Climate Change Responses of Cocoa Farmers in Ghana

Abstract

Background

Undoubtedly, vulnerability and adaptation of the agricultural sector to the adverse impacts of climate change are among the most crucial concerns of many developing countries where agriculture is largely rain-fed. In Ghana, the cocoa sector is the mainstay of the agricultural sector, contributing about 60% of agricultural GDP. The cacao tree is susceptible to the vagaries of climate, a fact which manifests in outbreak of pests and diseases and their pattern, loss of pods and early ripening of young pods, among others. Cocoa farmers have over the years used short-term (coping) strategies and long-term (adaptation) strategies to offset the effects of climate change on their production.

Methods

A field survey of 444 cocoa farmers in Ghana was conducted, using a guided interview schedule.

Results

Farmers' coping strategies included those on crop, soil fertility and soil water management practices. Adaptation strategies included behavioural adjustments (spraying, fertilizer application, weed control, pruning) as well as institutional and technological adjustments (change in variety and increased extension services).

Conclusion

The study showed that farmers who perceived that the climate had changed and had some effect on their production usually employed adaptation measures. Differences in farmers in terms of personal managerial and entrepreneurial capacities and family circumstances influence their responses to climate change. However, one major challenge is to separate the adaptations in response to climate change from adaptations in response to other stimuli, such as market price or government policy changes that farmers face in the real world. Assessing adaptation strategies also provides the information needed by cocoa farmers to increase their capacity to moderate potential damages and to take advantage of opportunities, if any, to survive in a changing climate

Keywords: Climate change, vulnerability, copping strategies, adaptations

Introduction

Climate change is arguably the greatest contemporary threat to agriculture and the livelihood of most people who live and work on land. It is one of the worst environmental, social and economic threats the world has ever faced [1]. The effects are rather more rapid than previously expected, with serious devastating impacts, especially, on developing countries that are particularly vulnerable because of their relatively high dependence on natural resources, and their limited capacity to adapt to a changing climate [2].

Export crops have traditionally been important sources of foreign exchange earnings and revenue to the governments of developing countries. In Ghana, cocoa has been the engine of growth and poverty reduction. Cocoa's share of the income from agriculture has been increasing rapidly, and the existing yield gaps and prospects of continuing high world commodity prices suggest a further growth potential [3].

In Ghana, cocoa has historically been a key economic crop and a major source of export and fiscal earnings [4]. Hence, there is great dependence on the export of cocoa for economic growth and development in Ghana. Over the years, the cocoa industry has played a crucial role in the economic development of the country by contributing significantly to the Gross Domestic Product (GDP), employment generation and eing a major source of Ghana’s foreign exchange earnings. The cocoa sector also contributes to government revenue in the form of export duty, and supports infrastructural development. Most of the foreign

exchange earnings from cocoa are retained in the country thereby boosting foreign exchange reserves of the country. [5].

Ghana's cocoa is known for its high quality due to the slightly low levels of debris and defective beans, higher-than average fat content as well as mild and rounded flavor [6]. However, there have been doubts about the sustainability of cocoa production in Ghana due to the fact that, as in other parts of Africa, the increase in production has been mainly due to expansion in the land area under cacao [7, 8]. This method of expanding production is no longer sustainable, taking into consideration the increase in population and concomitant land-use demands, and the fact that the cocoa crop, like many other crops, thrives best only in certain agro-climatic regions. There is evidence that former cocoa growing areas have now become marginal. Farmers in old cocoa production areas, who found that sales prices barely covered their costs, increasingly turned from cocoa to food production [9]. There may not always be new areas favourable to cocoa production as some old areas become marginal due to climate change. Ghana's agriculture, like other African countries, is predominantly smallholder, traditional and rain-fed, and changes in rainfall patterns, frequency, distribution, duration and intensity affect production levels greatly [10].

Cacao is highly sensitive to changes in climate [11]. Climate change may alter the stages and rates of development of cocoa pests and pathogens, modify host resistance and result in changes in the physiology of host-pathogen/pests interaction, altering crop yields and losses [11]. These changes impact socio-

economic variables such as farm income, livelihood and farm-level decision making.

Undoubtedly, vulnerability and adaptation to the adverse impacts of climate change are among the most crucial concerns of many developing countries. Adaptation is identified as one of the policy options for reducing the negative impact of climate change [12, 13]. Adaptation involves long term initiatives and measures to reduce the vulnerability of natural and human systems to actual or expected climate change effects [14]. Studies have shown that, without adaptation, climate change is generally detrimental to the agricultural sector. However, with adaptation, vulnerability can largely be reduced [15, 16, 17]. Vulnerability studies have therefore shifted their focus from the estimation of impacts to the understanding of farm-level adaptation and decision making. The understanding which is gaining ground is that, while climate change is a global phenomenon, adaptation is largely site-specific [18].

Coping strategies are usually short term measures used to offset the effects of day-to-day changes in climate as seen in changing growing seasons. A common disadvantage for local coping strategies is that they are often not documented, but rather handed down through oral history and local expertise. As site-specific issues require site- specific knowledge, experience has shown that identified adaptation measures do not necessarily translate into changes everywhere, because there are context-specific social, financial, cultural, psychological and physiological barriers to adaptation [1].

It is very important to understand what is happening at the community level, because farmers are the most climate-vulnerable group. The evidence is that, cocoa farmers are not only keen observers of climate change, but they are also actively trying to adapt to the changing climatic conditions.

This study explored indigenous knowledge on perceptions of climate change, vulnerability, adaptations and coping strategies. It discusses the coping as well as the adaptation strategies practised by cocoa farmers in the study area and some constraints faced.

Methodology

Study Area

Ghana's cocoa belt lies in the south of the country (figure 1). The Central and Western Regions were covered in the survey. These areas represent a cross-section of the geographical variation in the cocoa belt. Some parts of the Central Region, have been traditional cocoa-growing areas, whilst the Western Region is a new production area. The Assin Foso cocoa district in the Central Region and the Sewfi Boako and Sekondi-Takoradi cocoa districts, both in the Western Region, were used for the study. The soils in these areas fall under the suitable to highly suitable cocoa soil classification [19].

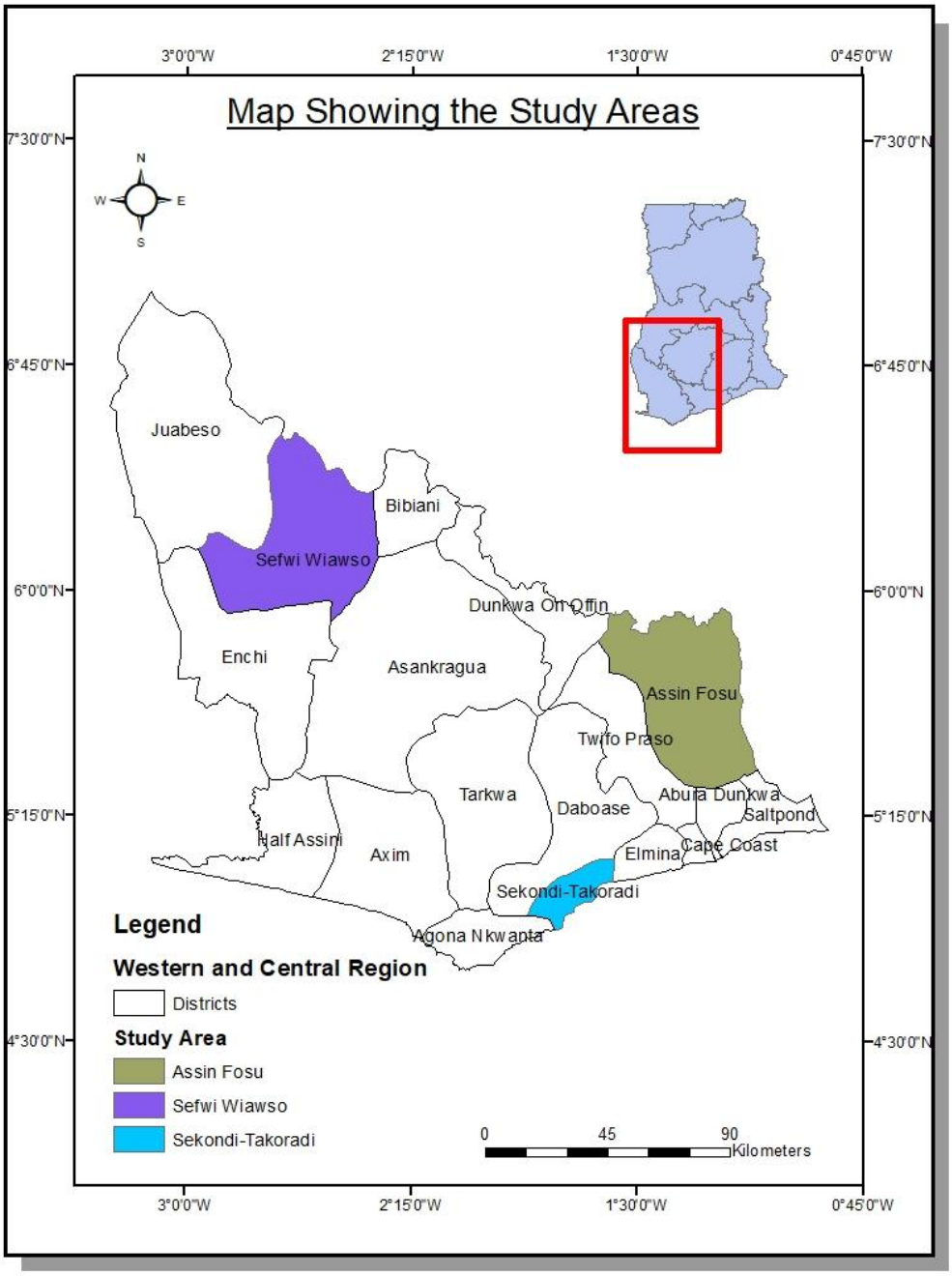

Figure 1: Map showing study areas

The Assin Foso cocoa district lies within Longitudes 1° 05’ East and 1° 25’ West and Latitudes 6 ° 05’ North and 6° 40’ South. The Assin Foso cocoa district falls within the moist tropical, mainly deciduous forest. The area has an

annual rainfall between 1500 and 2000mm. Annual temperatures are high and range between 30°C in March/April and about 26°C in August. Average relative humidity is high, ranging from 60% to 70%.

The Sekondi-Takoradi cocoa district is characterized by an equatorial climate. Temperatures are high, with an average of 22°C. It has a mean annual rainfall of 1,380 millimetres, which is experienced heavily in May and June, with the minor rains occurring between September and October. The climate offers opportunities for varying agricultural production. The Sefwi Boako cocoa district falls within the tropical rainforest climatic zone, with high temperatures between 25^{o}C and 30^{o}C throughout the year. It has a moderate to heavy rainfall between 1524mm and 1780mm per annum, with double maxima characteristics in June to July and September to October. Humidity is relatively high, about 90 per cent at night, falling to 75 per cent during the day. There are two long wet seasons, separated by a short relatively dry season.

To fulfil the objective of this study, a systematic and an integrated methodology was used to collect data for analysis. A field survey was conducted in some cocoa growing communities in the Central and Western Regions of Ghana between July 2015 and February, 2016. Three main participatory research methods were used in conducting the field survey. Key informant interviews, an administration of a guided interview schedule to cocoa farmers and participants' observation were used to solicit information on climate change issues – farmers' adaptation strategies, constraints to adaptation and alternative livelihood options

in the communities. Altogether, 444 cocoa farmers were purposively chosen from 29 communities in the Central and Western Regions. Only farmers who had been in the occupation for 10 years and over were interviewed, on the assumption that they had more experience on climate change observations. In addition, two farmers who had farmed 30 years and over were selected for in-depth interviews since they showed profound knowledge of environmental changes around them. Key issues discussed included awareness about climate change and its observation, impacts on livelihoods, adaptation measures and the vulnerability of the cocoa sector. The data collected were tabulated and statistically analyzed. Descriptive statistics were used to show the various adaptation measures being used by farmers.

Results and Discussion

The study distinguishes between cocoa farmers' short-term and long-term responses to climate variability and change. It defines short-term responses to a decline in cocoa yield and income in abnormal years as coping strategies, and defines longer-term or permanent changes in the ways in which cocoa is produced and income is acquired as adapting or adaptation strategies, after the work of Davies [20].

Coping Strategies to Climate Change

Not surprisingly, 5 out of the 443 cocoa farmers interviewed, though perceiving a change in the climate, did not use any coping strategies. This

number, added to the one person who perceived no change in climate, makes a total of 6 farmers who did not use coping strategies. However, the majority (99%) of those who perceived some change in the climate practised several coping strategies. Farmers' coping strategies included those on crop, soil fertility and soil water management practices.

The various coping strategies used by farmers in response to the perceived changing climate are presented in Table 1. Analyzing the strategies commonly used by all the respondents revealed that intercropping was the most important adaptation made in response to climatic vagaries. In addition to cocoa, most (86%) of the farmers engaged in the production of food stuffs – plantain (*Musa spp.*), cassava (*manihot esculenta*), cocoyam (*Colocasia esculenta*), yam (*Dioscorea spp.*) tomatoes (*Lycopersicon esculentum*), pepper (*Capsicum spp.*) and garden eggs (*Solanum melongena*), among others.

Agro-forestry was the next most favoured strategy adopted by farmers to reduce the effects of climate change. The importance of agro-forestry practices as a climate adaptation strategy has been widely emphasized in many parts of the world [21, 22]. The integration of agricultural systems with trees on the same piece of land can ensure the complementary use of environmental resources that can enhance productivity [23]. A large proportion (60%) of the farmers had grown economic trees such as pears (*Pyrus communis*), oranges (*Citrus sinensis*), and mangoes (*Mangifera indica*) around their farms. In addition to providing shade for the farm, their fruits are sold for additional income. Through education by extension officers, most of the farmers have recognised the importance of

planting economic trees (including commercial timber) on their farms to shade their crops as well as to eke out their livelihood. In sum, agro-forestry systems provide both mitigation and adaptation measures to the menace of climate change [24].

An integrated farming system was the third most popular strategy used by the farmers to combat climate change. A large proportion (58%) of them practised this. In addition to cocoa farming, they kept some animals (poultry, sheep and goats) to augment household demands for protein and also for some ready cash.

Stubble mulching was also practised by an estimable proportion (55%) of the farmers. They left the residue of cocoa husks on the farms after the pods had been broken and the beans removed. Apart from a few farms where women later burnt the cocoa husks for soap making, a large majority of the farmers spread the husks under the trees. This, according to them serves as fertilizer for the farm, in addition to mulching the land to prevent erosion and early loss of water.

Adjusting the farming sequence, including changing the time of raising nurseries and transplanting seedlings to take advantage of the changing climate, with its associated change in heat and moisture levels was another option adopted by 22% of the farmers. To cope with climate change, farmers have developed a wide range of management practices such as increasing shade, dry season vegetable farming and rice farming. The abrupt climate fluctuations such as increasing drought had made some farmers adopt the nursery method which provides for augmenting water demands by watering from nearby streams and wells, and from harvested rain-water, in cases of critical water deficits.

At the early developmental stages of some crops, the use of weather-based index insurance schemes has also been explored in some countries in Africa such as Malawi [25] and Ethiopia [26]. The key principle underlying weather-based index insurance is that the government through its principal agencies, provides insurance against specific climate events like droughts that could destroy crops [27]. Hence, farmers who purchase this weather-based insurance are given specific payments to offset losses incurred from such droughts. Farmers within the same locality pay the same premium and are tied to the same local weather station [28]. Although weather-based insurance schemes hold great prospects for climate adaptation in many parts of Africa, it was the least attractive means of coping with climate change. Only 3% of the farmers used it, perhaps because it had not been popularized. Undoubtedly, agricultural insurance is important, considering the fact that cocoa farming, like any agricultural production, is surrounded by high risks and uncertainties. Through agricultural insurance, cocoa farmers can be saved from losses associated with climate change. According to Ray [29], crop insurance can cushion the shock of disastrous crop losses in a bad year, and help to ensure a considerable measure of security in farm incomes over a long period.

Table 1: ***Farmers' coping strategies***

Coping Strategy	**Frequency (Percentage)**
Intercropping	375(86%)
Agro forestry	262(60%)
Integrated farming system	256 (58%)
Stubble mulching	243(55%)
Change in time of farm operation	97 (22%)

Use of water conservation techniques	87 (20%)
Rain-water harvesting	82 (19%)
Pre-monsoon dry seedling	52 (12%)
Use of insurance	11 (3%)

Source: Field Survey, 2016

Adaptation Strategies

In the cocoa sector, adaptation activities in the face of climate change include behavioural, institutional and technological adjustments.

Behavioural Adjustments by Cocoa Farmers

Cocoa farmers in the study area have improved on their farm maintenance practices, since without proper care, the annual yield of their cocoa farms have fallen, more especially, with the effects of climate change. Some behavioural adjustments by cocoa farmers in the study area are presented in Table 2.

Table 2: ***Behavioural Adjustments by Cocoa farmers***

Behavioural Adjustment					
Spraying Frequency	Never	Once	2 -4 Times	5 – 7 Times	8 or More
	5 (1.1%)	9 (2%)	195 (43.9%)	171 (38.5%)	64 (14%)
Fertilizer Application	Yes		No		
	357 (80%)		87 (20%)		
Weed Control frequency	Once	Twice	3 Times	< 3 Times	
	9 (2%)	248 (55.9%)	160 (36%)	27 (6.1%)	

Source: Field Survey, 2016

Spraying

Many cocoa farmers now sprayed their farms themselves, in addition to the Cocoa Mass Spraying Programme initiated by the government of Ghana in the 2001/2002 cocoa season. However, some farmers depended solely on the mass spraying programme, with the result that no spraying was done in seasons when the scheme failed. Table 2 shows the frequency of spraying by farmers in the study area. Out of the 444 farmers in the study, a very large majority (99%) usually sprayed their farms. Only five farmers (1%) did not engage in any form of pest or disease control. About forty-four percent of the respondents sprayed their farms 2-4 times in a cocoa season. Other farmers (39%) sprayed their farms 5-7 times. Only nine farmers (2%) sprayed their farms only once; and about 14% sprayed 8 times or more.

Fertilizer Application

The effect of soil nutrient deficiency has been reduced in recent years by the timely introduction of the Cocoa Hi-technology Programme in the 2002/2003 cocoa season. Under this programme, farmers were supplied with packages of fungicides, pesticides and fertilizers to help increase the yields per hectare of farm land. The fertilizers were supplied on credit by COCOBOD to the beneficiary cocoa farmers. They paid later by instalments during the ensuing harvesting season (COCOBOD, 2007). Three hundred and fifty-seven (80%) of the farmers interviewed said they applied fertilizer to their farms. Apart from one farmer who applied organic fertilizer in the form of chicken droppings, the remaining 356

farmers used inorganic fertilizers ('assase wura', cocofeed and sidako). Of the number that used fertilizer, 344 (96%) applied it during March to May (just before the major rainy season), with the remaining 13 (4%) applying it between October and November (minor rainy season).

Weed Control

Controlling weeds on both young and mature cocoa farms is very important. Cocoa farmers were asked how often they cleared weeds on their farms, and by what means this was done. Manual weeding of farms was the most practised means of controlling weeds for most (69%) of the farmers. A considerable number – 135 (30.4%) of them used a combination of manual weeding and weedicides. Use of machinery only and of weedicides only were least preferred, with only 2 (0.5%) of the farmers practising each of them. About 2%, 56%, 36% and 6% of the farmers weeded their farms once, twice, 3-times and more than 3-times respectively in a growing season. This shows that with the exception of two per cent of the farmers who weeded only once, the remaining ninety-eight per cent kept to the recommended practice of at least two weedings in a year for matured cocoa farms.

This explains the labour intensive nature of cocoa farming using basic farm tools.

Other Farm Maintenance practices

Both young and mature cocoa farms need regular maintenance. Maintenance is important because every activity carried out on a cocoa farm helps in creating the

needed environment for optimal yield. Apart from spraying, weeding and fertilizer application, other farm maintenance practices examined were pruning, removal of damaged, diseased and dead pods, removal of piles of cocoa husks and removal of mistletoe. Table 3 below shows the results.

Table 3: ***Other Cocoa Farm Maintenance Practices***

Farm Activity	**YES (%)**	**NO (%)**
Pruning	439 (98.9%)	5 (1.1%)
Removal of damaged, diseased and dead pods	430 (96.8%)	14 (3.2%)
Removal of mistletoe on trees	437 (98.4%)	7 (1.6%)
Removal of piles of cocoa husks	49 (11%)	395 (89%)
Drainage of stagnant water on farms	134 (30.2%)	310 (69.8%)

Source: Field Survey, 2016

From Table 3, it can be observed that the vast majority – 439(98.9%) – of the farmers engaged in pruning their cacao trees. This is probably due to the awareness of the importance of pruning in cocoa production given to the farmers by the extension officers. Farmers who pruned their farms could testify that yields had increased. This confirms the findings of Bonaparte [30] and Adjaloo et al.[31] that high light intensity stimulates flowering, while shade decreases or suppresses it. As farmers prune their trees, they reduce shade and hence increase the intensity of light on their farms.

According to 183 (42%) of the farmers who practised pruning, pruning was also used to control the spread of pests and diseases. For 147 (33%) farmers, pruning helped to increase air circulation on their farms which made their cacao trees grow well. The remaining farmers gave increase in yield (16%) and reducing shade (9%) as their reasons for pruning their farms. Pruning eliminates

unnecessary drains from the plant. Thus the photo assimilates produced are directed more efficiently to the production of the fruits. Further in-depth interviews with the five farmers who did not prune their trees revealed that, to them, pruning was wasteful of cocoa pods, since pruned branches often had some young pods on them.

Removing damaged, diseased or dead pods from cacao trees is an important act practised by cocoa farmers on a day to day basis. This helps to control the spread of pests and diseases that may have just emerged on the farms. Early detection helps to avoid spreading and extra cost in treating affected farms. 430 (96.8%) of the farmers interviewed removed dry, dead and diseased pods from their farms periodically. The removed pods were collected in baskets and sent away from the farm.

Mistletoe removal is another important farm maintenance practice in cocoa farming. This improves tree health, as these parasitic plants reduce the amount of food and water getting to branches and pods. Mistletoe left on cacao trees tends to affect their production; and it even kills the trees. When asked whether farmers removed mistletoe regularly, 437 (98.4%) of them answered in the affirmative. Those who did not remove mistletoe from their cacao trees gave lack of capital to employ labour for that purpose as their reason.

The husks of cocoa after harvesting and breaking of pods were left on the farm by 395 (89%) of the farmers interviewed. Some of the farmers said the women in the communities later burnt them for soap making. Where the husks

were not burnt, they were spread under the cocoa trees to serve as manure. However, this practice may serve as a means of spreading diseases and pests, since for most of the farmers, harvested cocoa was carried from other farms to a central point where breaking is done.

Farmers in all 134 farms where water remained stagnant during the rainy season drained their farms. Cocoa trees standing in pools of water often become unhealthy. Stagnant water may also encourage the spread of the black pod disease. Stagnant water on farms is drained by digging small drainage canals.

Changing the frequency and timing of farm practices was a major behavioural adjustment made by cocoa farmers to adapt to climate change and to reduce the effects on their farms.

Institutional and Technological Adjustments

Change of Variety

An important agricultural adaptation strategy is the promotion and cultivation of crops that have shorter gestation periods and are drought resistant. The Cocoa Services Department has developed and promoted this technology among cocoa farmers in the study area. Interviews with farmers and agricultural extension officers backed by field observations, indicate that farmers are cultivating a variety of improved hybrids of cocoa, maize, cassava and cereals that have shorter gestation periods and thrive well under the current climatic conditions. The new cocoa hybrid, 'akokra bedibi', is gradually being accepted and grown by the

farmers, although some are still sticking to the old varieties. This is because farmers, like any other group of people, have differences in the rate at which they accept change[10]. Most farmers are risk averse and will rather maintain their old methods than try a new method with an uncertain outcome. Even where farmers have changed the variety of cocoa they grow, the new variety (akokra bedibi) has been planted on a small scale in addition to the old variety. About 179 (40%) of the farmers have changed the variety of cocoa they grow.

On whether their decision to change the variety of cocoa grown was a result of climate change, of the 179 farmers who had changed the variety of cocoa they grew, 162 (91%) attributed the change of variety to a change in climate.

Improved Extension Services

Another significant institutional adjustment made is the proper zoning of cocoa growing areas into cocoa districts for easy administration and monitoring. More extension officers have been trained and assigned to specific farming communities which they visit on a regular basis. Training and personal farm visits are made so that problems on site are identified early and the appropriate remedies are taken to forestall spreading and total destruction of cocoa farms. Majority (88%) of the cocoa farmers had regular interaction with the extension officers assigned to their communities.

How often extension officers visit a site is very important to help control the spread of pests and diseases, in addition to education on current and improved

farming methods. Cocoa farmers in the study area confirmed an increase in the number of visits to their communities and farms by extension officers. About 72% of the farmers had monthly visits to their farms.

Conclusion

The study showed that farmers who perceived that the climate had changed and had had some effect on their production usually employed adaptation measures. Significant among the strategies used are intercropping and agro-forestry; and the least used strategy is crop insurance. Most of the farmers preferred animal rearing and vegetable farming as alternatives to cocoa farming in the event that climate change drastically reduced their yields.

It is observed that farmers' responses vary when confronted with the same stimuli. Such varied responses, even within the same geographic area, are partly related to the variety of agricultural systems involved and the different market systems in which farmers operate [32]. However, a more important factor of such varied farmers' responses is the differences between farmers in terms of personal managerial and entrepreneurial capacities and family circumstances. Also, farmers can be influenced by their peers' perceptions and by values prevalent in their communities, as well as their professional associations. Hence, there is the need to carefully explore how farmers' choice of adaptation measures is influenced by socioeconomic as well as political characteristics so as to enable region-specific adaptation policies to be designed and implemented.

Assessing adaptation strategies also provides the information needed by cocoa farmers to increases their capacity to moderate potential damages and to

take advantage of opportunities, if any, to survive in a changing climate. Successful adaptation will require the involvement of multiple stakeholders, including policy makers, extension agents, NGOs, researchers, communities and the farmers themselves.

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