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Climate Change and Shift in Cropping System: From Cocoa to Maize Based Cropping System in Wenchi Area of Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. SAN and MK designed the study. MK performed the statistical analysis and wrote the protocol. SAN wrote the first draft of the manuscript. Both authors managed the analyses of the study. Both authors managed the literature searches, read and approved the final manuscript.

Research Article

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ABSTRACT

A study was conducted in Wenchi Municipality in the forest/savanna transitional agro-ecological zone of Ghana to analyze the past and present cropping systems and to identify the key drivers responsible for the shift. We used key informant and semi-structured interviews, focus group discussions and field observations for data collection. Historical analyses of the present and past cropping systems indicated that over the past forty years, there has been a shift from cocoa based to maize based cropping system. The shift in the cropping system was prompted by decline in the yield of cocoa and the difficulty in establishing new cocoa farms as a result of changing rainfall pattern, frequent bushfires and increase in the dry season. Other factors attributed to the shift by farmers included land tenure, soil fertility decline and vegetation change. Strategies being used by farmers to adapt to the changing climate and variability include planting of drought tolerant crops such as cassava, yam and maize and adjusting planting dates of crops to coincide with the onset of the rains. The study indicates that future shift in cropping system from

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maize to cocoa-based system is unlikely due to deforestation activities and the prevailing climatic conditions.

Keywords: Adaptation; bushfire; deforestation; land tenure; rainfall; soil fertility decline; vegetation.

1. INTRODUCTION

Cocoa is the most important export crop in Ghana and contributes substantially to the foreign exchange earnings of the agricultural sector. In 2009 for instance, the cocoa sector contributed 84.9% (US$ 1.865 billion) out of the US$ 2.197 billion of the foreign exchange earnings of the agricultural sector (ISSER, 2010). In Ghana, cocoa is a smallholder crop and employs over 800,000 smallholder farm families (Anim-Kwapong and Frimpong, 2004). The period 1983-84 saw a major twist in the cocoa industry in Ghana. According to Berry (1994), production levels dropped considerably from an average of more than 450,000 tons in the 1960s to as low as 159,000 tons. This massive drop was attributed to several reasons including pests and diseases, aging trees, lower producer price, unfavourable climatic conditions and the 1983 bushfires. It is estimated that the bushfires destroyed about 60,000 hectares of cocoa farms in the entire country and in comparison; production in 1983-84 was woefully 28% of the 1964-65 production level of 557,000 tons (Berry, 1994).

According to the Inter-governmental panel on climate change (IPCC) assessment report (2007), eleven out of twelve years (1995-2006) show global temperatures that are among the warmest years since 1850 while droughts have become more lengthy and intense and heavy rains more intense (IPCC, 2007). Recent studies confirm that Africa is one of the most vulnerable continents to climate variability and change because of multiple stress and low adaptive capacity (IPCC, 2007). Climate change scenario for Africa suggests that food security and smallholders' incomes are severely threatened as growing seasons shorten and percentage of arable lands decline. Projected reductions in yields in some countries could be as much as 50% by 2020 and crop revenues could fall by as much as 90% by 2100 (Boko et al., 2007).

In Ghana, analysis of 40-year data (1960-2000) from the Ghana Meteorological Agency reveals a progressive and visible rise in temperature with a simultaneous decline in rainfall across all agro-ecological zones (EPA, 2007). Climate change scenarios developed based on the forty-year data, predicted a continuous rise in temperature with an average increase of about 0.6ºC, 2.0ºC and 3.9ºC by the year 2020, 2050 and 2080 respectively. Rainfall is also predicted to decline on average by 2.8%, 10.9% and 18.6% by 2020, 2050 and 2080 respectively in all agro-ecological zones in Ghana (EPA, 2007). These predicted changes can have impact on pattern of agriculture production in Ghana, especially in the regions where the agro-ecological systems are in transition. Smallholder farmers in Ghana who produce the bulk of the food and cash crops are the most vulnerable to the various manifestations of climate change. Crops that are particularly important and would be adversely affected are cereals and cocoa (Agyeman Bonsu et al., 2008).

Cocoa is a crop of the humid tropics and thus requires humid climatic conditions for good growth and yield. Good cocoa production requires uniform distribution of rainfall throughout

the year. According to ICCO (2009), the year to year variations in the yield of cocoa are normally affected more by the rainfall regime than by any other climatic variable. Although cocoa trees have thrived on annual rainfall regime of between 1150 and 2500 mm per annum in some cases, it is recommended that an annual rainfall range between 1500 and 2500 mm is ideal for optimum growth and yield of cocoa (ICCO, 2009). Application of a physiological growth and production model of cocoa (SUCROS-Cocoa) by Zuidema et al. (2005) indicated that for Ghana, marked dry periods which may result in reduction in Leaf Area Index (LAI) are the key causes of the lower annual cocoa yields. According to Zuidema et al. (2005), regression analysis that was performed indicated that even though cocoa yield is correlated with total annual rainfall, it shows strong correlation with the total annual rainfall amount during the driest month of the year. It therefore suggests that rainfall amount during the driest months of the year is more important than the total annual rainfall in determining the yield of cocoa.

In the forest/savanna transitional zone of Ghana, climate change effects may be more pronounced due to the faster depletion of the forest vegetation and the ever expanding savanna horizons. The annual bushfires and prolong dry season make the production of cash crops such as cocoa extremely difficult. According to Amanor (1993) and Adjei-Nsiah et al. (2007), cocoa remained an important cash crop in Wenchi until the 1982-83 bush fires which ravaged the whole country. An attempt to replant cocoa in the Wenchi area after the 1983 bushfires failed partly due to increasing deforestation and the dry season bushfires (Amanor, 1993) resulting in a shift in the cropping system from cocoa to maize based cropping system. Although the shift has been blamed on the annual dry season bushfires as well as prolong dry season, no deep analysis of the causes of the shift has been made. This study was therefore conducted to provide a historical analysis of the current and past cropping systems in Wenchi area and identify the factors responsible for the shift from the cocoa to maize-based cropping system.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in the Wenchi Municipality in the Brong Ahafo region of Ghana. Wenchi which is located in the forest/savanna transitional agro-ecological zone has a population of 97,058 and 180 communities (Year 2000 population census). The topography of the Wenchi area is largely undulating with gentle slopes of less than one percent inclination. In terms of vegetation, the Wenchi area is known to have aspects of the semi-deciduous forest and guinea savannah vegetation which indicate that Wenchi lies in the transitional agro-ecological zone of Ghana. The vegetation is thus dominated by tall grasses, especially *Pennisetum purpureum* and *Panicum maximum* with few trees and shrubs scattered at unbalanced intervals. The study area has a bimodal rainfall pattern with peaks in June/July as well as September/October with a marked dry season from December-March. A 47 year (1961–2008) average annual rainfall amount of the area is 1234 mm with 1982–2001 average minimum and maximum temperatures of 21.45ºC and 31.27ºC respectively. The major growing season spans from April to July followed by a minor growing season from September to November.

The study was conducted in three representative communities in the Wenchi area; Asuoano, Beposo and Buoku. The three communities were strategically selected based on their location in the municipality. Asuoano and Beposo are twin communities in the northern part

and much closer to Wenchi town, the capital of Wenchi Municipality. Buoku is located at the southern part of the municipality about 25 km from Wenchi town and close to Sunyani Municipality. Therefore the communities were selected to ensure that data collected is as comprehensive and representative as possible. Also, Asuoano and Beposo have open land area while Buoku is bounded by a forest reserve and that could give an option to further explore the choice of crops, cropping patterns and behaviour of farmers.

2.2 Research Methods and Selection of Respondents

In total, 80 farmers (mainly natives) were interviewed from the three selected communities; 30 from Asuoano, 30 from Buoku and 20 from Beposo. Data collection was done by using participatory diagnostic tools such as semi-structured interviews, field observations and surveys, key informant interviews and focus group discussion.

The semi-structured interviews were used to obtain as much quantitative data as possible from farmers on specific issues while at the same time getting deep qualitative information for describing and explaining situations. This was done by developing a checklist on each specific issue for which quantitative data is sought. These include among other issues, the drivers for the changes in cropping systems; indicators of changes in climate, and adaptation strategies of farmers. The checklist was pre-tested to ensure its effectiveness before it was readjusted and improved for the actual interviewing. The semi-structured interviews were done on one-on-one basis so that responses can be quantified. The field level surveys and observations were carried out to obtain good visual understanding and appraisal of dominant crops, cropping patterns and other bio-physical parameters. They were also carried out to provide a better pictorial understanding of the conditions and crop data during the interviews and focus group discussion. The surveys and observations were done through farm visits to have a view of the cropping pattern, spatial distribution and arrangement of crops and also to identify the dominant crops in the cropping systems. The key informant interviews and focus group discussion were undertaken to obtain adequate qualitative information from different perspectives. These were essential to understand, explore and describe the realities of shifts in cropping systems over time as influenced by the perceived changes in climate and other factors which may play a role.

Respondents for the one-on-one interviews and focus group discussion were selected using the stratified sampling technique. Lists of farmers in the communities were obtained from the agricultural extension officer in the area and elderly men and women were selected to form the bulk of the respondents due to the focus on tracking historical changes in cropping systems and climatic variables across the years. In the focus group discussion, 11 elderly men and 11 elderly women were selected and discussion was done separately for each group. Cocoa farmers were also strategically selected since the study tended to analyse the trend of cocoa production, its apparent disappearance and subsequent difficulties in its re-establishment in the Wenchi area.

Relevant government agencies and private companies formed the secondary target groups. To this effect, Ghana Meteorological Agency and the Ministry of Food and Agriculture in Wenchi were interviewed. Discussions were also held with Ghana Cocoa Board (COCOBOD) Sunyani regional office, PBC Ghana Ltd (a licensed cocoa buying company) and also the Forest Services Division of the Ghana Forestry Commission in Sunyani because they have the oversight responsibility for the management of forests in reserves and off reserves in the Wenchi area. Both qualitative and quantitative data were collected from these sources. Data were also obtained from literature.

3. RESULTS

3.1 Current Cropping System

Secondly data obtained from the District Agricultural Development Unit in Wenchi indicated that maize, yam and cassava are currently the main crops cultivated by majority of the farmers in Wenchi. In 2008, farmers cultivating these three crops accounted for about 73% of the total number of farmers cultivating the major crops (Fig. 1).

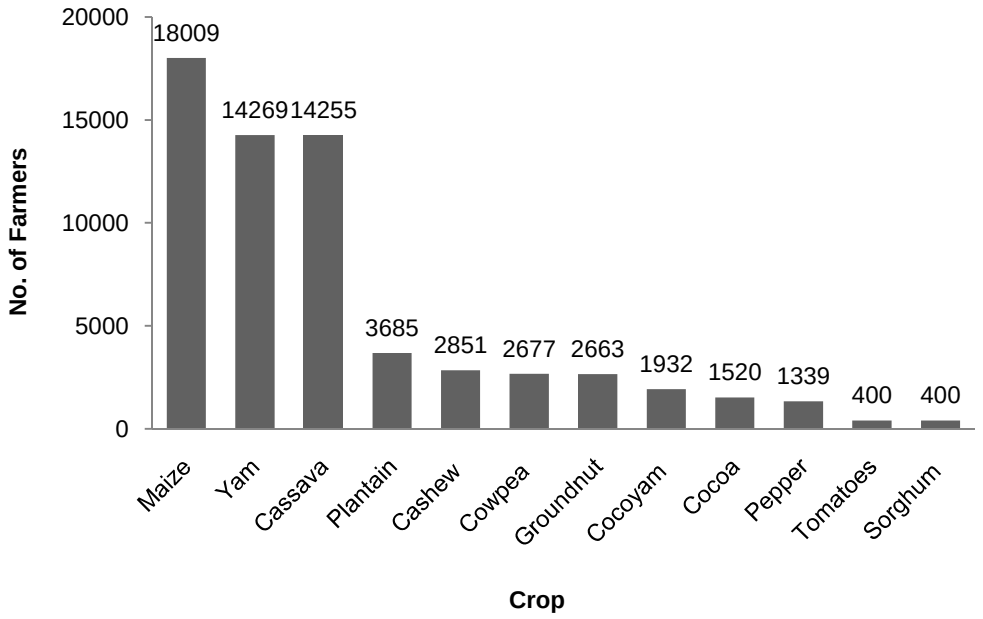


Fig. 1. Number of farmers cultivating each of the major crops in 2008.
(Source: MoFA, Wenchi)

This was confirmed by the interviews with farmers from the three communities which also showed maize, cassava and yam as the most important crops in terms of the number of farmers cultivating these crops (Table 1). It must be noted that the sum of the percentage number of people cultivating the various crops add up to more than 100% because some farmers cultivate more than one crop since smallholder farmers in Ghana in general and Wenchi in particular practise mixed cropping. Yam is planted on mounds to increase the volume of soil for the development of tubers with cassava and cocoyam planted in the rows between the yam mounds in a sequential order for efficient utilization of nutrients. Cowpea and groundnuts are grown to serve two purposes: household food security and income and also to improve the soil fertility, particularly nitrogen for subsequent crops. Crop succession is planned such that maize is planted after harvesting the cowpea or groundnut to take advantage of the nitrogen fixed by the cowpea or groundnut. In this way it helps to either reduce or avoid the use of nitrogen fertilizers which may increase the cost of production.

Table 1. Number of farmers growing major crops in Wenchi in 2009

Crop	% of farmers (N=80)
Maize	90
Cassava	69
Yam	64
Cocoyam	51
Plantain	38
Cocoa	15
Cashew	14
Groundnut	13
Cowpea	11
Pigeonpea	6
Pepper	4
Sorghum	3
Tomatoes	3

In terms of magnitude, maize, cassava and yam appear to be the most important crops occupying about 80% of the total land area under cultivation among the major crops in the Municipality (Fig. 2). Maize alone occupies about half (47%) of the total land area under cultivation in 2008 while cocoa occupies only 3% of the total land area (Fig. 2).This shows the importance of maize as the major cash crop in Wenchi replacing cocoa which before the 1982/83 bushfires was the most important cash crop in Wenchi.

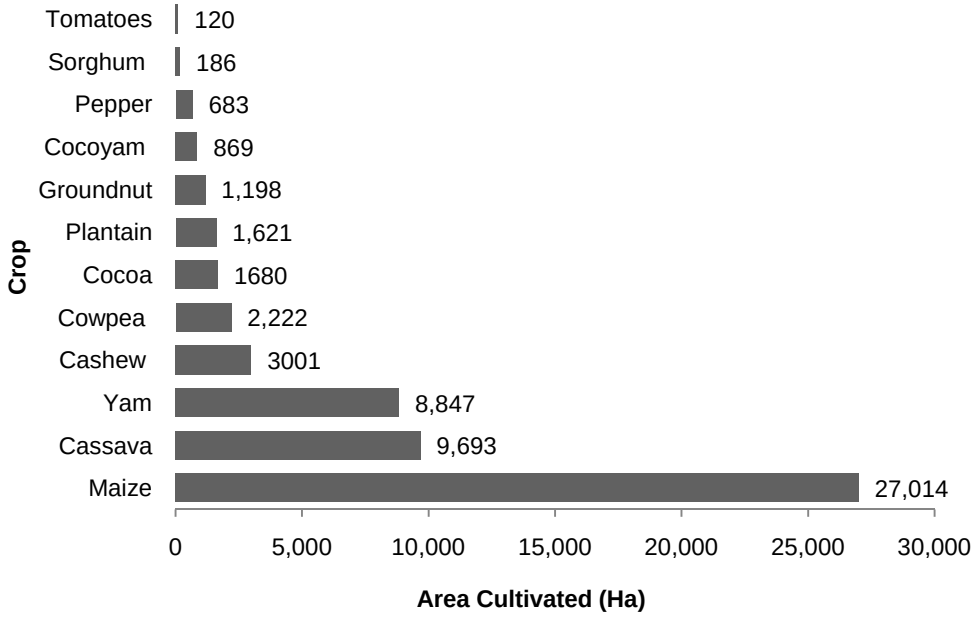


Fig. 2. Area cropped (in ha) under the major crops in 2008
(Source: MoFA, Wenchi)

3.2 Past Cropping Systems

In terms of magnitude and the number of people cultivating the crops, the farmers ranked cocoa as the most important crop in Wenchi before the 1982/83 bushfires followed by yams and maize (Table 2). According to the farmers, they obtained at least 70% of the household income from cocoa cultivation. Yam was mainly for home consumption and only surpluses were sold to supplement household income. They indicated that although maize was the third most important crop, it was cultivated on a smaller scale and grew steadily as an important cash crop after the 1983 when the climate became drier and cocoa production declined over the years thereby replacing cocoa as the most important crop. The widespread production of cassava was also indicated to be recent when drought became more frequent in the area as a result of the increasing dry condition in the area. Available data from Ghana COCOBOD indicated that cocoa production in Wenchi and Brong Ahafo in general started declining from the 1970s onwards and continued until the early part of 1990s (Fig. 3). While cocoa production was decreasing in Wenchi and the entire Brong Ahafo Region, available data indicated that cocoa production was at the same time also increasing in Western Region, another major cocoa producing area in Ghana which lagged behind Brong-Ahafo in cocoa production in the 1970s (Fig. 3). This suggests that factors responsible for cocoa production in Wenchi and Brong-Ahafo were specific to the local conditions in Wenchi and the entire Brong-Ahafo Region.

Table 2. Ranking by farmers of major crops cultivated before 1983 and major crops currently being cultivated in Wenchi

Major Cultivated Crops	Ranking	
	Before 1983	Current
Cocoa	1	-
Yam	2	3
Cassava	-	2
Maize	3	1
Plantain	4	4
Cashew	-	-
Cowpea	-	-
Cocoyam	-	-

3.3 Drivers of Cocoa Decline and Farmers' Perceived Causes and Indicators of Climate Change

Table 3 below shows the perception of farmers of the drivers responsible for the decline in cocoa production and the subsequent shift from cocoa to maize based cropping system in Wenchi. Change in climatic conditions particularly rainfall pattern was attributed by farmers as the major cause for decline in cocoa production and the subsequent shift from cocoa to maize based cropping system. Other factors responsible for the shift according to the farmers included land tenure, vegetation change, decline in producer price and soil fertility decline. Farmers single out rainfall as the single most important climatic variable which has significantly changed over the past few decades and has had impact on their cropping system. A significant number of farmers considered shortened rainy season and frequent droughts as the most significant indicators of climate change (Table 4). This according to the farmers is reflected in the number of days it rains in a year in recent years. This claim by farmers is confirmed by the analysis of the rainfall data in Wenchi over the past four decades

(Fig. 4) which shows a sharp fall in the number of rainy days in Wenchi between 1962 and 2001. Although, it is evident that cocoa production in Brong-Ahafo Region also declined during the same period as indicated by cocoa purchase from 1969-2001 (Fig. 4), there is no strong correlation between the number of rainy days and cocoa production during the same period.

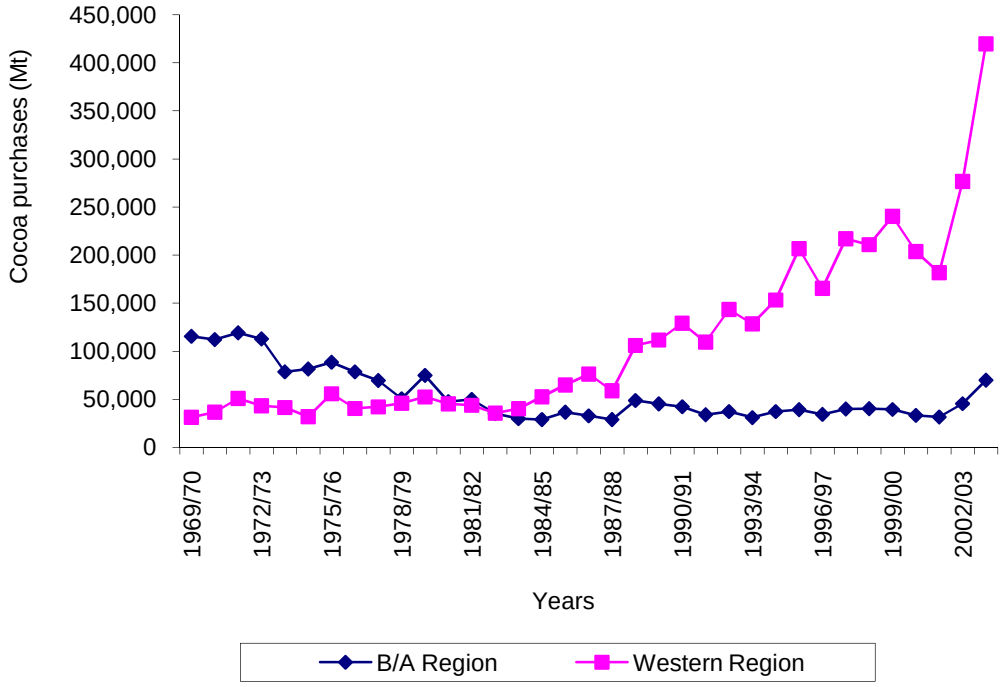


Fig. 3. Cocoa purchases in the Brong Ahafo and the Western Regions of Ghana. (Adapted from Policy Planning, Monitoring and Research Dept.,COCOBOD in Anim-Kwampong and Frimpong, 2004)

Table 3. Key drivers for decline in cocoa production and shift to maize production in Wenchi

Key Driver	% Of Farmers (N=80)
Rainfall	58
Bushfires	48
Land Tenure	45
Deforestation	44
Cocoa Producer Price	38
Soil Fertility Decline	29
Food Security	21
Migration	20

Table 4. Farmers' perception of current indicators of climate change

Indicator	% of farmers (N=80)
Frequent droughts	58
Delayed onset of rains	44
Irregular rainfall distribution	54
Shorter rainy season	75
Erratic rainfall	39

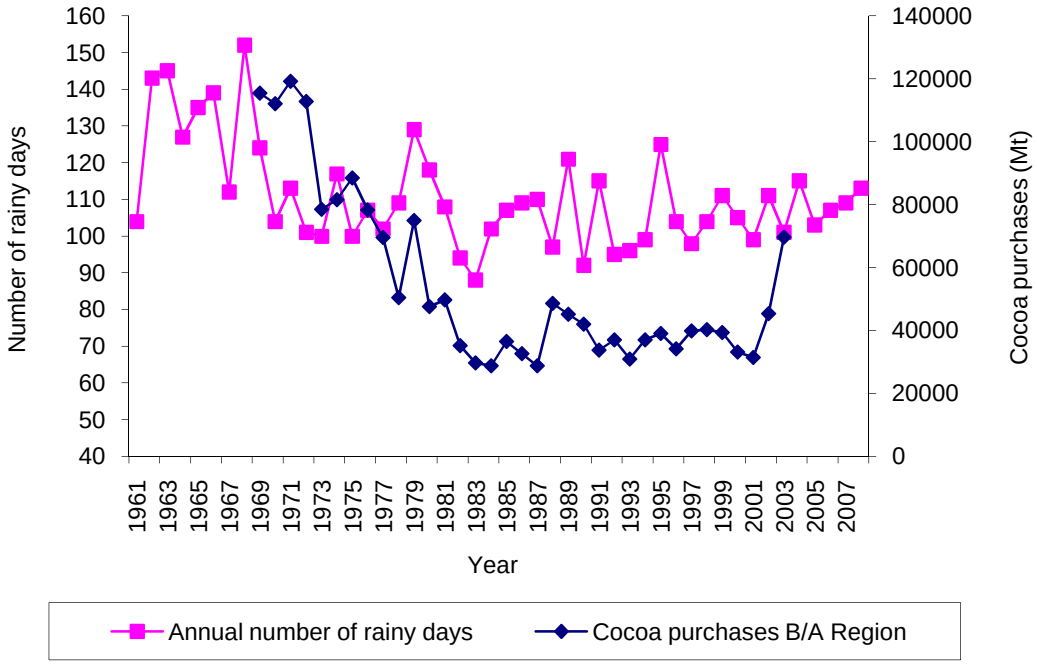


Fig. 4. Annual number of rainy days, Wenchi, 1961–2008 plotted against cocoa purchases in Brong Ahafo Region, 1969-2003

Sources: Rainfall data - Ghana Meteorological Agency and cocoa purchases – COCOBOD in Anim-Kwapong and Frimpong (2004).

The average rainfall amount for the two driest months, particularly December and February from 1961-2008 also shows a rapid decline from 1971 to 1993 (Fig. 5a) with the period of most rapid decline occurring between the period 1979 and1985 which also coincided with the period of most rapid decline in cocoa purchase. Careful analysis of the total rainfall for the four driest months in the year (December, January, February and March) (Fig. 5b) shows that there was sharp drop in rainfall between 1981-1983 below 50 mm per month and this period coincided with the period of the lowest cocoa production in the history of Ghana. Even though the catastrophic bushfires of 1983 could be responsible for the low production in 1983, rainfall could also be a major factor as the dry climatic conditions may favour the occurrence of the bushfires. The overall rainfall data does not reveal a visible decline in the total annual rainfall amounts. However when the average rainfall amounts in the different decades within the 47 year period are compared, a decline in rainfall is observed. As

presented below, the average rainfall for the period 1971 – 1980 expressed as percentage of the average for 1961 –1970 reveals a -6.4% decline in rainfall within those periods. Also if the decade 1961-1970 is used as a reference again, and expressing the average rainfall within the period 1971 – 2008 as percentage of the average in 1961 -1970, a -4.5% decline in total rainfall is then observed

$$1.\ \frac{\text{(Average rainfall 1971-1980) – (Average rainfall 1961-1970) x 100}}{\text{Average rainfall 1961-1970}}$$

$$\frac{1210.03 – 1293.17}{1293.17} \times 100 = -6.42\%$$

$$2.\ \frac{\text{Average rainfall (1971-2008) – (Average rainfall 1961-1970) x 100}}{\text{Average rainfall 1961-1970}}$$

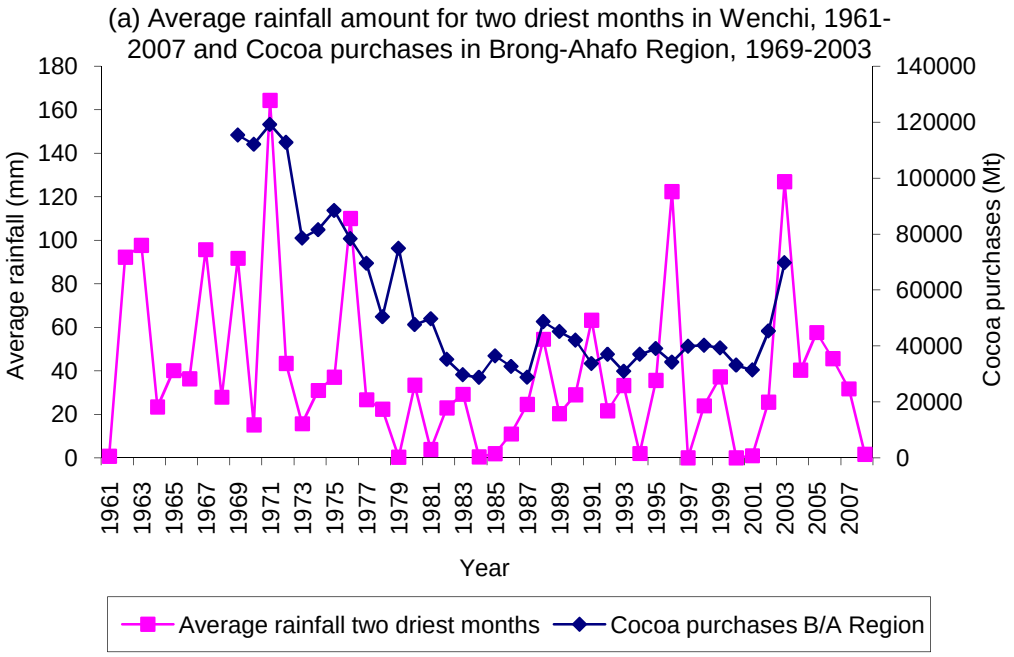
$$\frac{1234.95 – 1293.17 \times 100}{1293.17} = -4.49\%$$

3.4 Climate Change Adaptation Strategies

Important adaptation measures being used by farmers include change in planting date particularly for crop like maize to coincide with the onset of the rains, selection of crop types such as maize, cassava and yams that may be able to withstand the prevailing climatic conditions. These adaptation options are aimed at meeting the climatic requirement of crops and /or selecting crop types that are able to perform well under the prevailing climatic condition in the area. In addition to these adaption strategies, farmers also resort to strategies such as cultivating of tree crops such as cashew, mangoes and teak as well as leaving some selected trees standing during land clearing. These strategies could be considered as measures to adapt and/or to mitigate against the changing climatic conditions in the area as these tree crops are tolerant to drought and bushfires.

Besides farmers, other stakeholders such as the Ministry of Food and Agriculture (MoFA) and the Forestry Commission (FC) have undertaken a number of activities aimed at helping the farmers to adapt and at the same time mitigate against the climate change and variability. Activities undertaken by MoFA in this direction include provision of tree crop seedlings particularly cocoa to farmers for planting and training of farmers in cocoa agronomy which are aimed at increasing the forest vegetation through integration of shade trees in the cocoa system.

The forestry services division of the forestry commission has also undertaken a number of activities aimed at regenerating the forest. The Forestry Services Division of the Forestry Commission has collaborated with a number of organizations such as the Municipal Assembly, the Ghana Fire Service, radio stations and NGOs to organise forums aimed at educating and sensitizing the people on wildfire prevention, forestation and reforestation programmes through the modified *taungya* system (MTS). Although the MTS is aimed at increasing forest regenerating and the capacity of the forest reserved, it is anticipated that increased forest vegetation may help in mitigating the changes in climate by inducing rainfall.



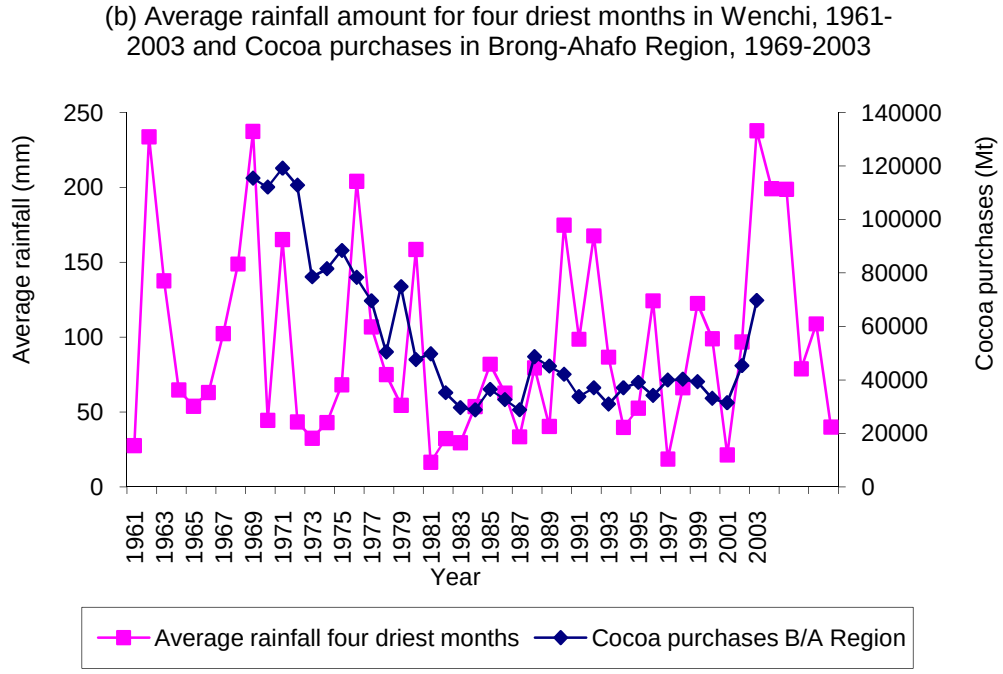


Fig. 5. (a) Average rainfall amount for two driest months in Wenchi, 1961-2007 and cocoa purchases in Brong-Ahafo region, 1969-2003 and (b) Average rainfall amount for four driest months in Wenchi, 1961-2007 and cocoa purchases in Brong-Ahafo Region, 1969-2003.

Source: Rainfall data, Ghana Meteorological Agency, Wenchi and cocoa purchases – COCOBOD in Anim-Kwapong and Frimpong (2004).

4. DISCUSSION

Results of the study indicate that maize has replaced cocoa as the main cash crop in Wenchi within the last forty years with cassava and yam as the major staple food crops. The emergence of maize as the main cash crop is attributed to the decline in cocoa production in the early 1980s. During the interviews with farmers, they mentioned that decline in cocoa production started prior to the 1983 bushfires and attributed it to intermittent droughts in the area due to poor rainfall and deforestation activities. Discussion with personnel of the Produce Buying Company Limited in Sunyani, a cocoa buying company which purchases about 60% of cocoa in Brong-Ahafo Region including Wenchi confirmed that cocoa production started declining in Wenchi prior to the 1983 bushfires to the point that in 1983, cocoa production in Wenchi became negligible. Consequently, beginning from 1990 cocoa purchases in Wenchi was fused with that of Techiman the two of which are now fused with that of Sunyani District because of low production in Wenchi and Techiman.

As pointed out by the farmers, the decline in cocoa production in Wenchi and the subsequent shift from cocoa to maize based cropping system could be attributed to prolong droughts in the area. Analysis of climatic data over the past four decades indicates that Wenchi has been experiencing drier conditions since the 1980s, and the rainfall figures for the dry season (December to March) indicates a 30% decline in the number of rainy days compared with the period 1961-1980 with the two dry driest years all occurring since 1981 (Adjei-Nsiah et al., 2010). These prolong dry seasons made it difficult to re-establish new cocoa fields due to high seedling mortality (Anim-Kwapong and Frimpong, 2004). Such dry condition also negatively affects growth and yield of cocoa as cocoa is a crop of the humid tropics and thus requires humid climatic conditions for good growth and yield (ICCO, 2009, Naturland, 2000). Application of a physiological growth and production model of cocoa (SUCROS-Cocoa) by Zuidema et al. (2005) indicated that marked dry periods which may result in reduction in Leaf Area Index (LAI) are likely to cause reduction in cocoa yields. According to Zuidema et al. (2005), regression analysis that was performed indicated that even though cocoa yield is correlated with total annual rainfall, it shows strong correlation with the total annual rainfall amount during the driest month of the year. In Wenchi, analysis of the rainfall data shows that the average total rainfall amounts for the two driest months of the year (December and February) has been declining since 1969 (Fig. 5a) with the most rapid decline occurring between 1979 1985 which also coincided with the period of lowest decline in cocoa purchases in Brong-Ahafo Region. According to ICCO (2009), for optimum growth and yield of cocoa, rainfall amount of less than 100 mm should not be experienced for more than three months in a year. This is confirmed by the analysis of the rainfall data in Wenchi which indicate that, between 1981 and 1989 when average rainfall amounts for the four driest months were less than 100 mm per month cocoa production decline reached its highest (Fig. 5b).

According to Hulme (1992), three broad categories of factors may be responsible for rainfall decline. These may include factors related to land cover change in the area, those related to global ocean circulation and associated pattern of sea-surface temperatures and thirdly those related to the changing composition of the global atmosphere. In the case of Wenchi, the declining rainfall pattern in the area may be closely related to land cover change within Wenchi area, although there is no theoretical or empirical evidence that the destruction of the forest significantly has reduced the rainfall in the area.

The period of the lowest cocoa production in Wenchi, which occurred in 1981-83 was the period when the average total rainfall amount for the four driest months in Wenchi dropped

below 50 mm and which eventually resulted in the 1983 bushfires. It is possible that farmers might have become fed up with cocoa production and therefore decided to shift from cocoa to maize production. This is rational as farmers respond to changes in environmental conditions by selecting crops suitable for the new conditions (Donatelli et al., 2000). In such a situation, farmers resorted to the cultivation of maize, yam and cassava which have different moisture requirement different from that of cocoa as adaptation strategy. According to Amanor (1993), the decline in cocoa production after the 1983 bushfires and the subsequent failure of the establishment of cocoa as a result of the increasing dryness in the area and deforestation attracted the migrant labour force which hitherto worked on the cocoa farms to shift to maize production. As a result of this, more forest land was brought into cultivation which attracted more migrants from the Upper West Region into the area. The proximity of Wenchi to Techiman, a functional regional market for the West African sub-region where high value crops like maize and yams are in high demand also served as an incentive to attract more migrant farmers into maize production. These migrants employed farming technologies and practices such as hoe cultivation and the use of ridges and mounds to which they were accustomed. Such practices which were intentionally employed by the migrants so as to create environment similar to that of their home of origin to enable them cultivate more maize, hastened the conversion of the forest to grassland (Leach and Fairhead, 2000). The changing vegetation in Wenchi from forest to grassland partly as a result of the farming activities of the migrants as well as logging also appeared to have better supported the cultivation of maize than cocoa. This is because the moist micro-climate ideally suited to cocoa was lost when the forest area was opened up through the felling of trees, bushfires and unsustainable farming practices of the migrants.

Decline in producer price of cocoa during the early 80's was considered by farmers as another driver responsible for the shift from cocoa to maize production in Wenchi. Although it is true that a higher producer price motivates farmers to increase their maintenance practices for higher yields that alone was not sufficient to cause such a massive shift, since the decline in cocoa producer price was supposed to have equally affected cocoa production in all cocoa producing areas in Ghana. However, as cocoa production declined in Wenchi and the entire Brong-Ahafo Region, that of the Western Region, another cocoa producing region in Ghana increased steadily although the producer price was the same in the country (Fig. 3). This implies that the causes of decline in cocoa production in Wenchi and the entire region of Brong-Ahafo were specific to the local conditions in the area. Another possible factor besides increased dryness and declining producer price that might have caused the decline in cocoa production in Wenchi was decline in soil fertility as pointed out by the farmers. This situation might have forced more people to move to the new frontier areas in the Western Region of Ghana in search of fertile land for cocoa cultivation. Hence, the increase in cocoa production in Western Region at the same time that cocoa production was on the decline in the Brong Ahafo Region (Fig. 3).

As transpired during the focus group discussions with the communities, the genuine interest by the migrant farmers in Wenchi in the production of food crops, particularly maize and yams was also partly responsible for the shift from cocoa to maize-based cropping system in Wenchi. Prior to the shift, migrant farmers constituted the main labour force in the cocoa industry in Wenchi. Because, migrants could not own land in Wenchi to cultivate cocoa, the only means through which they could benefit from the cocoa industry was the share cropping arrangement in the form of Abusa (Adjei-Nsiah, 2007). Under this arrangement, the migrant farmers contributed their labour to the cocoa production and received a third of the proceeds from the sale of the cocoa beans. Although this arrangement seemed unfair to the migrants, they had no options as they could not own land in Wenchi to undertake their own cocoa farm

enterprise. Consequently, with the decline in the cocoa production, their interest shifted from cocoa to maize production as the farmlands which were previously cultivated to cocoa were either rented to them or given to them for share cropping for the production of food crops, particularly maize. These arrangements attracted more migrant farmers into the area. Most of these migrants regarded their stay in Wenchi as temporal and had the ambition to return eventually to their communities of origin (Adjei-Nsiah et al., 2007). This short time horizon of migrants led most of them to be more aggressive in their farming practices compared to the host population living in the area which was also partly due to tenure insecurity (Adjei-Nsiah et al., 2004; Codjoe, 2006).

Although the Ministry of Food and agriculture has been undertaking several activities including provision of tree crop seedlings such as cocoa to farmers and training of farmers in cocoa agronomy both as mitigation and adaption measures, these have largely been unsuccessful due to frequent bushfires and increasing dryness and deforestation in the area.

5. CONCLUSION

Cropping systems in Wenchi have been greatly influenced by climate change and variability, particularly increased dryness induced by deforestation in the area over the past few decades culminating in a shift from cocoa to maize based cropping system. The shift has become necessary as a result of increasing dryness and frequent bushfires which make establishment of new cocoa farms extremely difficult. The increased dryness was partly hastened by the farming activities of migrant farmers (which involved practices such as hoe cultivation and the use of ridges and mounds) resulting in the loss of the moist micro-climate ideally suited to cocoa production.

Analysis of the rainfall data in Wenchi over the past four decades suggests that declining cocoa production in Wenchi reached its peak during the period that the total rainfall for the four driest months (December-February) a period critical for cocoa production fell below 100 mm. The shift from cocoa to maize by farmers in Wenchi was as a response to the need to replace a humid cocoa crop with a short duration/and or drought tolerant crops which are less sensitive to rainfall variability. Other factors such as declining producer price, land tenure and declining soil fertility have also been blamed for the shift. The Ministry of Food and Agriculture in Wenchi Municipality have been undertaking a number of activities to help farmers to bring back cocoa to Wenchi but these efforts have met with very little success due to increasing dryness, deforestation and annual bushfires in the area.

The prevailing climatic conditions and the deforestation activities in Wenchi suggest that future shift from maize to cocoa based cropping system is unlikely. Adaptation needs of farmers in Wenchi suggest the need to redesign the research and extension support systems to include both technical (new technologies and technical practices such as new crop varieties, adapted cropping system, novel way of improving soil fertility etc) and institutional dimensions (e.g. adapted land tenure arrangement and contract, the re-organisation of input supply and marketing arrangement for the new cropping systems) in order to enhance collective adaptive capacity of the rural communities.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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