avoid bias, only one farmer was interviewed from a household with two or more farmers. A minimum of 15 farmers were interviewed in each operational area.

The structured questionnaire was designed to collect information on farming systems, perception on climate change, concerns for changes in climate, capacities of farmers to cope with climate change and the support they need to build resilience to it. Data were collected through a field survey by face-to-face interviews with the farmers. They were invited to take part in the survey through agricultural extension agents and other farmers. The questionnaire was designed in English but the interviews were conducted in the local language, *Twi*. The interview questionnaire was designed with sections adapted from a focus group discussion facilitated by Stroh Consulting (2005) on agricultural adaptation to climate change in Alberta, Canada.

The interview questionnaire was designed under the following headings:

a) **General system and practices:** This was used to obtain information on farmers' bio-data such as sex, age, household size, level of education, marital status, years in farming and farming systems and location of farm.
b) **Perception of farmers on climate change:** This section was used to obtain data about perception on the changes in the incidences of droughts, flooding, growing season (time of planting) and extreme temperature; concerns about changes in climate; changes in farming operation, rainfall patterns and temperature.
c) **Assessment of farmers' adaptation to climate change:** This section was used to obtain information about farmers capabilities to adjust to climate change; relative risks to climate and other farming risks such as pest and market price fluctuations; vulnerability of farming activities to climatic factors; management strategies to adapt to climate and weather related risks (eg. using different varieties and crop type, changing planting dates, diversifying from farm to non-farm activities, increasing the use of irrigation, moving to different sites.

Interviews were conducted in August 2008. Data from the questionnaire were analysed using the Statistical Package for the Social Scientists (SPSS) software. Temperature and precipitation data were also obtained from the Ghana Meteorological Agency in the Ejura-Sekyedumase District covering the period between 1993 and 2006. These data gave an overview of the trends of temperature and precipitation and vulnerability of the district to droughts and floods. The results presented in this paper cover the perception of farmers about climate change.

3. RESULTS AND DISCUSSIONS

3.1 Rainfall trends in the district

The district lies within the transitional zone of the semi-deciduous forest and Guinea Savannah zones of Ghana (Ejura-Sekyedumase District Assembly, 2006). Thus, it experiences both the forest and savannah climatic conditions. It is marked by two rainfall patterns: the bi-modal pattern in the south and the uni-modal pattern in the north (Ejura-Sekyedumase District Assembly, 2006). The two rainfall regimes occur from about April through June and from September through November, with a mean annual rainfall of 1430 mm (Cudjoe, 2003; Tan *et al*., 2008). From 1993 to 2006, the district experienced an annual rainfall below the District's average baseline of 1430 mm, with the exception of 2004 which received an annual average of 1480 mm. Figure-2 shows the rainfall anomaly for the various years with respect to the districts' average baseline. The rainfall anomaly is the deviation of rainfall from the annual average. Figure-2 indicates that there was high inter-annual rainfall variability (vast variations between annual rainfall amounts), with 1993 to 1998 experiencing extreme reduction as much as 234 mm to 560 mm below the Districts' average. With the exception of 2001, rainfall amount from 1998 to 2006 only varied from 50 mm above and 108 mm below the districts' average baseline. Amongst these years, 1994, 1996, 1997 and 2001 recorded the lowest annual rainfall amounts.

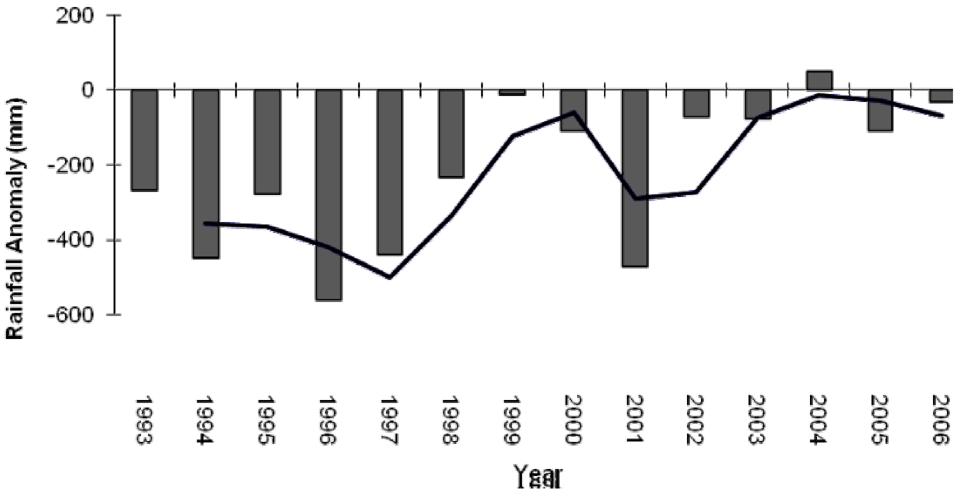

Figure-2. Annual Rainfall Anomalies in Ejura-Sekyedumase District from 1993 to 2006.

As shown in Figure-3, 1996, 1997 and 2001 were marked by three consecutive dry months from November through to December and January of the subsequent years. Not only has the inter-annual rainfall amount varied significantly but also the intra-annual distribution of rainfall (Figure-3). This is likely to have a great impact on agricultural production since the amount and distribution of rainfall in a given year determines the success or failure of crop production (Nhemechena and Hassan, 2007). A year with extreme rainfall separated by longer dry spells

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despite an above average annual rainfall can be detrimental to crop production because farmers are more likely to harvest greater yields if the rains fall at the right times and the right amounts. If the amount of rain at any point in time results in the soil reaching its field capacity, then water will be available to crops at the optimum level to ensure high crop performance.

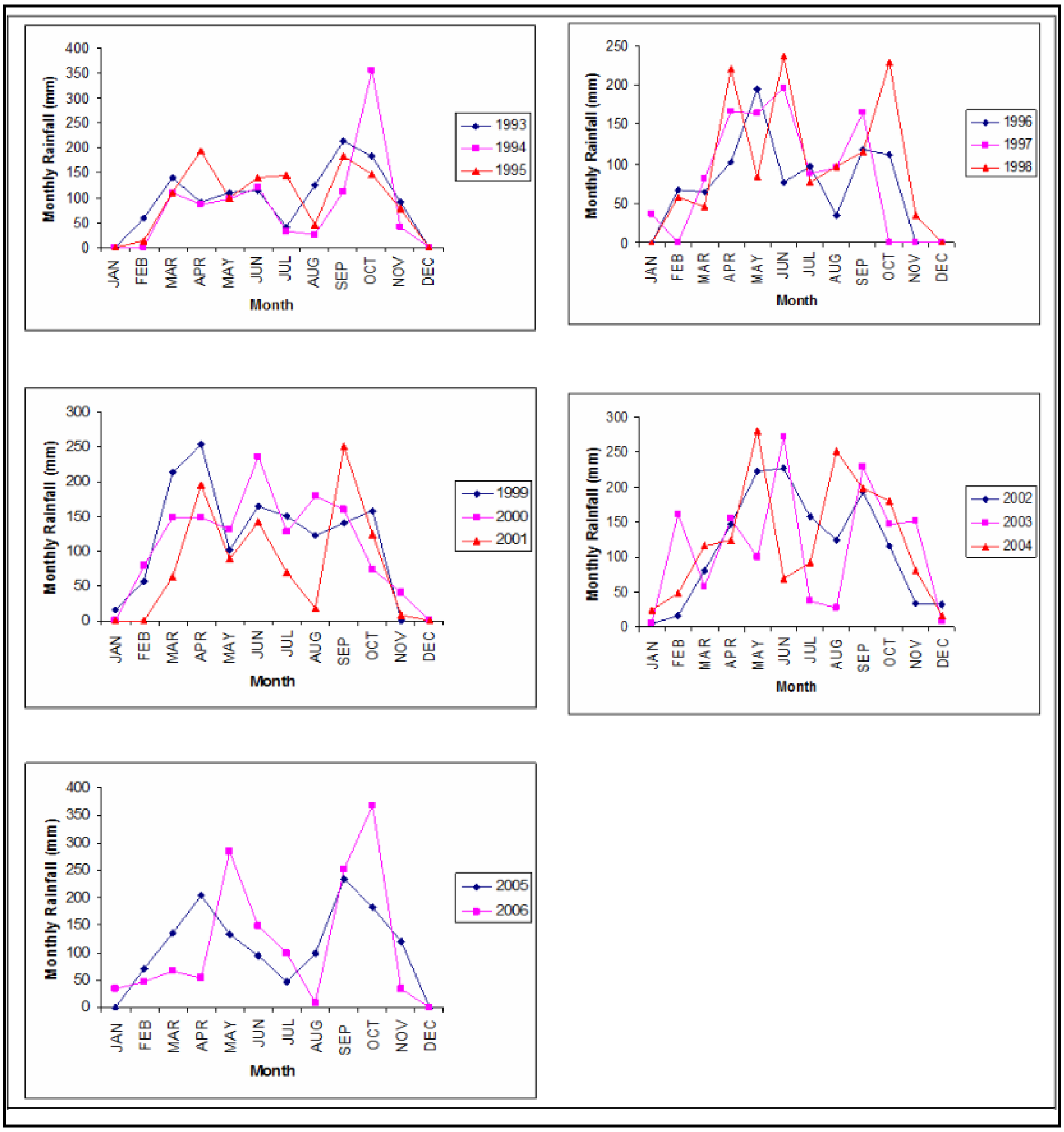

Figure-3. Intra-annual distribution of rainfall from 1993 to 2006 in Ejura-Sekyedumase District.

Trends in rainfall distribution were similar in 1993, 1994, 1995, 2005 and 2006 where the amount of rain received during the major rainy season (April - June) was lower than the minor rainy season (September - November) (Figure-3). The rainfall trend however changed from 1996 to 2000, where the amount of rain received during the major rainy season was greater than the minor rainy season. Between 2002 and 2004 the highest amount of rainfall occurred in the last month of the major season and the first month of the minor season.

These changes confirm the report by Maddison (2007) that rains in Africa is less predictable and shorter in duration. It has also become erratic with extremes that normally lead to flooding and drought.

3.2 Temperature trends in the district

The mean annual minimum and maximum temperatures between 1971 and 2000 were 21.4 °C (±0.4) and 31.2 °C (±0.5), respectively with an average of 26.3 °C (Tan *et al*., 2008). Figure-4 shows the mean monthly temperature departures from normal (1971 - 2000 average baseline of 26.3 °C). It was warmer than normal from 1993 to 2001 and relatively cooler from 2002 to 2006. The mean monthly temperatures from 1993 to 2006 varied from 24.8 °C to 27.7 °C, which is approximately about 1.5 °C deviation from the District's average. The mean annual maximum temperature increased to 33 °C and the minimum temperature conversely reduced to 18 °C. These variations are large enough to cause stress to crop plants leading to reduced growth and yield.

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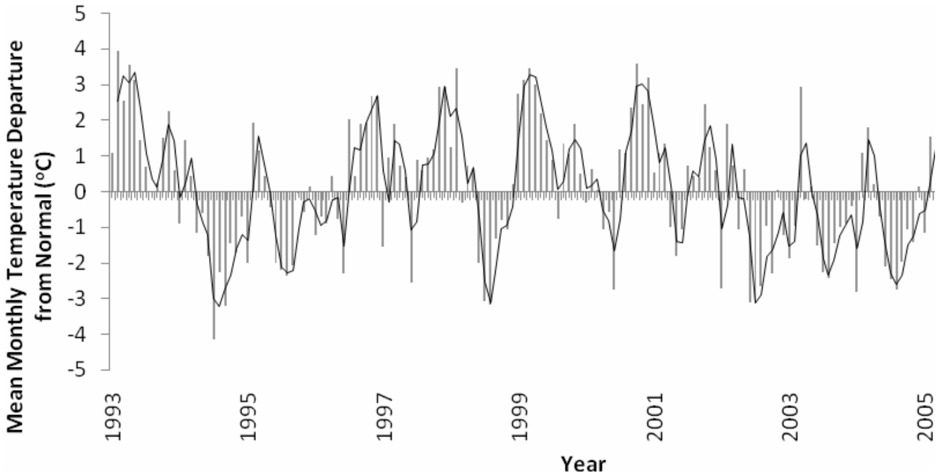

Figure-4. Mean monthly temperature departure from normal with respect to 1971 – 2000 baseline in Ejura-Sekyedumase District.

The observed monthly temperatures of the two rainy seasons also showed variations in temperature intensities between the seasons (Figures 5 and 6). The mean temperatures for the major and minor rainy seasons were 25.4 ^{o}C and 26.75 ^{o}C respectively. In other words, temperature in the minor season decreased by 0.94 ^{o}C from the Districts average and increased by 0.46 ^{o}C. This implies that from 1993 to 2006 the minor rainy season periods were generally warmer than the major rainy season (Figure-5). During this period, the mean monthly rainfalls in the major and minor rainy seasons were 1483.1 mm (53.1 mm + 1430 mm) and 1505.5 mm (75.5 mm + 1430 mm) respectively. This indicates an increased rainfall in both seasons above the districts average. However, the minor season received more rains than the major season. The minor season has therefore been warmer with higher precipitation than the major season.

Climate in Ghana is highly variable and the above results could have been a deviation from what occurred in the past 20 to 50 years or would be different from what could happen in future. If the current trend continues, appropriate adaptation measures that seek to conserve soil moisture would have to be implemented taking into consideration the timing for the implementation.

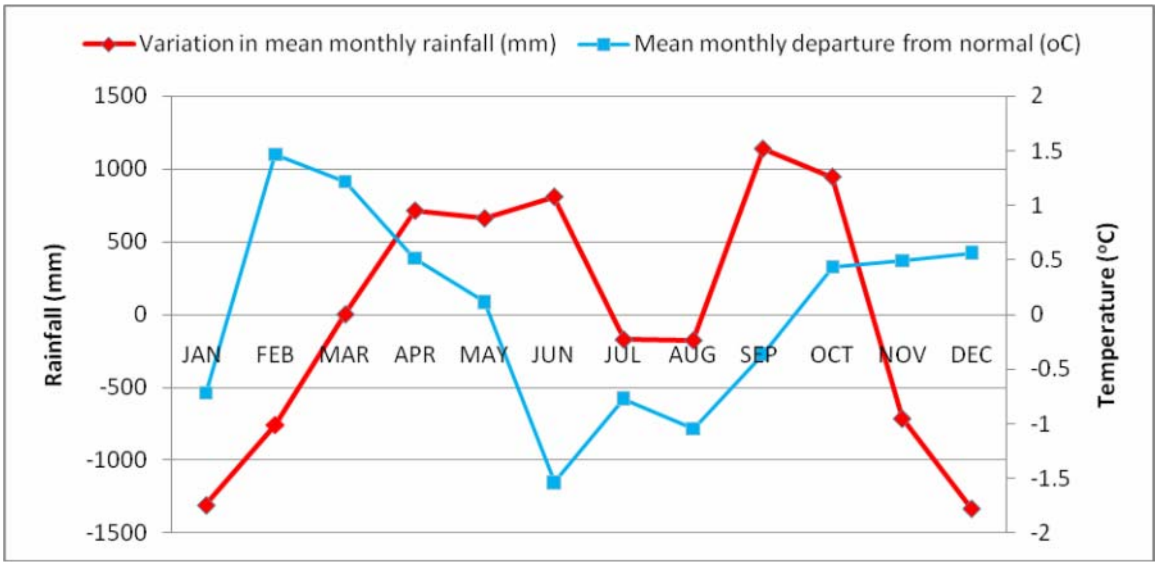

Figure-5. The relationship between mean monthly temperature departure and mean monthly rainfall anomaly (Baselines for rainfall and temperature are 1430 mm and 26.3 ^{o}C, respectively).

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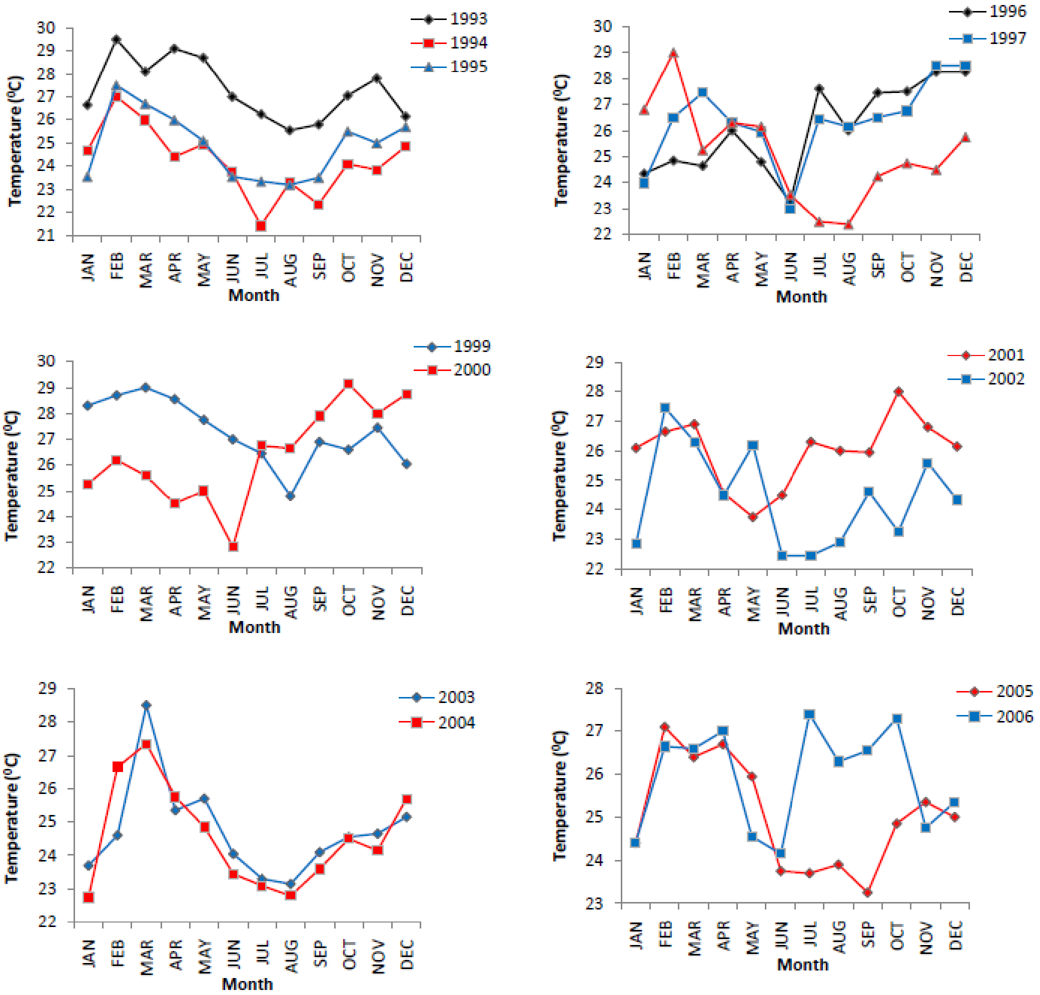

Figure-6. Variation in monthly temperature from 1993 to 2006 in Ejura-Sekyedumase District.

3.3 Farmers' perceptions towards temperature and precipitation

Majority of the farmers (82%) interviewed believe that temperature has become warmer (Figure-7). Though farmers perceived it has become warmer, the climatic data of the district showed the weather was warm from 1993 to 2002 but became relatively cooler afterwards up to 2006 when data was available. Their perception differed from the recorded data probably because the cooling effect after 2002 (Figure-6) is not significant enough for them to notice. Farmers' perception of temperature in the district compares with farmers' perception in other African countries as reported by Maddison (2007) and IFPRI (2008).

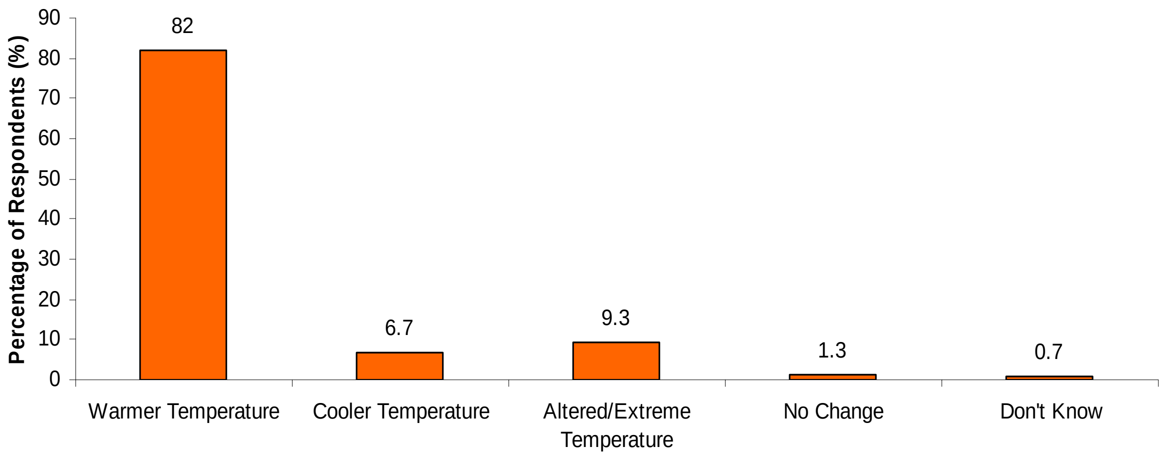

Figure-7. Farmers' perception towards changes in temperature for the past 10 years.

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With respect to precipitation, farmers were asked whether they had noticed any change in the amount, frequency and the timing of rainfall. Farmers gave multiple responses to this question by stating whether the amount and frequency have increased or decreased and the timing changed or not. A large percentage (93%) was of the opinion that the timing of the rains is now irregular and unpredictable as shown in Figure-8. A significant number (39.3%) also believed that precipitation has decreased and consequently increased the frequency of droughts where there has been less rain than normal and crops are mostly moisture stressed. 35% and 28% of those reporting a change in the timing also reported a decrease in precipitation and increased frequency of drought respectively. Overall farmers were much concerned about the irregularity of rainfall. Studies in several other developing countries indicate that most farmers perceive temperatures to have become warmer and rainfall reduced over the past decade or two (Gbetibouo, 2008; Dinar *et al.*, 2008; Mubaya *et al.*, 2010; Deressa *et al.*, 2011).

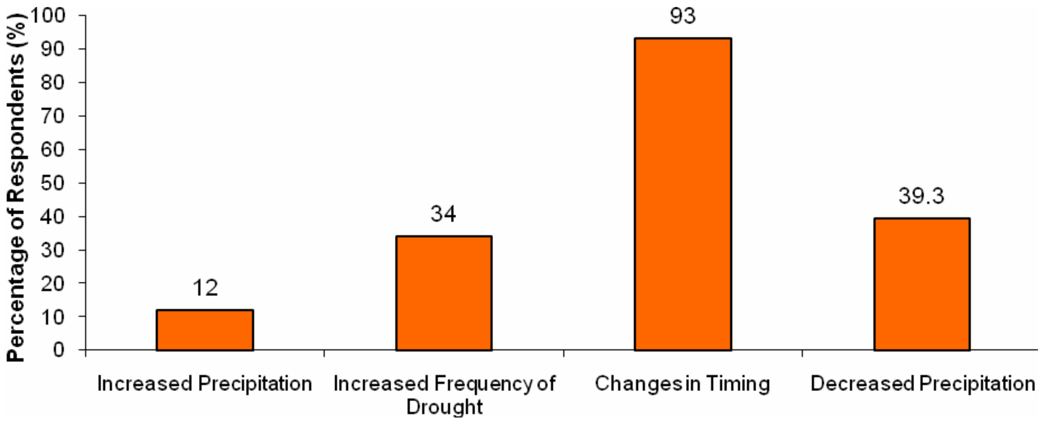

Figure-8. Farmers' perception towards changes in rainfall pattern for the past 10 years (Response of each rainfall characteristic is expressed as a percentage of n = 150)

3.4 Farmers' perception towards incidence of climate variables

Perception of farmers on the prevalence of droughts, floods, increased temperature and changes in growing season is presented in Table-1. A large percentage of farmers reported that there have been many changes in droughts, temperature and growing season. Only few farmers reckoned there have been changes with flooding incidences in the region for the past 10 years.

Table-1. Percent changes in the incidence of climate variables in Ejura-Sekyedumase district of total number of farmers interviewed.

Incidence	Extreme changes	Many changes	Some changes	Limited changes	Few changes	No change
Drought	15.3	43.3	24.7	7.3	6.7	2.7
Flooding	0.7	12.7	16.7	16	41.3	12.7
Increased temperature	14	40	22.7	9.3	10	4
Changes in growing season	4.7	52	30.7	9.3	3.3	0

The research also looked further into the vulnerabilities of farm location to the incidence of drought and floods. From Table-2, it can be seen that despite the location of farms, drought conditions were more prevalent than floods. Drought conditions on farms in lowlands and hills have been relatively high. This has caused many farmers to relocate production of certain crops such as vegetables to plots closer to rivers. This emerging practice will also have a detrimental effect on the ecology of the rivers and the surrounding habitats. Farming close to rivers destroys trees and tall shrubs which protect river banks against erosion. There is also a tendency for farmers to pollute rivers with chemicals such as pesticides, fertilizers and other agrochemicals which might destroy aquatic lives as a result of this new practice. Consequently farming close to rivers may have a long-term impact on the water availability for domestic use since most communities depend on these water bodies for household chores.

Table-2. Vulnerability of farm location to incidence of drought and floods in Ejura-Sekyedumase district (n = 150).

Location of farm	Incidence	Occurrence of drought and flood (%)					
		Extreme	Many	Some	Limited	Few	None
Near river	Drought	10.7	44.6	32.1	3.6	7.1	1.8
	Flooding	0.0	12.5	23.2	8.9	48.2	7.1
In hills	Drought	13.0	47.8	30.4	4.3	4.3	0.0
	Flooding	0.0	17.4	21.7	17.4	39.1	4.3
Low land	Drought	21.8	41.8	14.5	14.5	1.8	5.5
	Flooding	1.8	10.9	10.9	20.0	32.7	23.6
Near rivers and in hills	Drought	7.7	38.5	30.8	0.0	23.1	0.0
	Flooding	0.0	7.7	7.7	23.1	53.8	7.7
Near river and low land	Drought	33.3	33.3	0.0	0.0	33.3	0.0
	Flooding	0.0	33.3	0.0	33.3	33.3	0.0

3.5 Farmers' vulnerability to climate risks

Vulnerabilities to five potential climate risks as perceived by farmers are presented in Table-3. Each agricultural operational area gave a different opinion on what they are most vulnerable to. This may be as a result of the proximity of their farms to water bodies and natural forest reserves. Abrupt change in season was of major concern to farmers in Ejura, Babaso, Kasei and Dromankuma whilst farmers in Aframso and Ashakoko believed they are most vulnerable to droughts. Overall, farmers in the district were most concerned about the abrupt change in season. The second most vulnerable factor was droughts, and then reduced rainfall, increased temperature and floods followed in a decreasing order of vulnerability.

Table-3. Farmers' perception on their vulnerability to factors that affect farmers in Ejura-Sekyedumase district (Ranked on a scale of 1 to 5, where 1 is the highest).

Agricultural operational area	Abrupt change in season	Droughts	Less rainfall	Increased temperature	Floods
Aframso	2	1	5	3	4
Ashakoko	3	1	4	5	2
Ejura	1	4	2	3	5
Kasei	1	4	2	3	5
Babaso	1	4	2	3	5
Dromankuma	1	2	5	4	3
Average score	1.6	2.8	3	3.4	4.2
Overall ranking	1	2	3	4	5

Overall, 79.3 % of the farmers interviewed indicated that they were much concerned about climate change as shown in Figure-9. Thirty two percent (32%) of the farmers were extremely concerned whilst 47.3% were very concerned. Only 4.7 % said they have little concern about climate change.

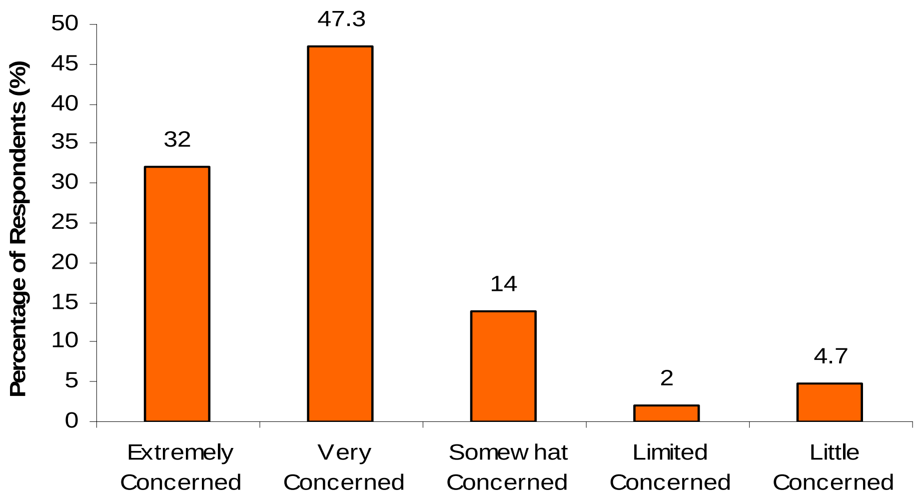

Figure-9. Concerns of farmers about climate change in Ejura-Sekyedumase district (n = 150).

Over the past 10 years majority of farmers (97.3%) changed their farming operations in response to numerous farm risks. Out of this total, 98% was in response to changes in climate (Figure-10). This gives an indication of how farmers have become aware of the instability and unpredictability of the weather, and progressively putting in place measures to cope with the situation.

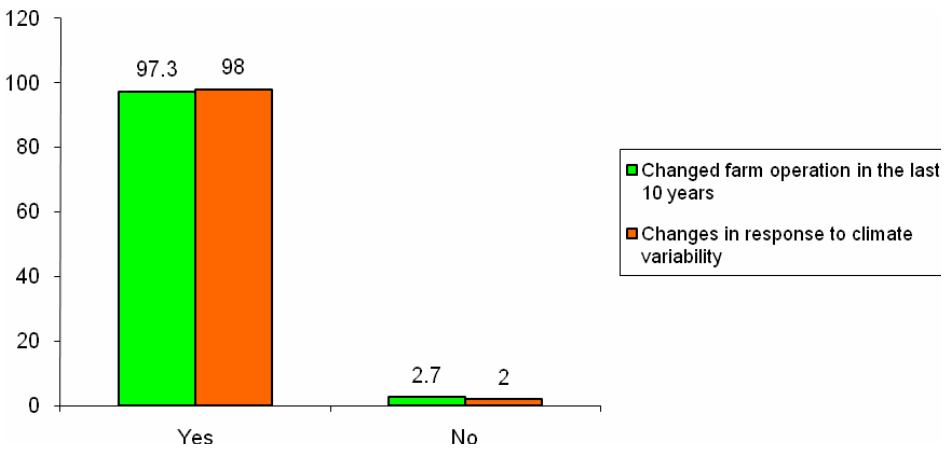

Figure-10. Farm operation changes in response to climate change.

Conversely, research reported by Maddison (2007) indicated that about one third of farmers in Burkina Faso, Cameroon, Ghana, South Africa and Zambia have not changed their operations in spite of their high perceived change in climate for reasons unknown. The situation was quite different in Egypt and Ethiopia where every farmer interviewed claimed to have made at least one adaptation. In a similar report, Nhemachena and Hassan, (2007) indicated that most farmers in Africa already perceive an increased temperature and insufficient precipitation for production. The perception of farmers in Ejura-Sekyedumase District agrees with the report of Nhemachena and Hassan (2007). Therefore, farmers are likely to implement adaptation measures in order to maximise production in events of climate risks.

4. CONCLUSIONS

This paper presented farmers' perception on changes in climate in Ejura-Sekyedumase District of Ghana. The study attempted to confirm farmers' perception on climate variability with the actual variations based on climatic data recorded from 1993 to 2006. It was based on interviews of 150 farm households in six agricultural operational areas. Frequencies and percentage of respondents were used to characterize farmers' perception of changes in temperature and precipitation.

The results indicated that more than 80% of farmers believe that temperature in the district had become warmer and over 90% were of the opinion that rainfall timing had changed, resulting in increased frequency of drought. Their perception conforms to observed or measured trends in the region. However, the data showed that the years between 2001 and 2006 has been less warm as compared to the rest of the 14 years for which data was available. Farmers also indicated that they are most vulnerable to abrupt change in season, followed by drought, then increased temperature, less rainfall and floods.

The adaptation policy message here is that more soil moisture conservation measures should be implemented to sustain production. For example, inter-cropping major crops with cover crops like groundnut and cowpea during the major rainy season can help farmers to conserve soil moisture. The use of mulches should also be considered in order to conserve moisture. Farmers should also be educated to avoid burning their fields before planting since it exposes the soil to the adverse effects of the sun. Also, mini dams and ponds can be constructed on farms to harvest excess water which can be used in November and December when there is normally minimal rains and the earlier months of the major season the following year. Minor rainy season farming can be more sustainable if drains can be created on farms to drain off excess water in the soil.

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