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Changes in cocoa farming system and consequences on production and adaptation to climate change in Ghana

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Master's Thesis

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DECLARATION

I do here declare that this thesis, apart from the references made which have been duly acknowledged, is my own effort under the supervision of Professor Jens Bernt Aune, a lecturer at the NORAGRIC Department of the Norwegian University of Life Sciences. I am solely responsible for all errors or omissions that may be found in this work.

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Date ……………………………………………………………

Kwabena Kyere.

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ABSTRACT

In the quest to restore her position as the leader in global cocoa production, the Government of Ghana has made several reforms and interventions in the cocoa farming system, in the areas of institution, marketing, social and agronomic. This study attempts to identify how these changes in the cocoa farming system have contributed to production yield and adaptation to climate change. With the help of multi-stage cluster and simple random sampling techniques, a sample size of seventy-eight smallholder cocoa farmers from seven farming communities within Nsuta Zone in the Techiman Municipality were selected and interviewed through a well-structured questionnaire. The data collected was analysed with Statistical Package for Social Sciences (SPSS) and Microsoft Excel. Descriptive statistics tools were used for the data analysis. The study revealed that shared-crop project scheme (*abunu*) system is the major mode of land acquisition for cocoa farming, which has adverse effects on farm size and cocoa output. The increase of producer price of cocoa to 70% (fob) price as a major market reform has contributed to increase in farmers income, which has made it possible for the farmers to purchase inputs to enhance production and adaptation to climate change. The study also revealed that there has not been much improvement in infrastructure and provision of social amenities in the rural areas and this have had negative impact on cocoa production. 90% of the farmers benefited from the cocoa mass spray and fertilizer subsidy programmes. 87.2% of the farmers who benefitted from these programmes indicated increases in their farm yields. The adoption rate of hybrid cocoa seeds as an adaptation measure was 58%. The study also revealed that the vulnerability level of the farmers, especially those with smaller farm sizes was very high due to low investment in good agronomic practices and adaptation measures resulting from lower incomes. Other factors that made cocoa farmers in the study area more vulnerable to the climate change impacts are low level of education, lack of adequate information on climate change adaptation measures and large family sizes. The major long-term adaptation strategies adopted by the farmers included planting of economic shade trees, diversify income sources and irrigation. The study concluded by suggesting that the government must improve infrastructure in the rural areas to retain youths to increase productivity, ensure 100% coverage of cocoa mass spray and fertilizer subsidy programmes, and promote cocoa agroforestry and planting of hybrid cocoa seedlings as an adaptation measure.

LIST OF ACRONYMS AND ABBREVIATIONS

BRICS	Brazil, Russia, India, China and South Africa
CMB	Cocoa Marketing Board
Cocoa Hi-Tech	Cocoa High Technology
CODAPEC	Cocoa Pests and Diseases Control Programme
COCOBOD	Ghana Cocoa Board
CRIG	Cocoa Research Institute of Ghana
CRP	Cocoa Rehabilitation Programme
CWSA	Community Water and Sanitation Agency
ERP	Economic Recovery programme
FAO	Food and Agriculture Organisation
FOB	Free On-Board
GDP	Gross Domestic Product
GSS	Ghana Statistical Service
IBM	International Business Machine
ICCO	International Cocoa Organisation
ICRISAT	International Crops Research for the Semi-Arid Tropics
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
LBC	Licensed Buying Company
PBC	Produce Buying Company
PPRC	Producer Price Review Committee
SPSS	Statistical Package for Social Sciences
SSNIT	Social Security and National Insurance Trust
TAR	Third Assessment Report (Intergovernmental Panel on Climate Change)

TMA	Techiman Municipal Assembly
UKCIP	United Kingdom Climate Impacts Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCCCAR	Victorian Centre for Climate Change Adaptation Research

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CHAPTER 1

1.0 INTRODUCTION

Cocoa was brought to Ghana by Tetteh Quarshie in 1876 from Fernando Po in the Equatorial Guinea (Howes, 1946). He started a farm in a town called Mampong of the Akwapim area in the Eastern Region of Ghana in the year 1879. Commercial cocoa production started in the 19th century and the first export was made in 1891 (Tweneboah, 2000). Akwapim is regarded as the provenance of cocoa production in Ghana. That is where cocoa plantation started and spread to other parts of the present day Eastern Region of Ghana, and later to other parts of the country where cocoa is produced (COCOBOD, 2010).

As time went by, land became scarce around the Akwapim area in the Eastern Region of Ghana. The migrant farmers who were attracted to the area for cocoa production moved towards the north-west end of Ghana forest zone, that is the present-day Ashanti and Brong Ahafo Regions where they bought lands outright to start cocoa plantation (Hill, 1959, Kolavalli and Vigneri, 2011). Gradually the production frontier was shifted into Ashanti and Brong Ahafo Regions. As production spread northwards, the Ashanti chiefs also showed interest in cocoa farming and cultivated cocoa farms, making the region a dominant producer (Ludlow, 2012). By 1947, the Ashanti, which covers the present-day Ashanti and Brong Ahafo Regions was leading in the production of cocoa in Ghana (COCOBOD). Loss of soil fertility and reduced rainfall have now moved most of cocoa production in the country to the south-western most part of the country (the Western Region), making the Region the hub of cocoa production in recent times.

Between 1911 and 1976, Ghana emerged as the world leading producer of cocoa, contributing 30-40 percent of the global output (Darkwah and Verter, 2014). Ghana however toppled from this position in the mid-1970s, a phenomenon, attributed to several factors including bad weather and unfavourable world market price for cocoa beans (Darkwah and Verter, 2014). Until the 1990s, cocoa share of total export earnings averaged 35% annually. Currently the annual percentage share is below 35%. Despite these challenges, it remains the most important economic crop for the country (Essegbey and Ofori-Gyamfi, 2012). The share of cocoa to Gross Domestic Product (GDP) in 2005/2006 was 8.1% and contributed 22.6% of Agricultural GDP. While 28% of foreign exchange was received from export of cocoa products in the same period (Breisinger et al, 2007).

Cocoa is currently grown in seven regions in Ghana, namely Western North, Western South, Ashanti, Brong Ahafo, Eastern, Central and Volta (Cocobod, 2018). The cocoa sub sector provides livelihoods for over 700,000 farmers and their dependents (Kolavalli and Vigneri, 2011).

The period between 1964 and 1983 saw cocoa production at its low ebb, the sector nearly collapsed. Several factors accounted for this phenomenon. The prominent among them are the 1982/83 outbreak of bushfire, which swept through the entire country causing mass destruction to both plant and animal lives. Large hectares of cocoa farms got burnt and production in the ensuing years dropped significantly (Acheampong, 2014). Around the same period most of the cocoa trees were aged and infested with pests and diseases such as capsid, swollen shoot and black pod diseases (Amanor, 2005). The most devastating factor which almost paralyzed the cocoa sector between the 1964 and 1983 was the simultaneous collapse of the world price of cocoa beans in 1965 and a sharp drop in the real producer price because of high inflation in the country around the same period (Stryker,1990).

The contribution of cocoa to the economy of Ghana and its importance in the support of the livelihood of many people in the country encouraged the government to take programmatic measures to revamp the cocoa farming system and resuscitate it from total collapse through 1983 to2008. In consequence, several interventions were rolled out to revive the sector. First, the government introduced the Economic Recovery Programme(ERP) in 1983, which included special programme to revive cocoa farming system (Cocoa Rehabilitation Project). Under the Cocoa Rehabilitation Programme (CRP), farmers received 52% of the world price of cocoa in 1996/97 crop season (IMF, 1997). And in 1997/98 season, farmers' share went up by 54% of the free on board (f.o.b.) price. Cocoa trees infested with swollen shoot virus were cut down and replanted. Farmers who did that were compensated. In addition, Cocoa Research Institute introduced high-yielding cocoa seedlings to farmers. Another significant change was the restructuring of Cocobod between 1992 and 1995 (Vigneri and Santos, 2008).

Government's commitment to resuscitating the cocoa sector since the 1980s has been phenomenal. Several changes have been made in the cocoa farming system towards this direction. Most of the research work have focus on the impacts of climate change on cocoa production and adaptation of cocoa to climate change. However, there has not been much research work on how changes in cocoa farming system have contributed to both cocoa production and adaptation to climate change. This study therefore seeks to examine the impact of the changes in the cocoa farming system on production and adaptation to climate change.

The purpose of this project is to identify changes that have been carried out so far since independence in the cocoa farming system in Ghana and attempt to find out the effects of these changes on production and adaptation to climate change.

Findings from this study will give stakeholders in the cocoa industry, especially the government, relevant information which will be useful in any future plans and policies towards sustainable cocoa production in Ghana. It will also be useful in the evaluation of current projects in the cocoa farming system and their impacts on adaptation to climate change. Thus, it will help the stakeholders to decide on which of the projects and programmes to promote and which to discontinue.

1.1.0 OBJECTIVE AND RESEARCH QUESTION

1.1.1 Research objective:

To identify the changes that have taken place in the cocoa farming system since independence and their contribution to production and adaptation to climate change.

Specific objectives:

1. To determine effects of changes in the cocoa farming system on production yield.
2. To determine the impact of the changes in the cocoa farming system on adaptation to climate change.

2.1.2 Research Questions:

This study attempts to answer the following research questions;

a. how has the changes in the cocoa farming system from independence impacted on yield in cocoa production?
   b. how has these changes enhanced adaptive capacity of cocoa production to climate change?

1.2.0 THEORETICAL FRAMEWORK

The theoretical framework for this study will cover the areas of farming system, climate change and adaptation (incremental adaptation)

1.2.1 Farming System

According to International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (1974), farming system is defined as "the overall complex of development, management and allocation of resources as well as decisions and activities that within an operational farm unit or combination of such units results in agricultural production and the processing, marketing (and utilization) of the products". A closely related definition is the one given by Tezwani (1974), defining farming system as 'the entire complex of resources preparations, allocations, decisions and activities, which within an operational farm unit or a combination of such units, result in agricultural production. According to FAO, farming system is a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Lastly, Garrity et al, 2012 defined farming system as a population of farm households, often a mix of small and larger farms, that as a group have broadly similar patterns of livelihood and consumption pattern, and constraints and opportunities, and for which similar development strategies and interventions would be appropriate. Often such systems share similar agro-ecological and market access conditions.

Cocoa farming can be described as a system just like any other farming systems. It comprises individual farms, usually mix with small and larger ones. The farmers share almost similar pattern of livelihood in terms of social and economic lives, opportunities and constraints. This makes it possible for the Government to always adopt common development strategies and interventions to deal with issues in the cocoa industry.

Policies such as changes in input and output prices, changes in technological innovations in the production of crop/enterprise often change the cropping pattern/enterprise mix, leading to a change in farming system. Change in consumption habit, risk in farming, economic programme of the Government like production of export oriented, high valued crops, local and regional market demand, farmers own needs and mechanization also change the farming system of a farmer. Such changes may be dramatic when favourable policies are combined with improved technologies (Bhowmick et al 1999). Again, cocoa production system has changed over time in different ways. These changes are in response to a range of factors related to climate change, trade, production, consumption and politics.

1.2.2 Climate Change.

"Climate Change refers to any change in climate over time, whether due to natural variability or as a result of human activity". (IPCC TAR, 2001 a). A more elaborate definition of Climate change was given by IPCC TAR, 2002 b) 12. According to IPCC TAR, climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land-use". "A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." This is UNFCCC version of climate change definition. (Pielke, 2011), also defined climate change as any multi-decadal or longer alteration in one or more physical, chemical and or biological components of the climate system. Pielke's definition gives broader perspective of climate change and will be adopted in this research work.

When climate changes, it affects the entire cocoa farming system, which needs to be adjusted to suit the current climatic pattern in order to reap the benefits of the new climatic system. These adjustments are the changes in the cocoa farming system (institution, market/price, social and agronomic), which when well planned and executed would improve production and adaptation to climate change.

1.2.3 Adaptation

Individuals and organisations have made research into climate change adaptation and have come out with definitions based on their findings and perspectives on the subject. The following are a few of them. IPCC (2007,869), defines adaptation as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. IPCC TAR 2001, identified the following types of adaptation;

Anticipatory Adaptation—Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.

Autonomous Adaptation—Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.

Planned Adaptation—Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Private Adaptation—Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest.

Public Adaptation—Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs.

Reactive Adaptation—Adaptation that takes place after impacts of climate change have been observed.

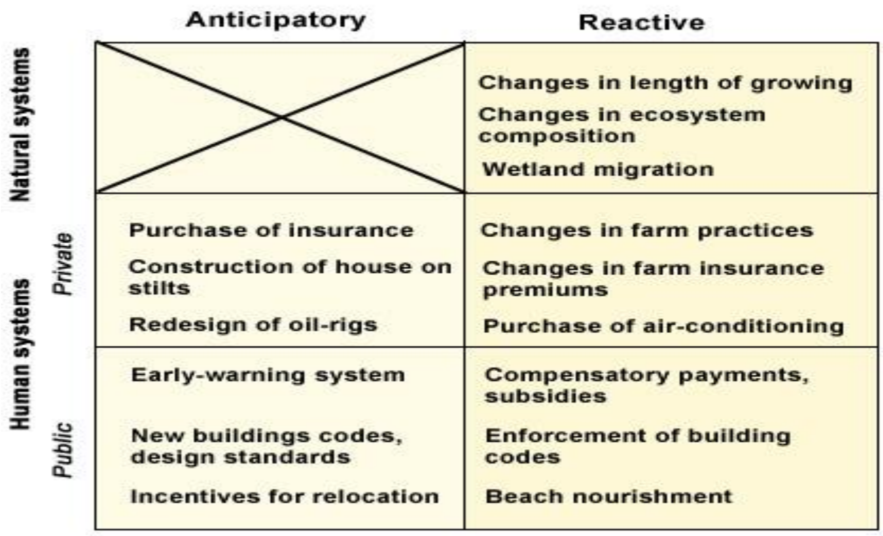

Fig 1: *Types of adaptation to climate change*

Source: IPCC, 2001

Changes in cocoa farming system in Ghana to increase production and adaptation to climate change can be likened to planned and reactive adaptations since it is an afterthought decision in response to the declining cocoa production from 1984.

According to UNDP 2005, adaptation is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented. The UK Climate Impact Programme (UKCIP, 2003) also defined climate change adaptation as, "the process or outcome of a process that leads to a reduction in harm or risk of harm, or realisation of benefits associated with climate variability and climate change". VCCCAR 2018, says adapting to climate change is about taking deliberate and considered actions to avoid, manage or reduce the consequences of a hotter, drier and more extreme climate and to take advantage of the opportunities that such changes may generate.

Cocoa production system is imbedded in economic, social, environmental, political and cultural context which must be clearly considered before options for climate change adaptation can be explored and executed.

1.2.4 Incremental Adaptation

Currently, most of adaptation measures being carried out in the cocoa industry in Ghana are based on incremental adaptation, which has been defined as extension of actions and behaviours that already exist in order to avoid the disruption of a system (Kates et al 2012; Berrang-Ford et al, 2011).

Pelling (2011) defined incremental adaptation as 'adaptation as resilience', when its purpose is enabling the contribution of desired systems' function into the future through the application of technology or social learning, although it can enable unsustainable or unjust practices to persist.

According to Danglade 2014, incremental adaptation is an extension of actions and behaviours to reduce losses and enhance benefits of natural variation in climate change and extreme events. It also includes range of actions to sustain the ability to deal with forecasted change in the near future.

Stafford-Smith et al (2011) expressed that incremental adaptation emphasizes small adjustments to current systems. It implies continuation of certain types of actions in the future with climate change considered.

Lastly incremental adaptation is defined as either alter exposure, decreasing sensitivity, or increasing resilience to cope with change (Adger et al, 2005)

1.3.0 CONCEPTUAL FRAMEWORK

The objective of this study is to determine the consequences of changes in cocoa farming system on production and adaptation to climate change. So far, very little or no study has been conducted specifically into how changes in the cocoa farming system in response to climate change have contributed to productivity and adaptation to climate change. In most of the literatures the focus has been on climate change impacts on farming systems but not on how changes farming systems impact on production and adaptation to climate change. However, there has been evidence of the use of shade agroforestry making cocoa farms more resilient to climate change impacts and increase in output (Asare, 2016). In a study to assess the performance of the diversified Tunisia farming system, the result showed that 55% of the farming systems were resilient to climate change (Souissi et al, 2017). In another study conducted by Olsen et al (2011), it was revealed that farmers across Europe are currently adapting to climate change, in terms of changing crops and management.

Figure 1is a conceptual framework within which this research is organised

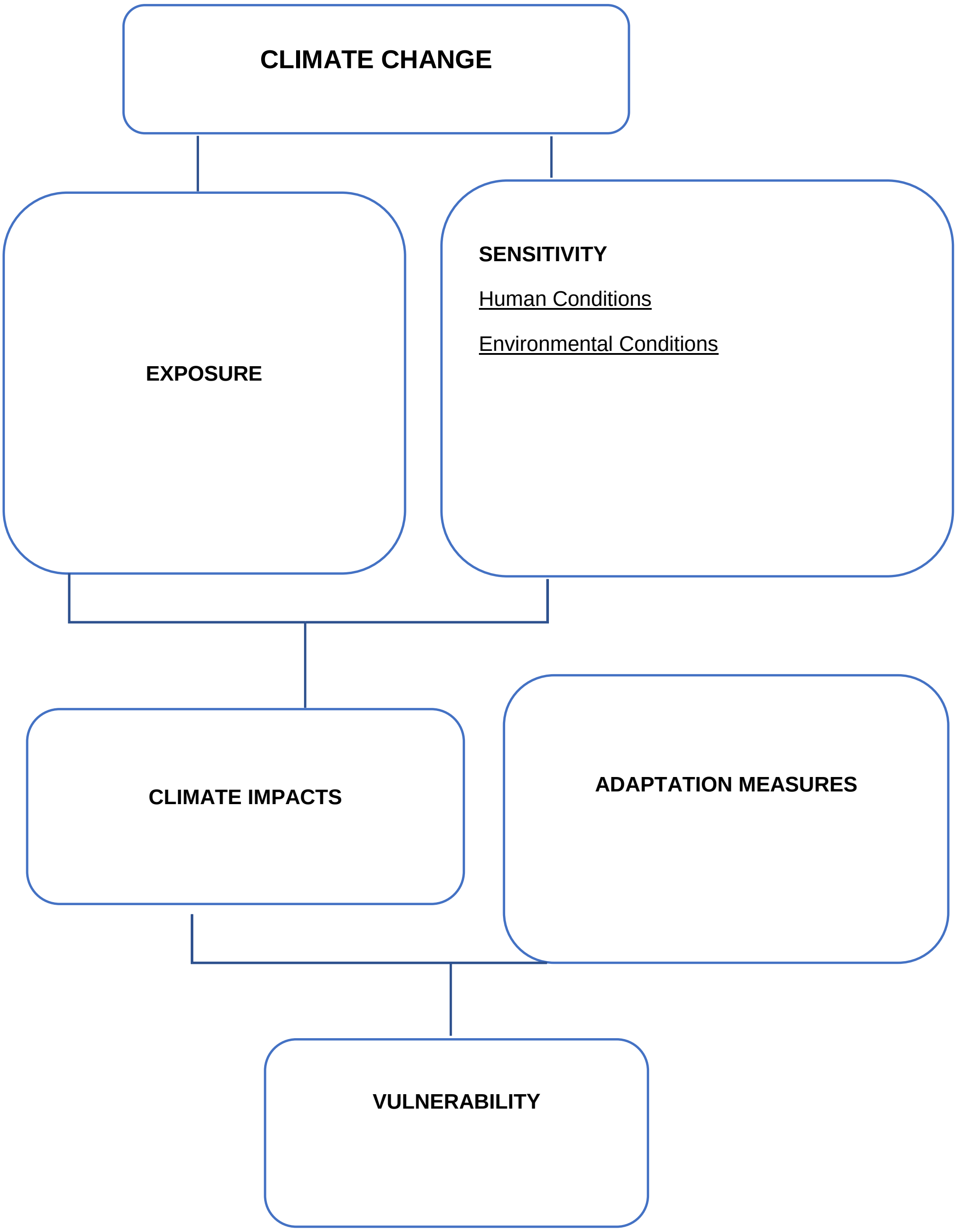

Figure 2: conceptual framework

Source: Modelled from Turner et al 2003 (Vulnerability framework)

Exposer refers to the particular climate phenomena of changing means and extreme events the system will face, such as increase temperature, rainfall variability, reduced humidity etc.

Sensitivity is the extent to which a system is affected by current weather conditions. Or the responsiveness of the system to the current weather conditions

Adaptability is the ability of a system to cope with the current and future effects of climate change.

Vulnerability refers to the susceptibility to, and or inability of a system or humans to cope with the adverse effects of climate change.

CHAPTR 2

2.0 LITERATURE REVIEW

Ghana cocoa farming system has undergone series of periodic changes since its introduction into the country. Some of these changes were in response to a fall in production and or introduction of innovations into the sector. The recent climate conditions more than any other phenomenon have called for more interventions in the Ghanaian cocoa farming system. These changes have had the dual effects on productivity and adaptation to climate change. For this research, the changes in the cocoa farming system will be grouped into institutional, market/price, social and agronomic changes. Climatic conditions necessary for cocoa cultivation will also be reviewed.

2.1 Institutional changes in the cocoa farming system

Until 1940s, prospective cocoa farmers who went to the Akwapim area to cultivate cocoa bought lands to grow cocoa. As population increased due to the influx of migrant farmers, land became scarce. As a result, land owners were no longer willing to make outright sale of their lands. A new system, known as sharecropping (*'abunu' or 'yomayenkye'* in the local parlance) was then introduced in the 1960s to replace the outright sale of lands. Farmers also formed informal labour groups or mutual self-help groups, called '*nnoboa'* in the local language to help on the farm work (Vigneri, Teal and Maamah 2004, Amanor 2010). This *nnoboa* system helped the farmers to carry out their farm activities even in the absence of hired labour. The farmers were helping each other on the farm in turns.

Until 1945, cocoa prices were negotiated between farmers' cooperatives and multi-national cocoa buying companies (Young et al, 1981). This system did not favour the producers because whenever price fell, they were the ones who suffered financial lost. The then British colonial government, in 1947 established marketing board, called Cocoa Marketing Board (CMB) to oversee the price fixing of cocoa beans. The board had the prime objective of stabilising the farmers' incomes (Lundstedt and Pärssinen, 2009). Besides, CMB was mandated to take control over the export of cocoa. And this was done through its subsidiary body called the Cocoa Marketing Company (Lundsted and Pärssinen, 2009). Licensed buying companies were however permitted to purchase cocoa for the CMB.

In 1961, the Cocoa Marketing Board was given monopsony power to purchase cocoa in Ghana. This system however did not last as it was abandoned in 1966 to give way to the reintroduction of the multiple buying system. Again, in 1977, the monopsony system re-emerged, and the Produce Buying Company, a state-owned buying company was given the sole responsibility to operate on the internal market chain (Ministry of Manpower, youth and Employment,2008, p28).

The first major institutional reform in the Ghana cocoa sector was carried out in 1984, which focussed on the restructuring of the Cocoa Marketing Board. Between 1992 and 1995, the board reduced its membership strength by 90%. A staff of about 100,000 was down sized to a little over 5,000. This was to ensure efficiency and cut down excesses to reduce operational cost of the company. In consequence, the board changed its name to "the Ghana Cocoa Board" (COCOBOD) (Lundsted and Pärssinen, 2009).

At the same time, plans were put in place to restructure production by providing farmers with inputs like seedlings to replace aged cocoa trees and also improving on extension work and the use of fertilizers and pesticides. Roads in cocoa growing areas were upgraded for ease of transportation of cocoa beans (van Duursen and Norde, 2003).

In 1993, another reform was carried out. This reform saw the reintroduction of the multiple buying system. As a result, the licensed buying companies were once again given the opportunity to operate on the domestic market together with the PBC (Varangis and Schreiber, 2001). The rationale behind this liberalisation reform was among other things, to introduce competition in internal market to bring about efficiency and possibility of paying higher competitive producer prices to farmers (Laven, 2005).

The most recent reform in the cocoa sector in Ghana took place in the year 2000, when the Produce Buying Company was partly privatised and introduced on the Ghanaian Stock Exchange. Currently, the Ghana Government holds only 37% share of PBC. The Social Security and National Insurance Trust (SSNIT) holds 38% of the shares and others, consisting of institutions and individuals, hold 25% (Essegbey and Ofori-Gyamfi, 2012).

From 2001, this regime of the COCOBOD having sole responsibility of setting cocoa prices changed. A committee, known as the Multi-Stakeholder Producer Price Review Committee (PPRC) was set by the Government to set prices for cocoa beans produced in the country. This committee comprises a representative from the farmers, COCOBOD, Ministry of

Finance and Economic Planning, Hauliers (Transporters) and Licenced Buying Companies (LBCs).

2.2 Market/price changes

Ghana cocoa industry is governed by a marketing board known as the Ghana Cocoa Marketing Board. As part of its mandate, COCOBOD set a guaranteed price for local cocoa beans. And this is done against the backdrop of volatile international market prices. As a result, cocoa farmers are always assured of stable price, and this keep them in production.

Favourable world market prices of cocoa during the colonial regime enabled the Cocoa Marketing Board (CMB) to pay cocoa farmers a relatively higher price for their cocoa beans. This encouraged farmers to increase production through expansion of cocoa farms, leading to doubling of production between 1950 and 1960. The increase resulted in a glut in the world market and this led to a sharp fall in the price of the commodity in the 1970s (Lundt and Par, 2009). The situation in Ghana became worse due to the high domestic inflation and a fixed nominal price paid for the cocoa beans in the country. Consequently, cocoa production fell significantly between the 1970s and 1980s (Amanor, 2005). The boom of the cocoa sector in the 1950s and 60s nonetheless continued until 1973, because of good weather conditions and successful mass-spraying scheme against cocoa diseases (Leith and Soderling, 2003).

Cocoa output began to fall steadily between the late 1960s and the mid1980s, due mainly to low producer prices offered to cocoa farmers. Most of the cocoa farmers however shifted their attention from cocoa production and resorted to other more profitable ventures (Ministry of Manpower, Youth and Employment, 2008). However, statistics indicates increase in cocoa production between 2001 and 2011 (389772-1012839 tons). This increase in output was achieved due mostly to higher producer prices offered to cocoa farmers. Cocoa farmers were paid about 70% of the free on-board (FOB) prices (COCOBOD, 2018).

Before the introduction of marketing boards, cocoa prices were determined in negotiations between farmer cooperatives and multi-national cocoa buying companies (Young, 1981). From 1947 onwards, COCOBOD took over this responsibility as sole agent for the determination of producer prices of cocoa in Ghana, and this continued until 1984 (Amoah, 1998).

Ghana cocoa sector has undergone several forms of price setting mechanisms since the inception of the COCOBOD. First, the COCOBOD set up a special technical committee from within its staff to determine producer price of cocoa every year, subject to government approval. The objective for the use of this mechanism was to maximise government's tax revenue (Quarmine et al, 2014). According to Amoah (1998), COCOBOD developed efficient system that could guarantee maximum export revenue, even under the world price volatility. Based on current and expected export revenue, the technical staff could estimate optimal producer price that would maximise tax revenue. The problem with this mechanism was that it failed to make up for inflationary effects on the farmer's income. As a result, the real producer price paid to farmers was always declining. This however did not encourage farmers to increase production (Ofosu-Asare, 2011).

Following international donors pressure on African countries to move away from government-controlled economies to more liberalised ones, the government of Ghana in the 1984 decided to use multi-stakeholder and more scientific approaches to determine producer price for cocoa (Quarmine, 2014). The objective of this price mechanism was to set producer price which has a closer relation to the costs in the supply chain, and also be at a level that would motivate farmers to increase production. The government therefore set up a multi-stakeholder price system mechanism that implied the payment of a percentage of the net freight on board (net FOB) price that the COCOBOD received when exporting cocoa. The PPRC decided to pay up to 70% of the net FOB price as the producer price. This price to the farmer was considered to be enough to cover the remaining costs and leave him or her some profit (Quarmine et al, 2014)

2.3 Social Changes in the cocoa farming system

Provision of adequate infrastructure in rural areas is very important for growth of agriculture and poor infrastructure has been one of the constraints militating against agriculture development in most of the poor developing countries (Fan and Hazell 2001; Fan and Chan-Kang 2005). Since colonial time, efforts have been made by successive governments to develop the rural infrastructure which will inure to the growth and development of the agricultural sector.

In the 1920s the then colonial administration began construction of road and rail networks in the cocoa producing areas of the country to accelerate production and transportation of cocoa from the hinterlands to the harbour for onward exportation. (Kolavalli and Vigneri, 2011).

Again, the Cocobod Scholarship Scheme, which was initiated in 1951 is part of the Cocobod commitment to improving the education of the wards of the cocoa farmers in Government Assisted Second Cycle Institutions nationwide (Amoah, 2008). Cocobod also promote health through National Health Insurance Scheme and the establishment of cocoa clinics (Amoah, 2008). In 1958, the COCOBOD granted the Ghana Educational Trust an amount of five million Cedis for the building of secondary schools across the country, especially the cocoa growing areas of the country. This was to enable the children in the cocoa growing areas have access to secondary education in their own locality (COCOBOD).

In addition to the scholarship scheme, Cocobod has again initiated the Child Education Support Programme to eliminate the worst forms of child labour. To ensure this, schools in cocoa growing areas are rehabilitated and new ones built in communities where there are no schools (COCOBOD, 2015)

Another significant social intervention in the cocoa farming system in Ghana is the provision of potable water for the people in the cocoa growing areas. The Community Water and Sanitation Agency (CWSA) in conjunction with the Cocobod has made plans to provide safe drinking water from solar water machines to all cocoa growing areas by the end of the year 2013 (Amoah et al, 2016).

Under the climate smart project, there has been outline of policies to improve road network and other social facilities including schools in the deprived cocoa growing communities. This policy is aimed at making life in the cocoa growing communities more comfortable in order to reduce rural-urban migration. In the 2014/15 and 2015/16 cocoa seasons, about 127 contracts were awarded to construct and rehabilitate 1,421kilometre of roads across all the cocoa growing regions of Ghana (COCOBOD, 2016).

2.4 Agronomic changes in the cocoa farming system

Following a huge drop in cocoa production in Ghana between 1964 and 1984, the government adopted measure to restructure the cocoa industry through innovations that would help to increase production and as well promote adaptation to climate change.

Agronomic reforms were some of the key intervention strategies adopted towards this direction. First, through the Cocoa Rehabilitation Programme (CRP) which was introduced in the 1980s, Cocobod initiated the planting of Hybrid cocoa varieties. These cocoa varieties have shorter maturity period than the older Amelando and Amazon varieties. They also have the capacity to produce more fruits (pods) per tree. According to Vigneri (2008), by the year 2002, 57 percent of the farmers in the three-main cocoa producing areas (Western, Ashanti and Brong Ahafo regions) were growing hybrid cocoa.

In 2001, Cocobod initiated free cocoa mass spraying programme with the prime aim of combating diseases and pests that have devastated many cocoa farms in the country. According to a survey conducted by Steeman (2003), 90 percent of the cocoa farmers who participated in the survey linked their yield improvement to the effects of the programme. Another significant reform in the cocoa farming system is the increase use of fertilizer application. According to Kolavalli and Vigneri (2011), fertilizer use by Cocoa farmers in Ghana has increased from 9% in 1991 to 47% in 2003.

The government through the Cocoa Research Institute of Ghana (CRIG) has initiated a programme called Cocoa High Technology (Cocoa Hi-Tech) and Cocoa Pests and Diseases Control Programme (CODAPEC) to improve cocoa yield. The objective of the High Technology of cocoa is to sustain cocoa production by which farmers will increase and maintain productivity through soil fertility maintenance at levels that are economically viable, ecologically sound and culturally acceptable using efficient management resources (Appiah, 2004). This programme emphasizes the use of fertilizer and proper farm management practices to achieve higher cocoa production. To realize the maximum utilization of fertilizer, the programme was made to include other four sub-programme components namely cultural maintenance, application of fungicides, application of insecticides and harvesting, fermentation and drying technologies (Obuobisa- Darko, (2015).

The CODAPEC was introduced in 2001 to assist farmers to control pests and diseases. Production can be increased by weeding twice or thrice in a year, do general pruning and pruning of mistletoes and chupons, and also spray against diseases or pests twice or thrice a year (Obuobisa-Darko, 2015). Studies conducted by Edwin and Masters, 2005 and Vigneri, 2008 indicated positive correlation between production and increase use of fertilizer application on cocoa farms.

Furthermore, cocoa agroforestry is increasingly being recognised as environmentally more sustainable in the tropical forest regions than the other agricultural practices in this era of climate variability (UNDP, 2012.) It is believed that a 30% canopy cover cocoa farm with improved agronomic practices is viewed as agroforestry system that is considered as environmentally sustainable cocoa production that increases productivity (Katoomba, 2009). Cocoa yield can be improved without the use of full sun and agrochemicals, but improved farm management practices such as regular pruning and weeding helps to reduce pests and diseases and increase productivity (Clay, 2004)

As a matter of urgency, agroforestry has been incorporated into cocoa farming system as means of adaptation and mitigation measures by the farmers against climate change. According to Vaast and Somarribal (2014), farmers in West Africa have interest in planting more different types of trees in their farms to sustain cocoa production, diversify revenues, and improve their adaptation capacity. Farmers are advised to plant permanent shade trees a year before the planting of new cocoa seeds. Food crops such as plantain, banana, cassava etc. are usually used to give temporary shade to the young cocoa trees.

2.5 Cocoa Farming in Ghana

The traditional farming system in Ghana is described as ‘extensive farming system’ which involved slash and burn with a fallow period (Yoshida 2008). Cocoa is traditionally cultivated under partially cleared forest or natural shades like its original habitat in the Amazon basin where it grows in shaded rainforest understorey and can reach 20 to 25 metres in height. It was usually mixed with annual and perennial crops on the same piece of land (Asare 2005; Osei-Bonsu et al. 2005; Anglaaere et al. 2011), leaving an agroforest multi-strata system that also maintains a set of ecosystem services for Farmers.

With shortage of land and modernisation of agriculture system, farmers in Ghana have now adopted the hybrid cocoa variety, which can be planted in the full-sun with high chemical inputs for higher yield (Yoshida 2008). Cocoa under full-sun farming system with needed chemical inputs is potentially more productive than those in the agroforest farming system, however they tend to have shorter life span (Rice and Greenberg, 2000). Access to agricultural materials and good prices for cocoa beans in recent times have made it possible for most of the farmers to produce cocoa under full-sun, high-input cocoa farming system (Yoshida 2008).

According to Duguna et al 2001, cocoa farm in a forest-like landscape is considered more sustainable than any farming system. This system therefore has the capacity to withstand the shocks and stresses unleashed by the changing climate.

2.6 Conditions necessary for cocoa cultivation

Cocoa (Theobroma Cacao) is a native species of tropical humid forests on the lower eastern equatorial slopes of the Andes in South America. It is reported that the centre of genetic diversity of Theobroma Cacao is in the Amazon Basin of South America (Afoakwa, 2014)

Cocoa trees require a plentiful and evenly distributed rainfall through the year. An annual rainfall levels of between 1,500mm and 2,000mm is necessary for optimum yield. However too much rainfall can result in the increase incidence of black pod disease (ICCO, 2013).

Cocoa trees need hot and humid atmosphere for optimum growth and development of the trees. A maximum temperature range of between 30^o - 32^o Celsius and a minimum range of 18^o - 21^o Celsius is required for quality cocoa beans (Darkwah and Verter, 2014). Cocoa trees thrive well under shades, especially in the early years (ICCO, 2013).

The ideal soils for optimal cocoa production tend to have an average pH 5.6-7.2 in 1:2.5 water: soil, C/N ratio between 10-12, organic carbon not less than 3%, base exchange capacity of 3-15 me/100g soil available P greater than 20ppm in the 0-5 cm and 15 ppm in 0-20 cm layer (using buffered 0.002N H2SO4 extractant), exchangeable potassium (K) not less than 0.25/100g soil, (Ca + Mg) about 8-13 me/100g soil and no aluminium in the exchange complex (Ahenkorah, 1981)

2.7 Climate Change and Agriculture

There has been a recognition that agriculture has both contributed to and been impacted by climate change. Globally agriculture ranks third after energy consumption and chlorofluorocarbon production as a contributor to greenhouse gas emissions (IPCC, 2001a), and produces one-fifth of it through farming, forestry and land-use changes such as deforestation, tillage and burning practices, volatization of organic and inorganic fertilizers and methane emission from livestock and paddy rice cultivation (FAO, 2016). Agriculture is the major anthropogenic source of methane, a gas with very high ‘global warming potential’, which is on the ascendency at approximately $1\%\,yr^{-1}$ (IPCC, 2000; Wood et al, 2000).

The increase instability and variability of rainfall pattern together with rising temperatures have been the major threat to agriculture production globally. Climate change affects different localities in different ways, with potential benefits to some important food growing areas such as the Canadian Prairies but making agriculture more difficult in many drought prone areas such as sub-Sahara Africa (Hazell and Wood, 2008).

2.8 Climate Change Impacts on cocoa production in Ghana

According to International Cocoa Organisation (ICCO), the emerging economies in the world such as Brazil, Russia, India China and South Africa (BRICS) are going to make additional three percent increase in demand for cocoa by 2020. While at the same time global output will increase at a decreasing rate, creating a gap between demand and supply. Experts predict that by 2020-2025, additional one million tons of cocoa will be needed to meet global demand. This is likely to result in shortage by 2030 and increase in cocoa prices by at least five hundred percent.

To forestall this unfortunate happening, cocoa producing countries such as Ghana and Ivory Coast must make efforts to increase production in the long term. World Cocoa Foundation stated that annual increase in global demand for the past hundred years has been three percent per year. It is also estimated that the global demand will increase by the same levels in the years ahead (Witjaksono and Asmin, 2016).

Several research works have been carried out to find the linkage between climate change and cocoa production. According to Stige et al 2006, cocoa production is heavily dependent on natural factors such as land, rainfall and sunshine. Cocoa is susceptible to high temperatures and drought, as these elements could change the vigour of the cocoa plant. Cocoa seedlings are unable to survive under high temperatures and prolonged drought. Most cocoa flowers fall and wither under high temperatures. In some cases, mature cocoa trees could die due to prolong drought and high temperatures. According to Codjoe et al (2013), climate change significantly changes cocoa pests and pathogens incidence, hence affecting their interactions. They also concluded in the same study that climate change is the main factor affecting cocoa production in Ghana.

In a similar researched conducted by Oseni (2011) in Nigeria, the result revealed that the major climatic factors affecting cocoa production are rainfall and sunshine, as it was attested by 65.6% of the respondents in his study. It also showed high incidence of diseases and pests infestation as the modal effect of climate change on cocoa production.

The impact of climate change on crop production differ from one place to the other. Few studies conducted in Ghana by researchers on climate change and cocoa production have revealed alarming effects of climatic influence on cocoa production (Wiah and Twumasi-Ankrah, 2017). In a research carried out by Anim-Kwapong and Frimpong (2008), in which they estimated the impact of climate change on the dry cocoa beans, their work indicated that 60% of the changes in dry cocoa beans could be accounted for by the amount of preceding rainfall and the total sunshine duration. In 1991, Brew conducted a research study, under the caption “the relationship between yield, rainfall and total sunshine hours”. The results of his study indicated that a year with high rainfall precedes a year with larger cocoa crop output, although this correlation did not apply to all years in Ghana.

2.9 Recent climate trends and projections in Ghana

Temperature: since 1961, mean annual temperature rose by 1.0^{o} C, and average of 0.21^{o} C per decade. The rate of temperature rise was most rapid from the months of April through June (0.27^{o}/decade) (McSweeney et al, 2011). The mean annual temperature is projected to increase by 1.0^{o}C to 3.0^{o}C by 2060s and 1.5^{o}C to 5.2^{o}C by the 2090s (McSweeney et al, 2011). This will increase both day and night temperatures and cocoa becoming more vulnerable under such weather condition.

Rainfall: Annual rainfall in Ghana is highly uneven, making long term predictions almost impossible. However, empirical studies making comparison between 1951- 1979 and 1981 – 2000 at meteorological stations across the country indicated less rainfall (Owusu and Waylen 2009). At the eco-climatic level (Minia, 2008), rainfall is projected to decrease at 2020, 2050, and 2080 in the entire country. The decrease in rainfall tends to increase from north to south, from -1.1, -6.7, -12.8 percent in the Sudan Savanna Zone to -3.1, -12.3, -20.5 percent in the Coastal Savanna Zone for periods 2020, 2050, and 2080, respectively. Absolute change in rainfall is projected to be highest in the Deciduous Forest and Rain Forest Zones (243 and 423 mm decrease by 2080, respectively). These changes are going to have negative impact on cocoa production if practicable interventions are not provided.

CHAPTER 3

3.0. RESEARCH DESIGN AND PLAN

3.1. Study Area.

Nsuta is located south-west of Techiman town under the jurisdiction of Techiman Municipal Assembly in the Brong Ahafo Region of Ghana. It is predominantly farming community, producing mainly food crops on subsistence basis. The main cash crops in this area are cocoa and cashew, and cocoa being the most farmed cash crop. Before the 1983 bushfire outbreak which destroyed most cocoa farms in Ghana, Nsuta was the hub of cocoa production in the Techiman District. Oral history has it that Nsuta once topped the highest producer of cocoa beans in the whole of Brong Ahafo Region.

Frequent bushfires and bad weather conditions such as reduced rainfall and high temperatures made cocoa farming very difficult over the years. These conditions forced most of the farmers to move to the Western Region of Ghana to continue their cocoa farming projects. From the year 2000, due to effective bushfire campaign, which reduced the frequency of bush burning especially in the transitional vegetational zone of Ghana, most farmers at Nsuta rehabilitated moribund cocoa farms and replanted new seeds. As at now cocoa production has assumed a dramatic improvement in the area, contributing its quota to national development.

Fig 3: Map of Ghana showing Brong Ahafo Region

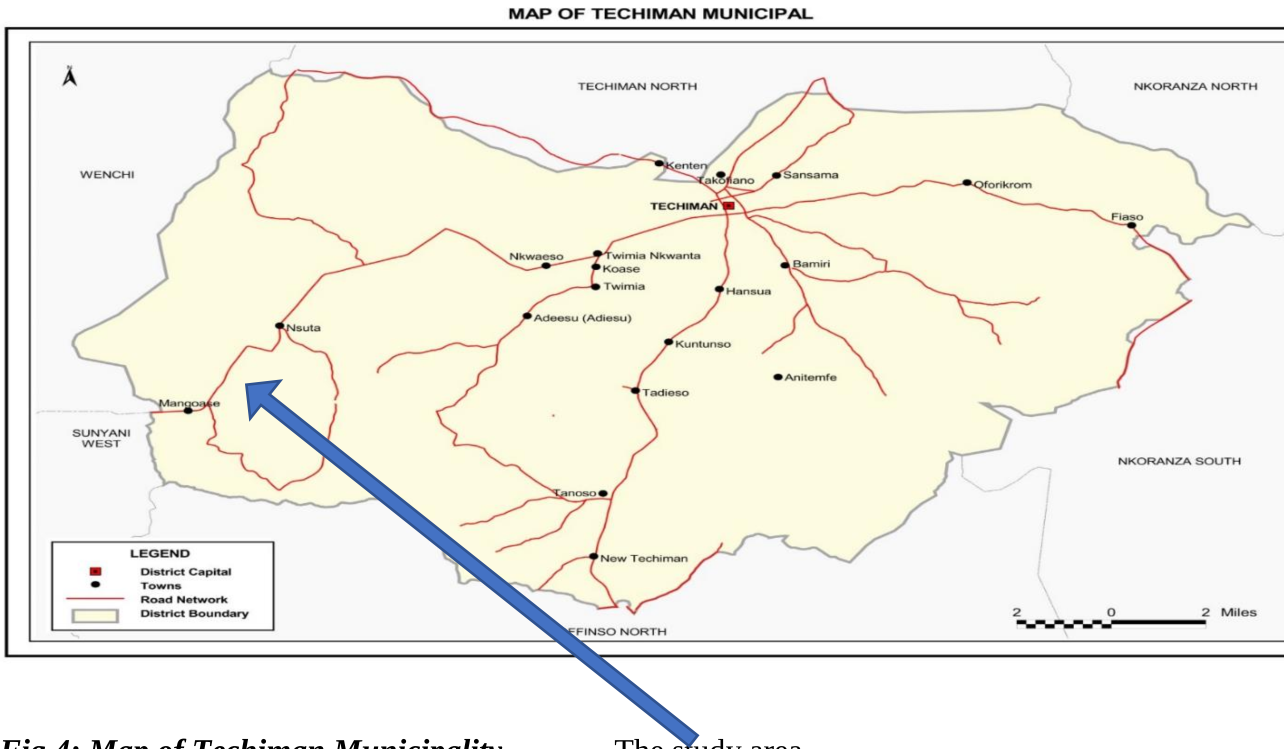

Fig 4: Map of Techiman Municipality The study area.

Source: Ghana Statistical Service, 2010.

3.2 Climate, Vegetation and Soil types of Techiman Municipality.

Techiman is in the middle belt of Ghana and situated in the central part of the Brong Ahafo Region of Ghana. It lies between longitudes 1°49' east and 2°30' west, and latitudes 8°00' north and 7°35' south Ghana Statistical Service 2014). The climate in Techiman is both semi equatorial and tropical conventional or savanna types, marked by moderate to heavy rainfall. The municipality experiences double maxima rainfall characterised by major rains from April to July and the minor rains from September to October. The mean annual rainfall is between 1260mm and 1660mm (Ghana Statistical Service 2014). It has one major dry (the harmattan) season, which is very pronounced, and it is influenced by the North-East Trade winds, which blows across the Sahara Desert into the country between the month of November and lasts until March every year. The average temperature range of the municipality is between 20^0 C (79^0 F) and 30^0 C (80^0 F). The highest temperatures occur in the months of March and April and the lowest is recorded in August (Anaafo, 2011). Relative humidity is generally high throughout the year (TMA, 2006).

There are three main vegetation zones in the Techiman Municipality namely the Guinea Savanna Woodland, located in the north-west, the semi-deciduous zone in the south and the transitional zone, which covers south-east and south-west and up to the north of the Municipality (GIS, 2014).

There are three major soil associations in the Techiman Municipality. These are the Damango-Murugu-Tanoso Association, the Bediesi-Bejua Association, and the Kumasi-Offin Association (GSS, 2014). The Damango-Murugu-Tanoso Association series are developed from the Voltaian sandstone under the savanna vegetation and are red, deep (over 200cm) well drained and permeable. They support crops such as legumes, cotton, maize, yam, tobacco, cashew, cassava, vegetables and others (TMA, 2006).

The Bediesi-Bejua Associations are developed from the forest vegetation and consist of Bediesi, Sutawa and Bejua series. They are very deep, red porous and well drained. They are suitable for crops like cocoa, coffee, plantain, cocoyam and others. They are found around Tanoso, New Techiman, Bamire, Hansua and Asubima (TMA, 2006).

The Kumasi-Offin Association is made up of Kumasi and Offin series. They are developed from Cape Coast granite complex. They also support crops like cocoa, coffee, yam, cassava and vegetables. They are found around Korfoso, Nsuta, Mampong, Sereso, Mangoase and other villages within the Nsuta catchment area in the south- western part of the Techiman Municipality (TMA, 2006).

3.3. Methods of Sampling, Data Collection and Analysis.

Due to the dispersed nature of Nsuta and its surrounding communities, the researcher used a multi-stage cluster and simple random sampling approaches to select respondents for the study. First, a cluster of seven farming communities within Nsuta zone was selected for the study. These communities are Nsuta, Komkrompe/Gyaukrom, Sreso, mampong, Bowohomoden, Nkrankrom and Mangoase. Afterward, a simple random sampling approach was employed to select eighteen (18) respondents from Nsuta, the village with the largest population within the zone and ten (10) respondents each from the rest of the communities, totalling seventy-eight (78) respondents from the seven communities. Since there were no accurate and reliable lists of all the cocoa farmers in all the seven communities, I contacted the chief cocoa farmer in the Nsuta Zone, who at any of the communities summoned the farmers to a meeting through the local information system. From all the communities except Nsuta ten (10) farmers were selected through a lottery-like ballot using cards marked with 'Yes' for selected and' No' for not selected. The same process was followed in Nsuta (the centre of the zone) but eighteen (18) respondents were selected because it has the largest population. The multi-stage cluster sampling was helpful because it helped me to get respondents concentrated in each geographic area (Bryman, 2016). This therefore reduced movement between and within communities, making the whole process cost effective. The simple random sample gives fair representation of the sample (Bryman, 2016). This is because all the prospective respondents in each community had equal chance of being represented for the research survey.

A structured questionnaire was used to collect data for the analysis of the study. Data was collected on variables such as the age, sex, number of years in the industry, size of the cocoa farm, number of bags of cocoa harvest, kind of cocoa breed on the farm, types of shade trees on the cocoa farm and food crops on the farm, farm management practices to ensure higher yield, long term investment to reduce impacts of the climate change, other factors that affect cocoa farming apart from the climate change and so on.

Secondary data from the Ghana Cocoa Board (COCOBOD) website was collected to augment the primary data from the survey. From the COCOBOD, data on output of cocoa in the Brong Ahafo Region between 2000 and 2016 was collected. Again, on various interventions by the government to revamp the cocoa industry, short interview was carried out with the Sunyani District Director of Agricultural Extension Service and the Community Extension Agent, Nsuta Operation Area. Information on producer prices for cocoa over the years were also obtained from the quarterly bulletins on Ghana Statistical Service and Cocobod Websites between 2000 and 2016.

Descriptive statistics was employed to analyse the data collected. Descriptive statistics such as mean, maximum, minimum, mode, frequency distribution, pie charts and bar graph were used to describe the data. Data was descriptively analysed using Microsoft Excel and Statistical Package for Social Sciences (IBM SPSS).

3.4 Limitations and Ethical Considerations

This research, just like any other, was not without some limitations. The research was carried out in an area made up of several farming communities, but due to time constraint only seven of these farming communities was selected and a sample of seventy-eight was drawn from them for the study. The high level of illiteracy in the study area posed a serious challenge for me, as most of the respondents were not able to respond to the questionnaire themselves without appropriately interpreting and guiding them. As a result, research questions were interpreted in the local language for most of the respondents before they could provide appropriate answers.

Another challenge that I faced was transportation. The roads linking up these villages were in bad shape as at the time I was carrying out the survey. Some areas did not have roads at all except few footpaths and farm tracks which were almost impassable due to their bushy nature. This impeded the movements from one village to the other. I found it very tough getting means of transport, especially from Nsuta to Konkrompe/Gyaukrom due to the bad nature of the road. Most drivers were not willing to ply the road, and those who accepted to help charged exorbitantly.

The last herculean challenge was the unavailability of the respondents to answer the questionnaire. Since all the respondents were farmers, they were mostly on their farms during the day time and most of them returned home late in the evening. This meant, I had to meet them between the hours of 17:00 and 19:00, which was very inconvenient for me and my team, and as well as the farmers themselves, because it was at the same time they would prepare dinner.

As a matter of urgency, this research was conducted in an ethically sound manner. The consents of all the respondents who took part in the survey was sought first before the whole exercise began. The purpose and objective of the research was explained to the respondents. The consequences of their involvement in the researched work was explained to them and they were assured of confidentiality of the information they would provide. They were also made to understand that they could withdraw their participation whenever they wished without any constraint. Finally, a consent form was handed to the participants to sign.

CHAPTER 4

4.0 RESULTS AND DISCUSSION

Based on the nature of the research questionnaire and the information collected from the respondents, descriptive analysis was deemed most useful for achieving the objectives of this study. Statistical tools such as frequency distribution, percentages and means were used to present and analyse the variables

4.1 General demographic information of the respondents.

Table 1 Demographic Characteristics of the Respondents

Variable	Frequency	Percentage (%)	Mean	Maximum	Minimum
Age			53.44	78	32
30 – 39	6	7.69			
40 – 49	22	28.21			
50 – 59	24	30.77			
60 – 69	22	28.21			
70 – 79	4	5.12			
Sex					
Male	60	77.00			
Female	18	23.00			
Education					
University	1	1.28			
Diploma	1	1.28			
Secondary	12	15.39			
Primary	43	55.13			
None	21	26.92			
Household Size			7.36	15	1
1 – 5	21	26.92			
6 – 10	49	62.82			
11 – 15	8	10.26			

From the descriptive statistics, majority (66.67%) of the sampled cocoa farmers in the study area were within the age bracket of 30 – 59, indicating that majority of them were in their youthful and productive age with the mean age of 53.44. (Table 1) This confirms the study conducted by Ehiakpor et al (2016) which showed that 73.34% of the smallholder cocoa farmers in Prestea Huni-Valley District in the Western Region of Ghana were within the age of 31 – 60 years. Another research study in the Sefew-Wiawso Municipality by Danso-Abeam et al (2014) also indicated a high percentage (88.46%) of youths in cocoa production.

Age may have influence on adoption of new technologies and adaptation measures because as the age increases, the physical strength tends to reduce, and this will affect the ability to use and implement most of farming practices and adaptation measures since they require some level of physical strength. Most of the farmers being in their youthful age shows good prospect for cocoa farming in Ghana. Since the efforts of younger and youthful farmers will be translated into increased productivity. Younger farmers are also more versatile and can easily adjust their farming system and adopt new farming methods which enhance climate change adaptation.

Out of the 78 respondents, 18 were females representing 23% of the sampled population. The 60 respondents which constitute 77% percent of the respondent's population were males. This also confirms the results of Ahiakpor et al, 2014 and Danso-Abbeam et al 2016 of 57% and 69.23% males respectively, indicating male dominance in land title and hence cocoa production in the cocoa growing areas. The male dominance could also be due to the fact that cocoa farming is laborious and labour-intensive, which women are not able to compete with the men. Again, women in Ghanaian family setting usually play subordinate role to their husbands. Men are mostly considered owners of factors of production in the family. It is expected that male dominance in the cocoa cultivation will lead to high adoption of new farming methods that improve yields and enhance adaptation to climate change. This is because men have more access to credit than women (Akudugu et al, 2009). The availability and accessibility of credit to men make them able to buy inputs and employ new technologies which enhance productivity and adaptation to climate change.

It is generally believed that formal education has positive effects on adoption of new technologies, because with higher level of education the farmer is able to technically and economically assess the new technology and its usefulness. Farmers with formal education also tends to adopt and adjust to new and modern farming methods easily**.** It was revealed in the study that 26.92% had no formal education, 55.13% had primary education, 15.39% had secondary education and both diploma and university education constituted 2.56%. This support the results of Aneani et al 2012, which revealed high level of low education among cocoa farmers in Ghana. The high illiteracy rate will have affect the ability of most cocoa farmers to adopt the new farming methods and innovative measures to promote adaptation to climate change.

The average household size of the respondents is 7.36. The minimum household size was 1 and the maximum being 15 persons. 62.82% of the respondents had a household size from 6 to 10. This supports the view that smallholder cocoa farmers mostly depend on family labour for their farm works. The larger the family size the more family labour will be available, and this will enable the farmer to adopt the new farm management practices and adaptation measures which are labour-intensive. The use of family labour helps the smallholder cocoa farmers to reduce cost on labour. Cocoa farming is labour-intensive, and poor smallholder cocoa farmers with large family sizes can carry out on farm activities with the help of their family members. In another instance, large family can limit the ability of smallholder cocoa farmers by putting high financial burden on the cocoa farmers. As a result, they unable to purchase farm inputs to increase production and adaptation.

4.2.0 INSTITUTIONAL REFORMS

4.2.1 Respondents' experience in cocoa cultivation

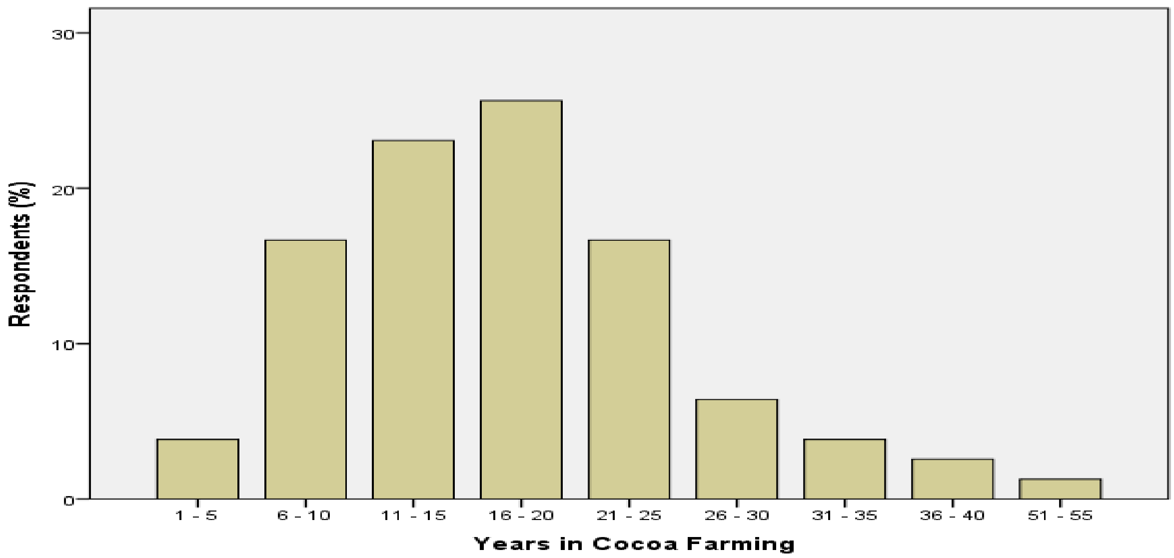

Fig 5 Experience of farmers in cocoa cultivation

Figure 5 represents the experience of cocoa farmers in the area under study. Most of the farmers (25.6%) had 16 to 20 years farm experience. Only 3.8 percent of the respondents had

1 to 5 years of experience in cocoa business. The maximum number of years was within the range of 51 to 55 years, and only 1.3 percent of the respondents fell within this range. This result is in conformity to recent study by Danso-Abbeam et al (2014) who reported 15 years and above as the experience of most cocoa farmers in Ghana. According to Denkyira et al (2016), years of farming experience have positive relationship with the usage of pesticides and other farm management practices. Farmers with more years of experience in cocoa cultivation tend to have higher yield per hectare compared to those with less experience Kumi and Daymond (2015). The modal years of 16 to 20 years in cocoa farming offers the farmers more practical knowledge in farm management practices which will inure to increase yield and adaptation to climate change.

4.2.2 How cocoa plots were acquired by respondents

Figure 6 describes the various means by which the respondents acquired land for their cocoa farms. 45 respondents out of the total number of sampled population, representing 58%, acquired land for their cocoa farm project through shared project scheme (*Abunu*) (Figure 6). This corroborates the findings of Asamoah and Owusu-Ansah (2017), which found a plurality of farmers 25.1% acquiring land by sharecropping system or the *abunu*.

Land acquisition plays significant role in cocoa production. Availability and accessibility of cocoa land is a major determinant in cocoa production in Ghana. Since majority of the farmers acquired their land through shared project scheme (*abunu*), their cocoa farm sizes tend to be smaller, because it is shared with the land owner. This explains why average farm size of smallholder cocoa farmers are generally small. This affects the income levels of smallholder cocoa farmers and makes it difficult to carry out most of the agronomic practices that lead to increased production and adaptation to climate change.

Fig 6. Modes of land acquisition

4.2.3 Types of labour used by cocoa farmers

The most common form of labour used by the farmers was family labour, followed by hired labour and self-employed labour (figure 7).

The use of family labour among smallholder cocoa farmers is of great importance, due to the high cost and unavailability of labour. Cocoa farm in Ghana is operated as family venture and as such, most smallholder cocoa farmers rely mostly on family labour and in some cases hired labour for their farm activities. Family labour is very helpful since they are used at a minimal cost to undertake most of the labour-intensive modern agricultural practices. This may explain why rural farmers in Ghana favour large family sizes. The move by the government to abolish the use of child labour in the cocoa industry may have negative effects on production and adaptation measures. The reason being that smallholder cocoa farmers, for a long time depended on family labour which involved the use of children for certain kinds of activities on the farm. So, any attempt to abolish this practice is going to have serious consequences on farm management practices and adaptation measures since most of the smallholder cocoa farmers do not have resources to hire labour for such farm activities.

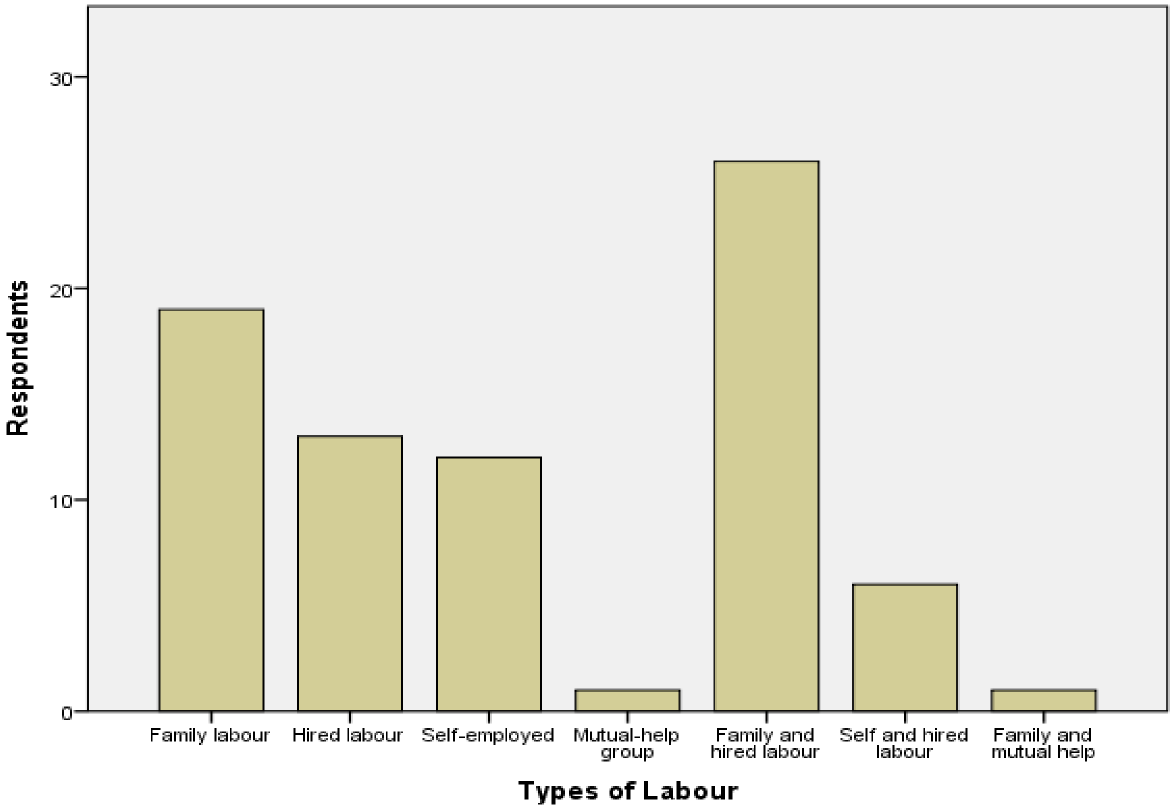

Fig 7: Types of Labour

4.2.4 Respondents' evaluation of performances of Cocobod

Respondents were asked to give their opinion based on the current performance of Cocobod towards the growth and development of the cocoa industry in Ghana. The large majority (figure 8) being satisfied with the performance of Cocobod confirms the report of Williams (2009) about the impressive performance of Ghana Cocoa Marketing Board.

Cocobod has contributed significantly towards sustaining the cocoa industry in Ghana. Through its subsidiary institutions like Cocoa Research Institute of Ghana (CRIG), Cocobod has provided improved cocoa seeds, which have higher yielding capacity and more tolerant to the climate change impacts. They have also provided among other programmes and projects

Cocoa Mass Spray programme to fight diseases and pests like swollen shoot, black pod, capsid and so on.

The efforts of Cocobod has lessened the burden of most smallholder cocoa farmers who do not have the resources to implement some of the adaptation programmes such as planting of hybrid cocoa seeds/seedlings, economic trees for shading, chemical spray against pests and diseases.

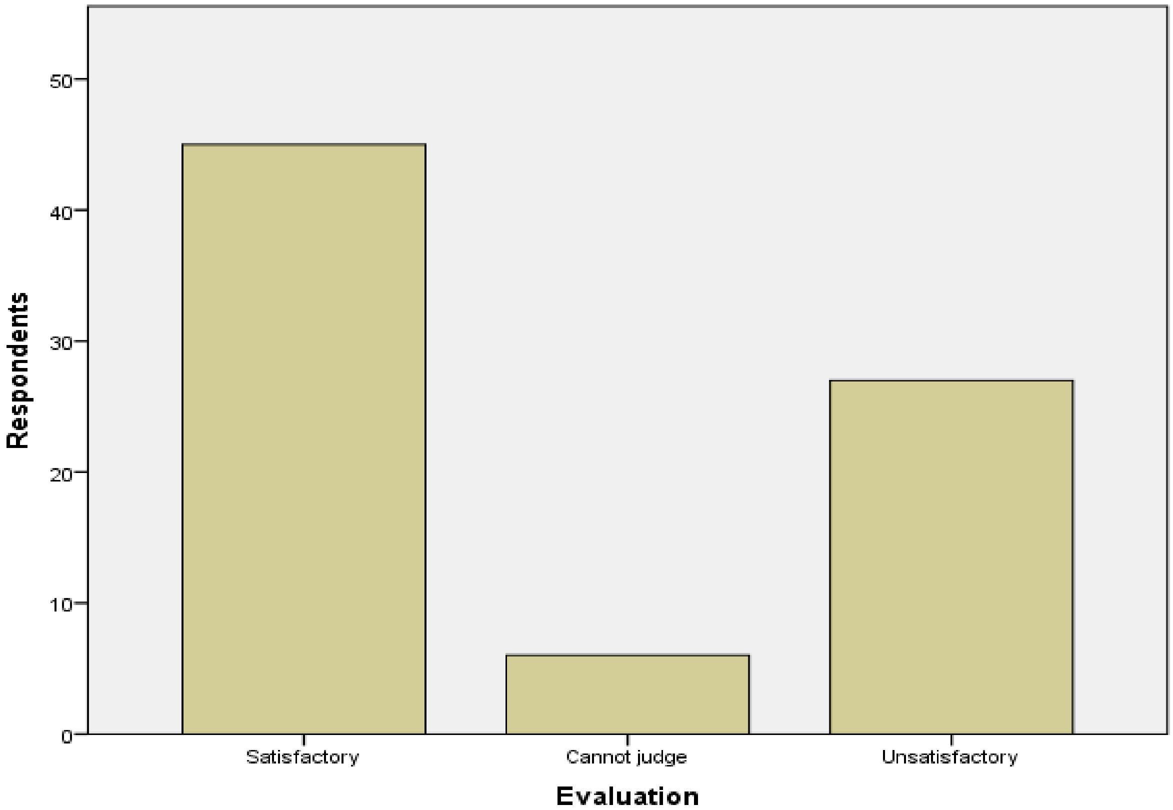

Fig. 8 Respondents' evaluations of performance of Cocobod

4.2.5 Respondents choice of purchasing agent

Table 2 Respondents' preferred purchasing agent

Purchasing Agent	Number of Respondents	Percentage (%)
Produce Buying Company (PBC)	11	14
Licensing Buying Companies (LBCs)	67	86
Total	**78**	**100**

Table 2 highlights the choice of cocoa purchasing agents among the respondents in the study area. The majority (86%) chose to sell their cocoa beans to the Licensing Buying Companies (LBCs) (table 2).

4.2.6 Reasons for the Choice of Purchasing Agent

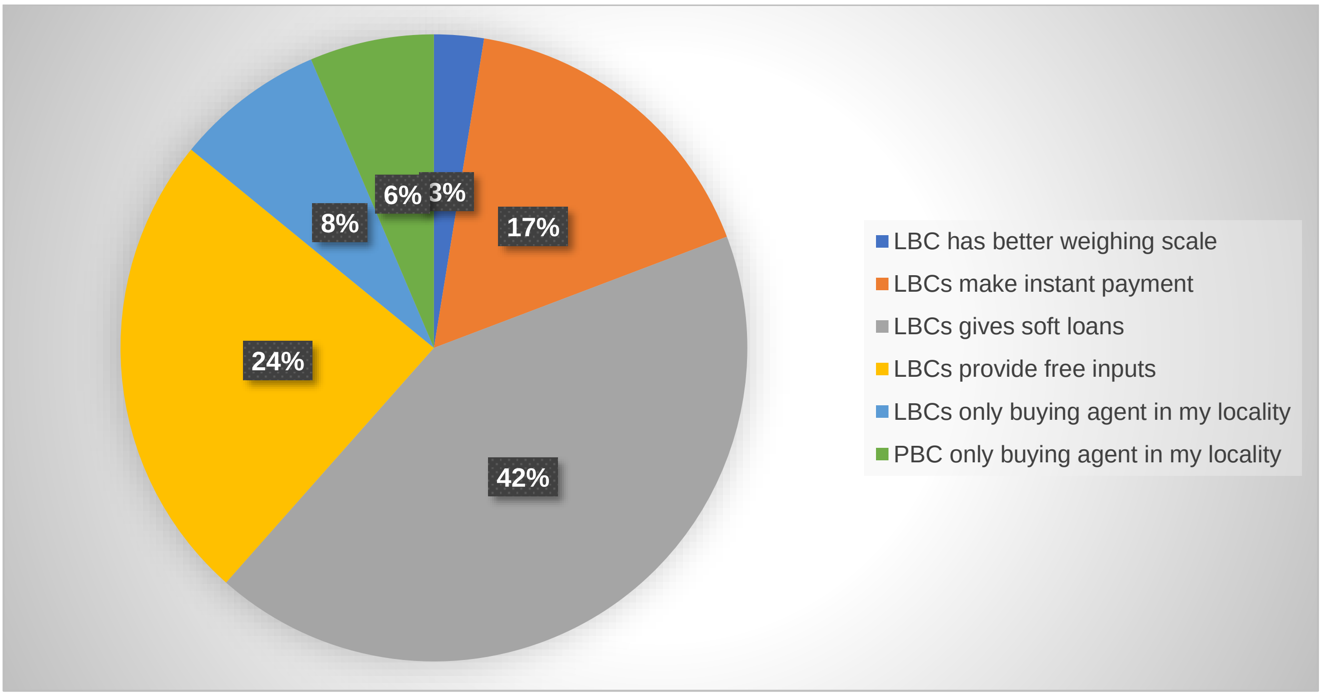

Fig. 9 Reason for the choice of Purchasing Agent

Figure 9 gives summary of the reasons for the choice of purchasing agents. Those who sell to the Licensing Buying Companies (LBCs) assigned the following reasons. 42% of the respondents said they could receive loans from the purchasing clerks without interest ('soft loans'). 24% also indicated that the LBCs provided them free cocoa farm inputs. Other reasons were instant payments upon selling their cocoa beans to the LBCs, the LBCs being the only purchasing agent in their locality and the use of good weighing scales by the LBCs. The last 6% of the respondents who sold their cocoa beans to the PBC gave the reason that it was the only cocoa buying agency in their locality.

From the above it is clear that smallholder cocoa farmers have preference to Licensing Buying Companies. According to Lundstedt and Pärssinen (2009), the LBCs do not compete with the PBC in prices, instead they offer benefits related to cash payment, different incentive packages which may include credit, subsidised inputs, use of accurate weighing scale and organising farmer forums among others. In some cases, they allow farmers to select their own purchasing clerk. These strategies might have contributed to the high preference of LBCs to the PBC by the cocoa farmers.

Farmers get new ideas on how to improve production and adaptation to climate change during the forums organised by PBCs for farmers. Besides, credit packages and subsidised inputs help farmers to get inputs for the maintenance of their farms to increase production.

4.3.0 MARKET REFORMS

4.3.1 Expansion of cocoa farm based on the current cocoa price

The overall picture showed that 44% of the respondents were strongly encouraged by the current cocoa price to expand production (Figure 10). This was followed by 31% of the respondents who also have desire to expand their cocoa farm based on the current price. The high percentage of respondents' readiness to expand their cocoa farms based on the current cocoa price is an indication of cocoa farmers' satisfaction with the 70% of the net free-on-board price paid by the Cocobod to the cocoa farmers (Laven, 2012). Only 23% of the respondents were not motivated by the current cocoa price to expand their cocoa farms.

Increase in farm gate prices of cocoa has been the most influential drive in expansion and increase in cocoa production in Ghana (Wessel and Quist-Wessel, 2015). The oscillation of producer price of cocoa from the1960s to date has been the major determinate of cocoa output in Ghana. While low producer price in the 1960s to the mid-1980s affected production negatively, increased in producer price (70% fob price) from 2001 triggered an increase in output from 389772 tons in 2001 to 1012839 tons in 2011 (Cocobod, 2018). According to Anim-Kwapong and Frimpong (2004), whenever prices of cocoa beans exceed variable cost farmers intensify farm management activities like investing in harvesting, weeding and the use of inputs. However, when price falls, they stop with maintenance and new planting activities.

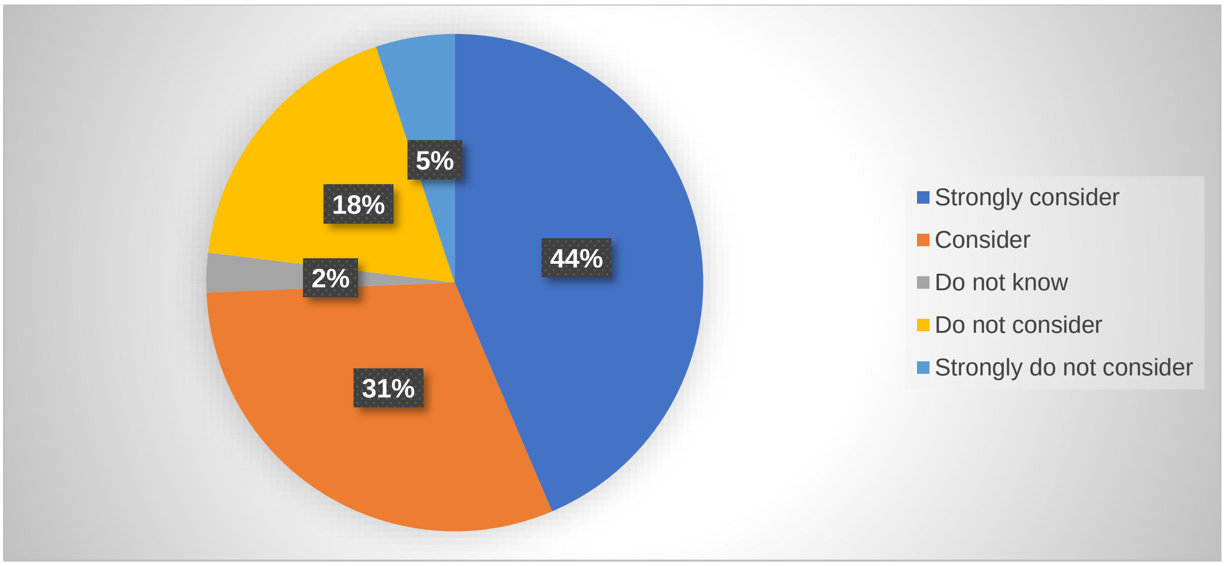

Fig 10 Expansion of cocoa farm based on current price

4.3.2 Cocoa Bonus received by the farmers.

Cocoa bonuses are incentive package provided by Cocobod to motivate cocoa farmers to remain in cocoa production and increase productivity. According to the farmers, it was announced that bonus would not be paid in 2017/2018 crop season following a drop in the world price of cocoa beans. However, some purchasing clerks of LBCs went ahead and paid bonus as a way of motivating and retaining their customers. This may explain why 67% of the farmers received bonus. and the remaining 33 percent did not

4.0 SOCIAL REFORMS

4.4.1 Number of respondents' wards in School.

The study revealed that every respondent in the study area has at least one ward in school (Fig 11). Most of the respondents had 8 wards in schools. This is an indication that cocoa farmers in Ghana have many children to take care of. This result is consistent with the national population structure. The result of 2010 Ghana population and housing census showed that 38.3 percent of the population are children under fifteen (15) years, most of whom are at school going age (GSS, 2012).

The large number of wards in schools put additional burden on farmers income, which affects their ability to maintain most of the farm management practices such as fertilization, chemical spraying which will lead to increase productivity; and adopt measures to increase adaptation.

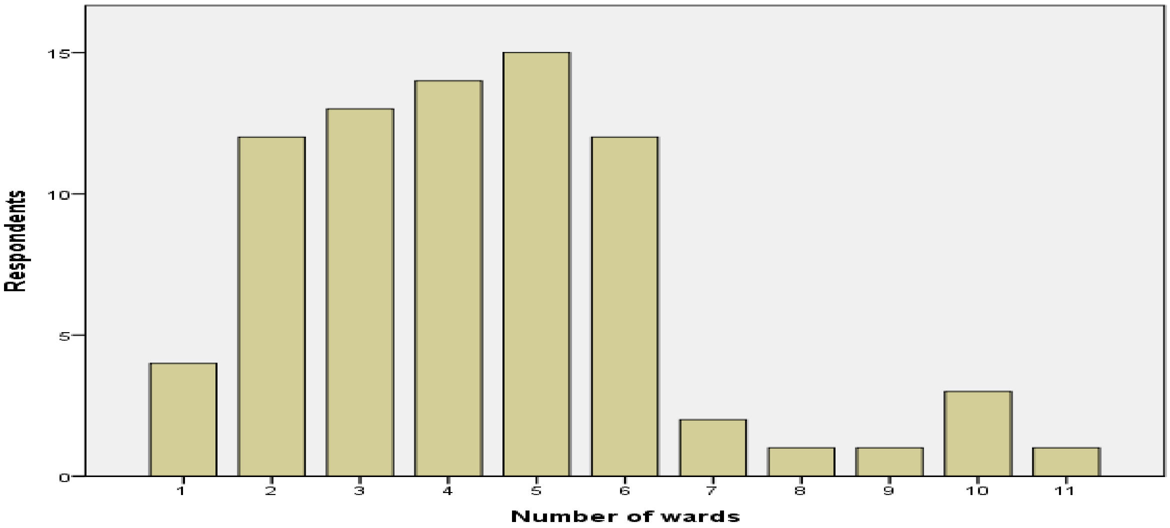

Fig. 11 Number of wards in school.

4.4.2 Cocoa Farmers Scholarship Scheme.

Cocoa farmers scholarship scheme is one of the numerous social interventions of the Cocobod to help and motivate cocoa farmers by awarding scholarship to their wards at the second cycle level of education. The study however revealed that most of the respondents (92%) in the study area have not been able to acquire this scholarship for their wards at the secondary school level. Only 8 percent have had cocoa farmers scholarship for their wards at the secondary school level.

According to Results from Development Institute (2015), the estimated average total cost of secondary education per student per year in Ghana is 793.00 Ghana Cedis and 1218.00 Ghana Cedis in government and private institutions respectively. This is huge money for the smallholder cocoa farmer. Acquisition of scholarship for their wards at the secondary school relieve the farmers of financial burden to cater for the expenses of their wards in schools. These funds which should have been expended on secondary education could be channelled into maintenance of their cocoa farms to increase production and adaptation to climate change.

4.4.3 Nature of Roads in the Study Area

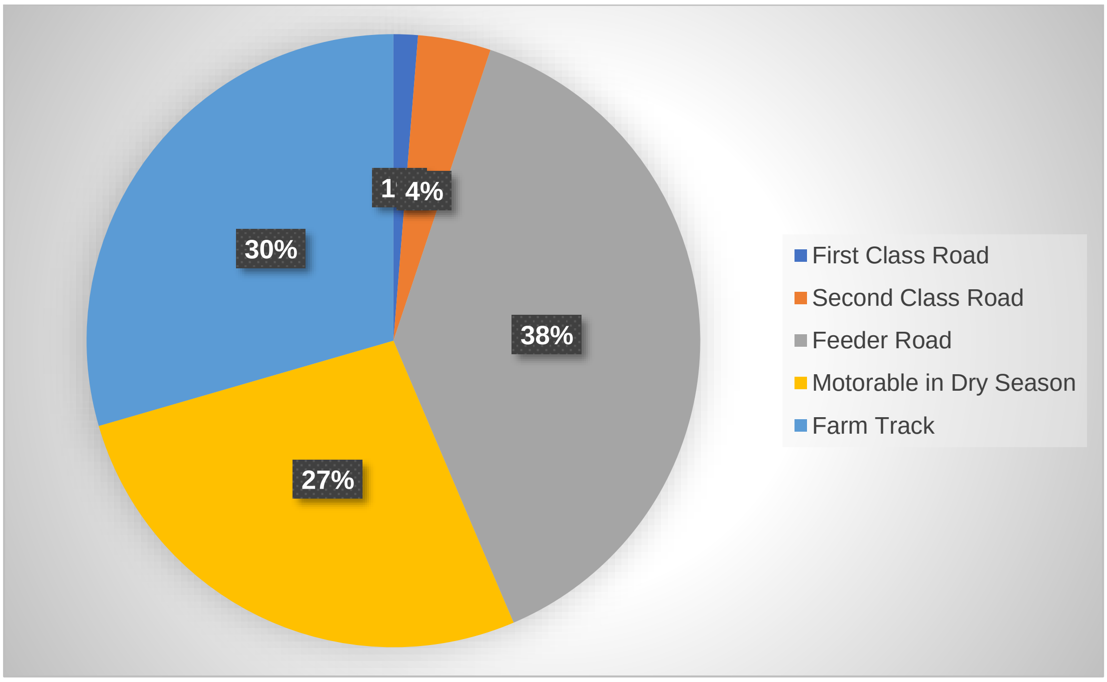

Fig 12 Nature of Road from the Farm to the nearest Town

Figure (12) presents the nature of road network in the study area. Almost 60 percent of road network in the study area can at best be described as poor. According to Mohammed et al (2011), lack of access roads in the cocoa growing areas is a major constraint to the expansion of cocoa production in Ghana. Availability of good roads linking cocoa growing communities to the urban centres contribute to easy movements of goods and people to and from rural areas. As a result, energetic young people are retained in the rural areas where they can work to increase productivity.

4.4.4 Schools in the cocoa farming communities

The study found out that most of the communities in the study area lack schools. Cocoa farming is cultivated in rural areas where most social amenities are lacking. Availability of amenities like schools, electricity and health centres make life in rural areas more conducive, thereby attracting and retaining youths who can contribute greatly to cocoa production.

Parents can send their wards to school and can have time to concentrate on their farm activities. Lack of these amenities is a setback to cocoa production.

4.4.5 Main source of Lighting in the Farm House

Figure 13 presents the results on the main sources of lighting for the respondents in their farm houses. Majority of the respondents (52%) used torchlight. Only (17%) used electricity. According to Dormon et al (2004), lack of amenities like electricity in rural areas of Ghana is a major cause of rural-urban migration leading to labour shortage and high labour cost, a phenomenon which results in low crop production. Government in recent times has stepped up efforts to improve rural electrification projects as a way of bringing development, employment, reducing poverty; and most importantly retention of youths in rural areas to bring about increased agricultural productivity.

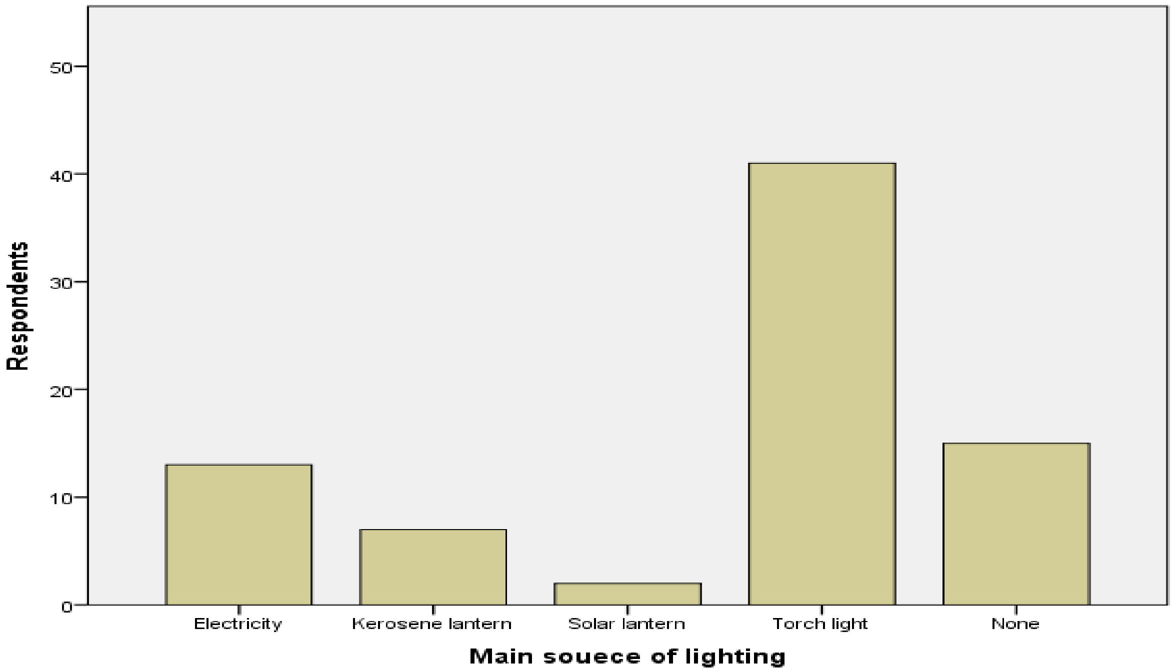

Fig 13 source of lighting

4.5.0 AGRONOMIC CHANGES IN COCA FARMING SYSTEM

4.5.1 Total cocoa farm size

Respondents were asked to give the total size of their cocoa farm(s). Since farmers are more conversant with acres, they initially stated the total sizes of their cocoa farms in acres and the results were converted to hectares for consistency. The results indicated that about 63 percent of the farmers had total cocoa farm sizes of between 0.10 – 5.00 hectares (figure 14). Only 2.56% of the respondents had total farm sizes of between 15.10 -20.00 hectares. The results of this study are in close relation with Danso-Abbeam et al (2012) who revealed that most smallholder coca farmers in Ghana have farm sizes between 1-5 hectares. In another study conducted by Anim-Kwapong and Frimpong (2004), the total farm sizes of most smallholder cocoa farmers range between 0.4 to 4.0 hectares.

Given the small sizes of their farms, production is always low. Low production reduces the incomes of the farmers making it very difficult to meet their household needs and at the same time have enough money to buy farm inputs. This has affected the ability of most farmers to maintain their farms to increase yield and also adopt most of agronomic and adaptation measures to improve productivity and adaptation to climate change.

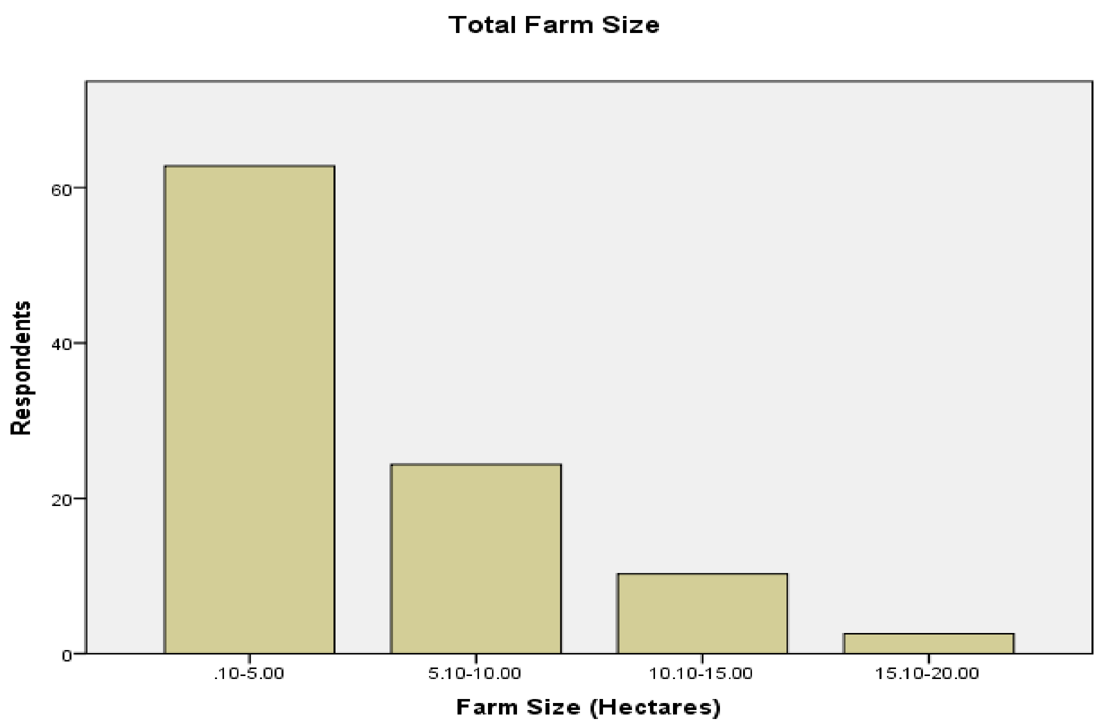

Fig 14 Cocoa farm size

4.5.2 Age of Cocoa Farm.

The mean age of the cocoa planting in the study area was 16.23 years (Table 3). This is an indication that most of the cocoa farms are above their maximum production age. According to Ngala (2015), cocoa trees produced their maximum yield between the ages of ten (10) and twenty (20). Age of cocoa farm has direct bearing on yield. Productivity of most cocoa farms begin to drop from twenty years onwards. To increase production, the government has launched a large rehabilitation and replanting schemes, which provides improved cocoa varieties, chemicals and fertilizers to cocoa farmers to increase production (Wessel and Quist-Wessel, 2015).

Table 3 Age of cocoa farm (years)

	N	Minimum	Maximum	Mean
Age of cocoa farm	78	2	38	16.23

4.5.3 Bags of cocoa harvested by farmers in the 2017/ 2018 cocoa season

Table 4 gives the summary of cocoa harvest in the last major cocoa season. A bag of cocoa weighs 64kg ('Accra weight'), which is the Producer Price Review Committee's (PPRC's) unit of 64kg per bag (Quarmine et al, 2012). The mean number of bags was found to be 18.46. Minimum and maximum number of bags were 1 and 70 respectively. The yield per hectare of cocoa farm in the study area was generally low, which was attributed to factors like the impacts of the climate change, non-adoption of research recommendations and low income of farmers to undertake proper farm management practices and implementation of adaptation measures to bring about increased production.

Table 4 Bags of Cocoa harvested (kg)

	N	Minimum	Maximum	Mean
Bags of cocoa harvested (64kg/bag)	78	1kg	70kg	18.46kg

4.5.4 Trend of cocoa production in Ghana since 2000.

The general trend of cocoa production in the study area since the year 2000 showed increased production, though marginally (fig 15). This is in line with the national output trend, which according to statistics on Cocobod website (2018), increased from 389772kg in 2000 to 778044kg in 2016. The success story of this increase has been the results of increased producer price of cocoa, the mass spray programme, intensification of the work of Agricultural Extension Service and adoption of agronomic and adaptation measures.

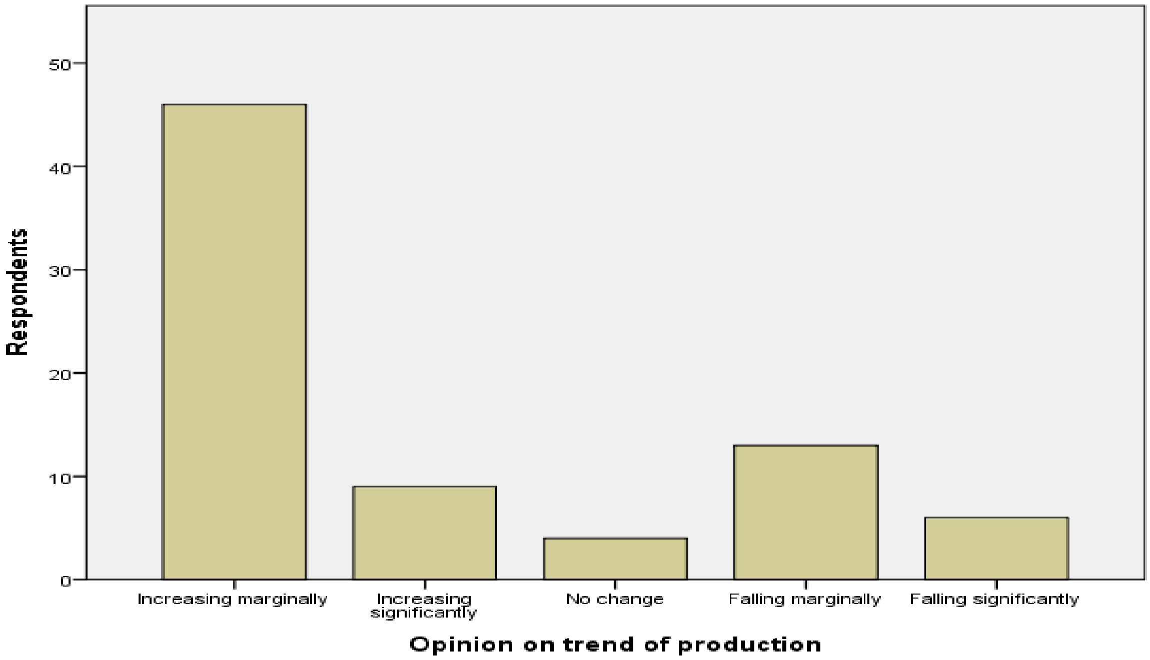

Fig 15 ***Trend of Cocoa output since 2000***

4.5.5 Cocoa Mass Spray and Fertilizer Subsidy Programmes

In 2001, the Government of Ghana introduced the Mass Cocoa Spraying Programme with the objective of helping cocoa farmers fight against cocoa pests and diseases. This programme was followed up with the reintroduction of fertilizer subsidy programme in 2008 to increase agricultural production. The study showed that 90 percent of the farmers have benefitted from these programmes. The impacts of these programmes have been reduced incidence of swollen shoot and black pod diseases and capsid, which have resulted in increased in cocoa production in recent years.

4.5.6 The effects of mass spray and fertilizer subsidy on cocoa production in Ghana.

The effects of the mass praying, and fertilizer subsidy programmes were rated very high among the respondents. 49% (fig 16) indicated that the programmes had significant improvement on the yield of their cocoa farms. Another 44% of the respondents said the programmes improved their total cocoa yield. In all, 87.2 percent of the respondents attributed increased in their cocoa yield to the programmes.

This goes to confirm the study conducted by Naminse et al (2011), which revealed 49.41% increase in cocoa yield from 85 percent farmers who benefitted from the Free Cocoa Mass Spraying Programme in the Upper Denkyira West District in the Central Region of Ghana

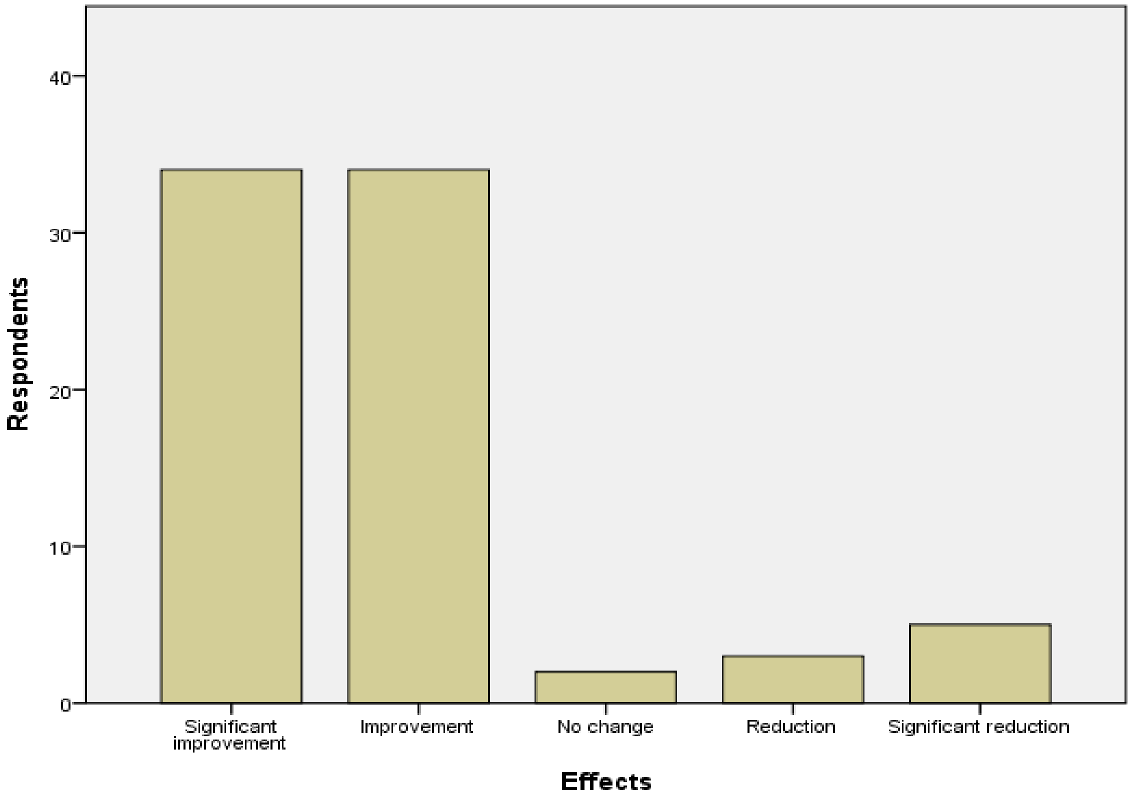

Fig 16 Effects of the Cocoa Mass Spraying Exercise and Subsidized Fertilizer Programmes on yield.

4.5.7 Farm management practices to ensure higher yield.

The result of this study agrees with the previous study conducted by Tetteh and Asase (2017), who investigated the 'socioeconomic profile and farm management practices of smallholder cocoa farmers in three cocoa producing districts in Southwestern Ghana', in which 75%

fertilizer application, 73.3% manual weed control and 80% insecticides spray were found as the major farm management practices adopted by the three districts in the southwestern Ghana.

The high rate adoption of pruning and regular weeding (45%) (figure 17) indicates farmers' understanding of the importance of adequate sunshine and ventilation in their cocoa farms to prevent black pod diseases, pest and competition of soil nutrients with weeds. Pruning improves the health of cocoa trees which is translated into higher yields. Due to exhaustion of soil nutrients reasonable number of farmers (41%) adopted fertilizer application and chemical spray to boost the nutrients of the soil and fight diseases and pest, which reduce the ability of the cocoa tree to bear more fruits.

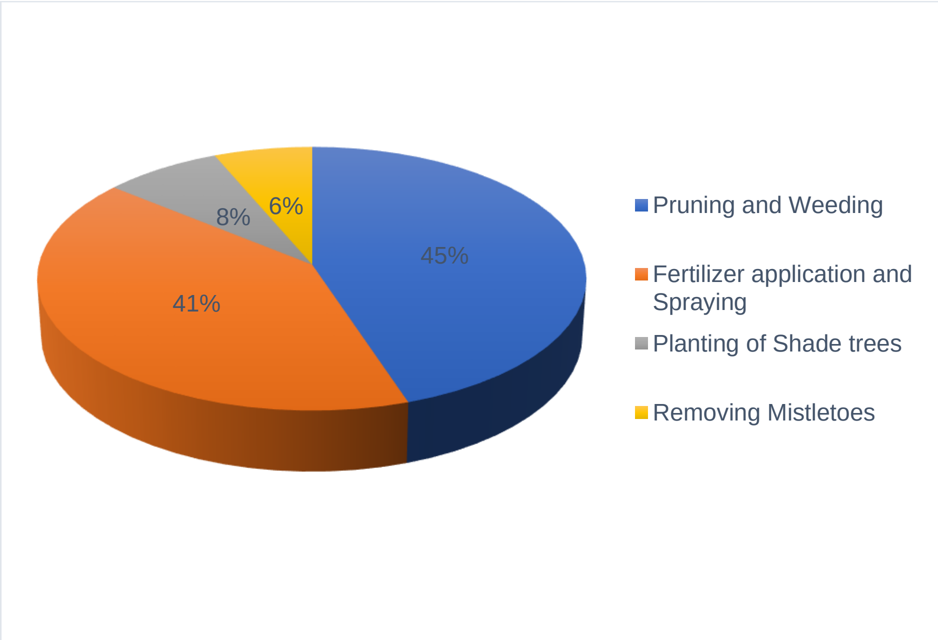

Fig. 17 Major farm management practices to ensure higher yield

4.5.8 Cocoa varieties planted by the farmers

The major cocoa varieties are Amazonia, Amelando and Hybrid. The results showed that majority of the respondents (58%) planted the hybrid variety (figure18). Only three (3) respondents, representing 4 percent said they had the Amelonado variety on their farms. This result agrees with that of Hoogendijk (2012) whose result showed 89% adoption of full-sun, high-input hybrid cocoa. In 1984, hybrid cocoa varieties were introduced through the government's Cocoa Rehabilitation Project (CRP) with the objective of revamping the almost collapsed sector (Kolavalli, 2011). The high percentage of respondents' (58%) (figure 18) adoption of hybrid cocoa varieties is an indication of farmers' acceptance of CRIG's recommendations of hybrid cocoa varieties as a better option to increase cocoa yield and make cocoa more adapted to climate change. Hybrid cocoa varieties are vigorous to harsh weather conditions and have advantage of high precocity.

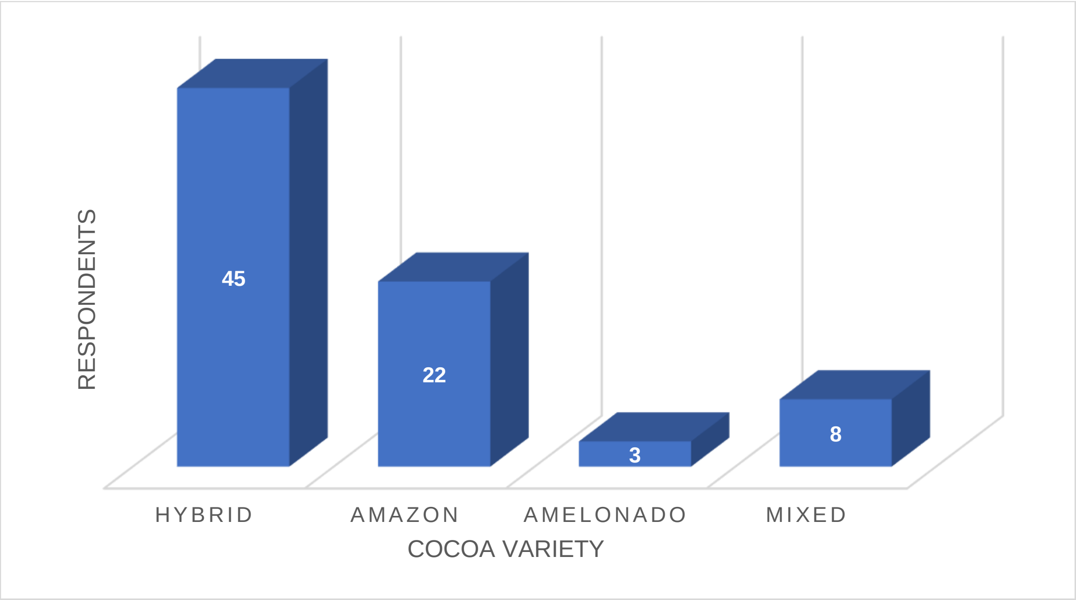

Fig. 18 Cocoa varieties planted by respondents

4.5.9 Types of shade trees commonly found on cocoa farm.

According to IPCC (2007, p869), adaptation is adjustment in natural or human system in response to actual or expected climatic stimuli which moderates harm or exploits beneficial opportunities. In this respect, farmers planted economic shade trees on their cocoa farms to attenuate the impacts climate change such as high temperature, reduced humidity and reduced soil moisture content which impair the growth and the health of cocoa trees. Farmers also enjoy economic benefits by cutting the shade tree as timber for personal use or sell for additional income. Planting of shade tree on cocoa farm is one of the adaptation-measure recommendations by CRIG to cocoa farmers in Ghana. Shade trees minimise intensity of heat cocoa plants receive during the Harmattan season and prevent mass evaporation of moisture from cocoa plants during the day, making them more resilient to the impact of the climate change. All the respondents in the study area had shade trees in their cocoa farms. The number of shade trees on cocoa farms ranges from 13 to 48 depending on the size of the farm, and they are of different species. Table 6 shows the commonest ones found in their farms. Most of the farmers (69%) grew the Terminalia Superba (*Ofram/Framo*) (Table 4) on their farms. The high preference for Terminalia Superba confirms Hoogendijk (2012), in whose researched 70% respondents showed preference for Terminalia Superba species on their cocoa farm. Greater majority of the farmers (69%) adopted the use of Terminalia Superba (*Ofram /Framo*) because of certain qualities it has over other species. One, it is deep-rooted tree and does not compete with cocoa trees for water and nutrients. Two, it is early maturing and reaches the size of timber in few years. And three, it has an elevated canopy height, allowing for higher light transmission. According to Kyere (2017), cocoa is highly sensitive to light and water, so any tree which does not allow adequate light and water will have adverse effects on the yield.

Terminalia superba, Milicia excelsa, Alstonia boonei and Terminalia ivoriensis are among the top CRIG recommended shade trees for cocoa in Ghana. Even though CRIG discourage farmers about the use of Ceiba pantandra and Triplochiton Scleroxylon species on cocoa farms, farmers prefer them because of their economic timber in recent times.

Table 5 Types of shade trees

Shade Tree (Species)	**Local Name**	**Number of Farmers**	**Percentage (%)**
Terminalia superba	*Ofram/Framo*	54	69
Khaya Species	*Mahogany*	2	2
Milicia Exelsa	*Odum*	11	14
Terminalia Ivoriensis	*Emire*	1	1
Ceiba Pantandra	*Onyina*	1	1
Alstonia Boonei	*Nyamedua*	4	5
Triplochiton Scleroxylon	*Wawa*	3	4
Citrus Sinesis	*Ankaa*	1	1
Other	---------	1	1
Total 9	**9**	**78**	**100**

4.5.10 Food crops commonly intercropped with cocoa.

Just like shade trees, food crops on cocoa farm provide shade to shield the young seedlings from the intensity of the effects of climate change such as high temperature, reduced soil moisture content and direct heat from the sun, which sometimes kill young seedlings. Availability of food crops on the farm help reduce growth of weeds on the farm. Besides, farmers get additional income from the sale of the food or use them for domestic consumption. So, the use of food crop on cocoa farm serve the dual purpose of reducing climate change effects on cocoa plants and providing additional income or opportunities to the farmer (IPCC, 2007,869). Intercropping cocoa with other food crops has been the traditional way of doing cocoa farming in Ghana. Farmers usually intercrop some food crops on their cocoa farm at the early stages of cocoa establishment. Table 6 represents the most common types of food crops found on the respondents' cocoa farms. The results from the study revealed that the combination of cassava and plantain is the most commonly food crops planted with the young cocoa plants. 35% of the respondents used that farming methods. The next most common combination (28% respondents) was cassava, plantain and cocoyam. The most single food crop usually intercropped with cocoa plants was plantain and followed by cassava (table 6). According to Osei-Bonsu et al (1998), planting food crops such as cassava, maize, plantain and others, or combination of any of them with cocoa give better result in terms of growth and precocity than cocoa planted on monoculture basis. Aside this, farmers get cash from the sale of food crops to defray part of the initial cost of the farm establishment. They also get income to maintain the farm.

Table 6 Food crops intercropped with cocoa

Food Crop	Number of Farmers	Percentage (%)
Cassava	11	14
Plantain	13	17
Cocoyam	4	5
Banana	1	1
Cassava and Plantain	27	35
Cassava, Plantain and Cocoyam	22	28
Total	**78**	**100**

4.5.11 Number of visits by Agricultural extension agents in a year

The more agricultural extension agents visit farmers, the more likely newer farming technologies and adaptation measures are transferred to and adopted by the farmers. This is because extension agents serve as conduit through which new farming methods and adaptation measures are transferred to cocoa farmers. From figure 19, 14% of the respondents did not receive visit from extension agents. 46% of the respondents received but only one visit in the whole year from the extension agents.

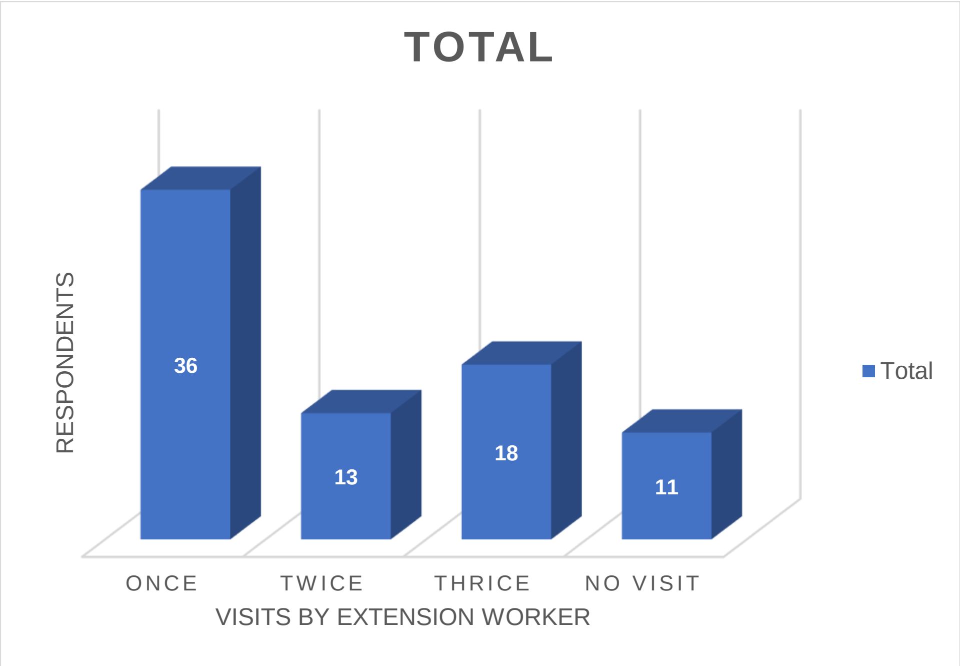

Fig 19. Visits by Extension Agent

4.6.0 CLIMATE CHANGE AND COCOA FARMING

4.6.1 Direct impacts of climate change on cocoa productivity

Pielke (2011), defined climate change as any multi-decadal or longer alteration in one or more physical, chemical and or biological components of the climate system. Climate change impacts cocoa production because climate is one of the key factors of cocoa production. It supports cocoa plants with inputs like water, sunlight and temperature, necessary for optimum growth of the cocoa plant. From the survey, majority of the respondents (31%) indicated that increased temperature, rainfall variability and reduced humidity have made plating of cocoa seedlings more difficult, some old cocoa trees were dying, and total farm yield had reduced significantly in the last ten years (table 7). It was also revealed that the most single highest impact of climate change on cocoa production was difficulty in planting new cocoa seedlings. In 2015, it was revealed by Hutchins et al that increased temperatures and erratic rainfall patterns are making it difficult to establish new cocoa farms. According to Wiah and Twumasi-Ankrah (2017), increased temperature and number of rainy days have negative effects on cocoa yield. Ofori-Boateng and Insah (2014) noted in their study that extreme temperature negatively affects cocoa output in the West African sub-region. This is because increased temperature, prolonged drought and erratic rainfall patterns lead to high mortality of young cocoa seedlings. Farmers knowledge and understanding of climate change and its impacts on cocoa production challenge them to implement the various recommended adaptation measures to safeguard the future of cocoa in Ghana

Table 7. Impacts of climate change on cocoa farm.

Climate change Impact	Number of farmers	Percentage
A= Planting new crops has become more difficult	20	26
B= Old cocoa trees are dying	9	11
C= Yield has reduced	5	6
D= Pests and diseases have increased	2	3
A, B and C	18	23
A, B, C and D	24	31
Total	**78**	**100**

4.6.2 Long-term investment plans to reduce the impact of climate change.

According to cultural theory of climate change risk (Rayner 1992), different forms of social organizations view and manage risks differently. The choice of different long-term investment plans to reduce climate change impacts by the farmers is in line with this theory. Farmers as individuals have different views of climate change impacts and hence different approaches in dealing with them. From the survey, most of the farmers opted for planting of shade trees. 3 percent of the respondents considered irrigation option (table 8), which is very unusual in Ghana, even though there has been a report that the government has the intention of embarking on irrigation schemes to improve cocoa production in the country (Cocobod Editorial, 2017; retrieved 14th April, 2018). Other options by the farmers are livestock rearing, planting of other cash crops such as cashew and undertaking other businesses. This result however contradicts Denkyira et al (2007) which indicated crop diversification as a major adaptation strategy among cocoa farmers.

Shade tree has been suggested as the most sustainable adaptation measure to reduce the impacts of climate change on cocoa production. Shade trees serve as buffer to the micro climatic conditions that affect cocoa production. Shade trees also provide ecosystem services such as improving soil nutrients and moisture contents.

Table 8. Long-term investment plans

Investment plan to reduce climate change impact	**Number of farmers**	**Percentage (%)**
Agroforestry – planting of shade trees	53	68
Cultivation of other cash crop – cashew	11	14
Construction of irrigation dam	2	3
Keeping of livestock	3	4
Other business	9	11
Total	**78**	**100**

4.6.3 Main source of information for farmers on climate change and adaptation measures.

Access to good information on climate change issues helps farmers to make wise decisions on adaptation measures which will be most appropriate in their individual circumstances. From the study, the following were revealed as the main sources of information on good agronomic practices and climate change adaptation measures. Most (46%) (Figure 20) of the respondent claimed that Agriculture Extension Agents in their locality are their main source information. Another 35.9% also received information from participation in the Farmer Field School. Other sources of information for the farmers were parents, friends and farmers own personal experiences.

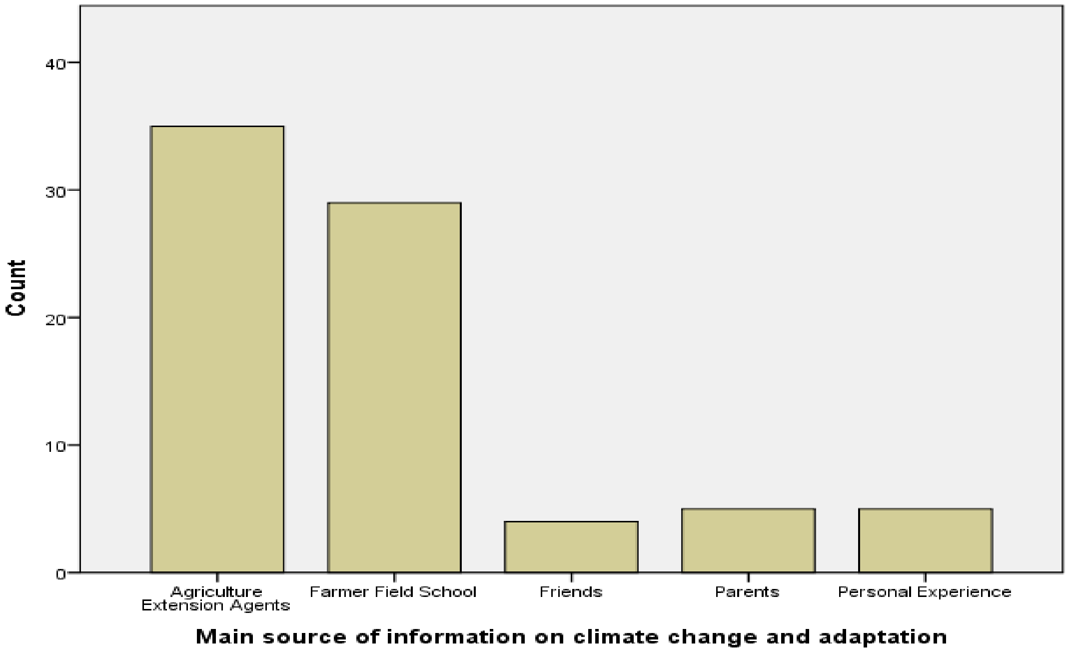

Fig. 20 Farmers main source information on good agronomic practices and adaptation measures

4.7.0 Other factors affecting cocoa production in Ghana.

The study revealed other major factors other than climate change that hinder cocoa production in Ghana. Table 9 gives summary of it. Incidence of increased attacked of pests and diseases was ranked highest, followed by lack of agricultural inputs. Unavailability of credit facilities to cocoa farmers was also considered as an inhibiting factor to cocoa production. In a sharp contrast to this result is the one revealed in the work of Yahaya et al (2015), which revealed producer price of cocoa as the most pressing issue affecting cocoa production in Ghana. This factor however was not indicated by any of the respondents in my study area. However, factors such as high cost of farm inputs, unavailability of credit facilities and increased pest and diseases confirm the results of Yahaya et al.

According to (Oyekale, Bolaji, and Olowa 2009), climate change is changing the stages and rates of growth of cocoa pests and pathogens and increasing cocoa vulnerability to such threats. Changes in elements of weather such as humidity, temperature and amount of rainfall have the potential to increase the incidences of pests and diseases as well as altering the types of pests and diseases that find the cocoa farm environment conducive haven. High cost of farm inputs has always been a constraint to cocoa production in Ghana. Smallholder cocoa farmers, with their little income, find it difficult to purchase inputs like improve seeds, fertilizer and chemicals to increase production and adaptation to climate change.

Table 9. Other factors affecting cocoa cultivation in Ghana

Other factors affecting cocoa cultivation in Ghana aside climate change impacts	Number of farmers	Percentage (%)
High cost of farm inputs	23	30
Lack of agricultural land and land tenure problems	6	8
Inadequate Extension Service Personnel	1	1
Lack of credit facilities	15	19
Inadequate farm labourer	5	6
Increased attack of pests and diseases	28	36
Total	**78**	**100**

4.8.0 Measures to prevent wildfire during dry season

Wildfire has been a major threat to cocoa cultivation in Ghana during the harmattan season, especially in the forest transition areas. The study showed that farmers have good knowledge about wildfire prevention and their consequences on cocoa production. They therefore adopt measures to prevent and manage them. Strategies adopted by the farmers to prevent wildfire in the study area are summarised in table 10 below.

Table 10 Measures to prevent wildfire

Bush fire prevention strategies	Number of respondents	Percentage (%)
Creation of fire belt	65	83
Frequent visit on the farm	3	4
Live in the farmhouse to keep watch	4	5
Formation fire volunteer squad	6	8
Total	**78**	**100**

4.9.0 Interview with Key Informant:

There was a short interview with one key informant in the study area who functions as the Community Extension Agent in Nsuta Operation Area, on agronomic practices imparted to cocoa farmers to enable them increase production and safeguard their cocoa farms against the impact of climate change. In the first place, he acknowledged that cocoa production in Ghana had been on the down-turn since the 1980s only to bounce back from the year 2000 onwards. He also asserted that the decline in yield is mostly attributed to the climate change phenomenon. According to him, Cocobod introduced Cocoa Extension Service in the industry in 2010 to assist farmers to embark on good agricultural practices through teaching by Community Extension Agents to direct, encourage and teach cocoa farmers kinds of practices that ensure higher yield.

On agronomic practices, he stated that he advised farmers to plant hybrid cocoa seeds because hybrid seeds have qualities such as early maturing, ability to withstand harsh weather conditions, diseases and pests like capsid. He also encouraged farmers to plant economic shade trees on their cocoa farms. The recommended shade trees by CRIG include Terminalia superba (*Ofram*), Terminalia ivorensis (*Emire)*, Milicia excelsa (*Odum*), Alstonia boonei (*Nyamedua*) and Funfumia elstica (*Funtum*). These are deciduous species whose leaf shedding occurs at different times of the year.

Beside permanent shade trees, he also encouraged the farmers to plant some local food crops such as plantain, cassava and maize on their cocoa farms to serve as temporary shades to the young cocoa seedlings and also serve as food and source of income to the farmers. According to him, food crops can no longer compete with the cocoa trees after 3 to 5 years. They are therefore removed from the farm and permanent economic trees take over to give shade to the matured cocoa trees.

He also stated that farmers are taught other farm management practices such as how to plant cocoa by following the recommended spacing of 3×3 metres to achieve maximum yield, pruning, removing of mistletoes, weed control and effective application of fertilizer and other chemicals to fight pests and diseases.

To conclude he said that he has observed steady improvement in the yield from the year 2013 up to date, which is partly attributed the outcome of the work of the Community Extension Service. He finally said, "*these practices are good and are yielding good results but some of the farmers find it difficult to cope since most of the practices are labour intensive"*

4.10 Using theories on climate change adaptation to understand cocoa farmers adaptation

The potential impact of climate change can be understood by the extent of exposure (Sutton et al, 2009): the farmers in the study area are exposed to increased temperature, rainfall variability and reduced humidity. Cocoa is sensitive to climatic conditions such as variations in temperature, rainfall variability and level of humidity. Sensitivity is the susceptibility of the system to the climate conditions. The following make cocoa farming in Ghana sensitive to the climate conditions. These are the farmers income level/ access to capital, government policy regarding changes in the cocoa farming system, access to inputs, knowledge about climate change impacts; and environmental conditions such as soil, pests and diseases, access to water and health of cocoa the tree.

Farmers in the study area are vulnerable to the impacts of the climate change due to the combined effects of climate change exposure, sensitivity and low adaptive capacity. However, those with smaller farm sizes are more vulnerable to the impacts of the climate change because of lower income from their farms. As a result, they are unable to purchase additional inputs to improve yields and adopt most of the adaptation measures. They are trapped in a vicious cycle of vulnerability due to the small sizes of their farms. Their condition is illustrated in the figure below.

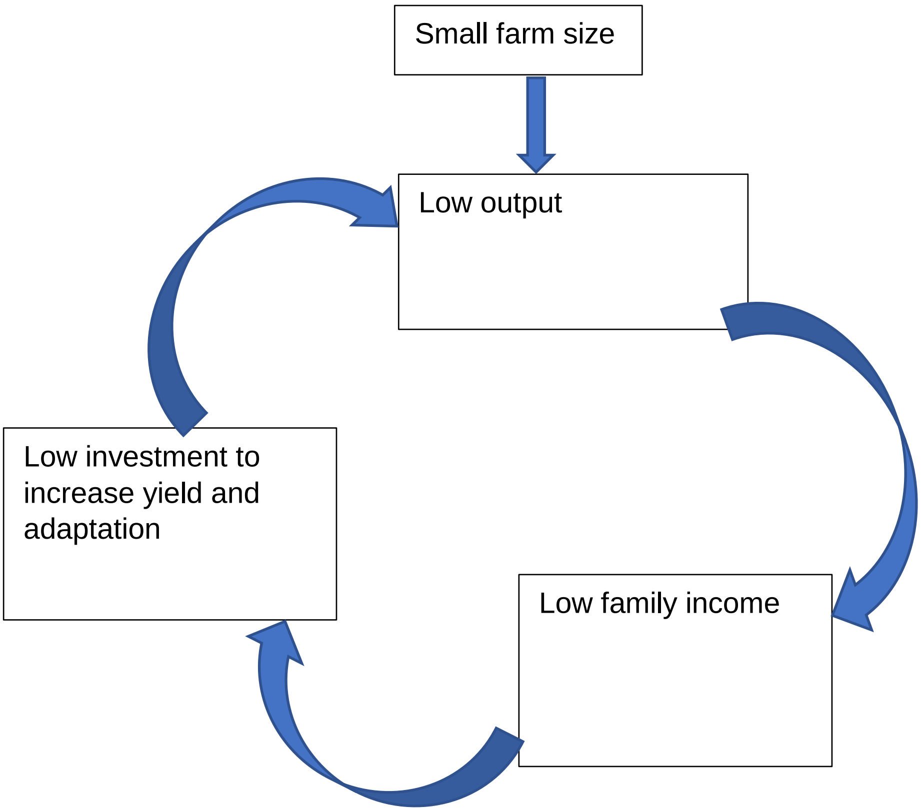

Fig. 21 Vicious cycle of vulnerability of cocoa farmers with smaller farm sizes to climate change impacts.

Other factors that make them more vulnerable are the large family size (ref. table 1), which affects their ability to adopt good agronomic practices and adaptation measures. Low level of education (ref. table 1) also increases their vulnerability to climate change impacts due to their ability to understand and implement most of the adaptation measures and good agronomic practices. Lastly, most of the farmers lack adequate information on climate adaptation measures. This inhibits their ability to adopt and implement them. Information flow is limited to the agricultural extension agents, and there are limited number of them in the study area.

Measures adopted by the farmers to increase yield and income include good agronomic practices such as pruning, regular weeding, removing of mistletoes, increase use of chemical fertilizers, spraying against pests and diseases (which most of it is done through the Cocoa Mass Spraying Exercise).

The following adaptation measures have been adopted by most of the farmers. Almost all the famers have at least13 trees per hectare of cocoa farm. Most of the farmers planted hybrid cocoa seeds (ref. figure 17), which have characteristics such as early maturing, drought resistance and resistance to pest and diseases. Others include increase knowledge on good agronomic practices and adaptation measures through the Agricultural Extension Agents and Farmers Field School programme. Lastly, the fix price system used by Cocobod has been able to cushion farmers against the volatile international price of cocoa.

The adaptation measures adopted by the farmers are both anticipatory and reactive ones (figure 1). Planting trees and food crops on cocoa land have been a traditional way of cocoa cultivation in Ghana. However, the increase awareness of the climate change impacts has drawn more attention to the need to use shade trees on cocoa farms.

CHAPTER 5

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This research work sought to investigate the various reforms in the cocoa farming system in Ghana, from the time of independence to date, and how these reforms have contributed to yield increase and adaptation to climate change. The areas of reforms are institutional, market/price, social and agronomic.

Institutional reforms such as mode of land acquisition in which shared project scheme (*abunu* system) was the largest, had negative effects on the size of cocoa farms with its resultant adverse effect on productivity. It was established that majority of the farmers depended on family and hired labour for their farm activities. The use of family labour was very helpful since it was cheaper, and farmers could use them at minimal cost to carry out most of the labour-intensive farm activities, both agronomic and adaptation measures.

Under the market reforms, it was established that the increase of producer price of cocoa to 70% of free on-board (fob) price as a major market reform has affected the incomes of the farmers positively, and this has been translated into expansion of farms, rehabilitation of moribund farms, increase use of farm inputs and adoption of climate change adaptation measures.

Major social reforms included cocoa farmers scholarship scheme, which only 8% of the respondents had benefitted. Provision of social amenities and infrastructure such as lighting, schools and roads was very low in the study area. Majority (52%) of the respondents used torchlight as their main source of lighting. 74% of the respondents did not have schools in their localities. And only 5% of the road network was in the class of first and second category of roads.

Major agronomic reforms included planting of hybrid cocoa varieties, promotion of shade trees on cocoa farms and introduction of cocoa mass spray and fertilizer subsidy programmes. These programmes have given positive results in terms of yield increase, mitigation and adaptation to climate change. There was increased use of fertilizer and chemical spray. Most of the farmers (58%) planted hybrid cocoa seeds. And there was increased use of shade trees of which Terminalia superba species (Ofram/Framo) was the dominant one.

Lastly, the long-term adaptation measures to reduce the impact of climate change included planting of economic shade trees (cocoa agroforestry), cultivation of other cash crops such as cashew (which is more resistant to harsh weather conditions than cocoa), rearing of livestock and undertaking of irrigation projects.

5.2 Recommendations

Based on the findings of this research, the following recommendations may be considered by the stakeholders of Ghana cocoa industry to bring about increased yield and improve adaptation of cocoa to climate change.

Acquisition of land for cocoa farm is a major problem for prospective cocoa farmers and has direct effect of farm size, which also affect productivity. There is therefore the need by the Lands and Minerals Commission of Ghana to make reforms in this area so that land for cocoa farm becomes readily available and affordable for the prospective cocoa farmers.

The Government of Ghana should make conscious efforts to improve the infrastructure needs and promote the provision of social amenities in the rural areas of the country, especially cocoa growing communities. This development will help to raise the standard of living in the rural areas and make life more comfortable so that youths will be attracted and retained in the rural areas to engage in farming to bring about increased productivity.

The increased use of fertilizer and chemical spray against pests and diseases through the cocoa Mass Spray and Fertilizer Subsidy Programmes have seen increased in yield, however not all cocoa farms in the study area were covered. The Cocobod must, as a matter of urgency intensified efforts to get 100% coverage of all cocoa farms in the country to increase productivity.

There is the need to increase and intensify education on good farm management practices such as pruning, fertilizer application and regular weed control as these have direct impact on yield.

The supply of Hybrid cocoa seed and shade tree seedlings as an adaptation measures should be accompanied with incentive packages to motivate farmers, especially the smallholder cocoa farmers.

Finally, farmers must be encouraged by the Agricultural Extension officers to plant food crops on their cocoa farms as a way of increasing their income and promoting adaptation.

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APPENDICES

Appendix 1: Questionnaire

I would like to solicit your help. I am a graduate student in International Environmental Studies at the Norwegian University of Life Sciences. I am conducting a survey on "changes in the cocoa farming system and the consequences on production and adaptation to climate change," for my Masters thesis. The purpose of this project is to identify changes that have been carried out since independence in the cocoa farming system in Ghana and how these changes have contributed to cocoa production and adaptation to climate change. Will you please help me complete this survey by answering some questions about your cocoa farm? This survey may take between 15- 20 minutes to finish. Your answers are anonymous. All answers will be kept confidential. Only group results will be presented. Your help with this research is strictly voluntary.

Thanks for your help.

SECTION A: INSTITUTIONAL CHANGES

1. How many years have you been in cocoa farming?

....

2. How did you acquire land for your cocoa farm?

a. shared project scheme (*abunu*)

b. purchased

c. family land

e. bequeathed land.

3. Did you find it difficult acquiring land to start your farm?

A yes,

B no

4 If yes, what was/were the difficulties.

……

……

…………………………………………………………………………………………….

5 If no, what made it easy to acquire the land?

……

……

……………………………………………………………………………………………

6a What labour do you use to do your farming? (tick as many as apply)

a. family labour

b. hired labour

c. alone,

d. *nnoboa* (self-help group)

6b Give reason for your choice of labour

……

……

……………………………………………………………………………………………

7. who takes care of the plantation?

a. myself

b. hired care taker

c. *abusa* (third-variant share contract)

8. Ghana Cocoa Board (COCOBOD) has undergone various transformations since its inception, how do you evaluate the current contribution of COCOBOD to the growth and development of cocoa industry in Ghana?

a satisfactory

b cannot judge

c unsatisfactory

9. What is your preferred purchasing agent?

a the PBC

b the LBC

10. Please give reason for your choice of answer in question 9

……

……

……

……

………………………………….

SECTION B: PRICE CHANGES

11 Based on the current price of cocoa, do you consider expanding your farm?

a. I strongly consider

b. I consider

c. do not know

d. I do not consider

e I strongly do not consider

12. Are you satisfied with the current situation where the government has the sole right to fix price for cocoa beans in Ghana?

a. very satisfied

b. satisfied

c. not decided

d. unsatisfied

e. very unsatisfied

13. Which of these price systems do you prefer?

a. free price mechanism (free market)

b. controlled price mechanism by the government (monopsony)

14. do you receive bonus for the sale of your cocoa beans?

a yes

b no

SECTION C: SOCIAL CHANGES

15 How many wards do you have in school?

…………………………………………………………………………………………

16 Has any of them benefitted from COCOBOD scholarship scheme?

a. Yes

b. no

17. what is the nature of the roads from where your farm is located to the nearest town or city? a. First-class road

b. Second-class road

c. feeder road

d. motorable only during the dry season.

e. no roads, only farm tracks

18. Do you have schools where your farm is located?

a yes

b no

19 How many kilometres is the nearest health facility from your farm house?

……………………………………

20. What is the main source of lighting at the farm house?

a electricity

b kerosene lantern

c solar lantern

d torchlight with dry cells

e none

SECTION D: AGRONOMIC

21. How many plots of coca farms do you have?

………………………………

22. What is the total size of your cocoa farm (s)?

…………………………

23. How old is your cocoa plantation?

…………………………

24. How many bags did you harvest in the last cocoa season?

………………………………………….

25a. Compared to the previous harvest, was there a change in the harvest?

A harvest increased slightly

B. harvest increased significantly

C harvest remained the same

D harvest fell slightly

E harvest fell significantly.

25b. If there was increase in harvest, what accounted for the increase?

A. additions from new ongoing farm.

B used of chemical fertilizers.

C use of pesticides,

D favourable rains

E other……………………………………..

25c. If there was a decrease in harvest, what accounted for the decrease?

a reduced rainfall

b diseases

c pests

d aging cocoa trees

e lack of application of fertilizers

f other……………………………………….

26 Since the year 2000, what has been the trend of production?

a production has been increasing marginally

b production has been increasing significantly

c production has remained the same

d production has been falling marginally

e production has been falling significantly

27. What major farm management practice/s do you use to ensure higher yield?

……….

28. Do you use chemical fertilizer on your cocoa plantation?

A yes

b No

29 if you use chemical fertilizer, where do you get it from.?

A. buy from the market,

b. from the COCOBOD

c. NGOs

30. Have you benefited from the Government free cocoa mass spraying and fertilizer distribution?

a yes

b no (if no skip question 30)

31. Has there been any improvement in the yield since cocoa mass spraying exercise and the application of the subsidized fertilizers.

a there has been a significant improvement

b there has been improvement

c no improvement

d there has been reduction in the yield

e there has been significant reduction in the yield

32. At what stage of your cocoa farm did you start using chemical fertilizers?

a After 5 years

b after 6 years

c after 7 years

d after 8 years

e after 10 years

33. How many bags of chemical fertilizers do you use per an acre of cocoa farm

a 1 bag

b 2bags

c 3bags

d 4bags

e 5bags

34. which of these cocoa varieties do you plant?

a. hybrid cocoa variety

b Amazonia cocoa variety

c. amelonado (Tetteh Quarshie) cocoa variety

d. Mixed cocoa variety

35. where do you get seeds/seedlings

a. purchased from market

b. COCOBOD,

c NGOs

d. free from friends

36. What shade tree is commonly found on your cocoa farm?

a. Termonalia Superba (Ofram/Framo)

b. Khaya Species (Mahogany)

c. Milicia Exelsa (Odum)

d. Terminalia Ivoriensis (sesemasa)

e.Ceiba Pantandra(Onyina)

f. Alstonia boonei (Nyamedua)

g. Triplochiton Scleroxylon (Wawa)

h. Citrus Sinesis (Orange)

i. Others (specify………………………………………………………………………)

37. Which of these do you intercrop with the cocoa trees on the farm as a temporary shade to young cocoa plants? (tick as many as apply)

a. cassava.

B. plantain

c. cocoyam

d. banana

e. orange

f. other ………………

38. How often do extension workers visit your farm?

A. once a year

b. twice a year

c. thrice a year

d. not at all

SECTION E: ADAPTATION TO CLIMATE CHANGE

39. Which of these is/ are true about the recent weather conditions? (Tick as many as apply)

A temperature rise.

B low temperature.

C increase rainfall.

D reduced rainfall

40. What can you say about the rainfall pattern of late?

A. very timely,

b. timely,

c. untimely,

d. late,

e. very late

41. how has climate change affected your cocoa farm? (tick as many as apply)

A planting of new crops has become more difficult.

B old cocoa trees are dying because of prolong drought.

C yield has reduced.

D Pests and diseases have increased

42. In case of low rainfall, what do you do to mitigate the effects on the farm?

……

……

……

……
………………………………….

43. In case of temperature rise, what measures do you use to mitigate the effects on the farm?

……
……
……
……
………………………………….

44. When the rains are more than needed, what measures do you use to safeguard your cocoa farm?

……
……
……
……
…………………………………

45. All these measures mentioned above in questions 39, 40 and 41, how did you acquire them?

……
……
……
……
………………………………….

46 What long- term investment plan have you put in place to reduce the negative impacts of climate change on your cocoa farm?

……
……
……
……
………………………………….

47. What has been the impact of the climate change on your cocoa farm?

a yield has reduced

b no change in the yield

c yield has increased

48. Apart from the climate change, what other factors might have contributed to the changes in the production of your cocoa farm?

……
……
……
……
…………………………………

49. What do you do to prevent your cocoa farm from bushfires?

……
……
……
……
…………………………………

SECTION F: PERSONAL INFORMATION

50. What is your age?

…………………………….

51. What is your sex?

a male

b female

52. What is your educational level?

a university degree

b diploma

c secondary education

d primary education

e. none

53. What is the size of your household?

…………………………………………………….

Appendix: 2

Regional Cocoa Purchases in Ghana from 1947/48 – 2015/16 Crop Year.

Crop Year	Ashanti	Brong Ahafo	Eastern	Central	Western	Volta	Total
1947/48	107630		56000		27970	20279	211879
1948/49	127880		81003		47062	26881	282826
1949/50	117875		68161		41146	24617	251799
1950/51	124630		70643		46116	25029	266418
1951/52	99231		60679		31194	23945	215049
1952/53	120190		62526		39863	28356	279291
1953/54	103322		52036		35676	22206	213240
1954/55	111063		53641		33727	22388	220819
1955/56	120940		50743		32666	28100	232449
1956/57	134929		55893		44804	32288	267914
1957/58	106597		42637		38942	21575	209751
1958/59	146247		37807		40322	25039	249415
1959/60	182775		58820		57285	23342	322222
1960/61	152754	92552	75082	46821	39318	30777	437304
1961/62	151646	71245	81112	61748	21176	29034	415961
1962/63	150200	83156	85907	64889	23278	21054	428484
1963/64	156586	90379	76911	57421	21871	24614	427782
1964/65	204427	130245	107820	75697	34935	27745	580869
1965/66	155816	101790	72149	41587	23800	20620	415762
1966/67	130220	87698	69511	50125	25040	18759	381353
1967/68	140844	109060	71323	52790	32329	24319	430665
1968/69	124903	85336	58733	43845	23282	19489	355588
1969/70	125406	115393	69431	55236	31113	20878	417457
1970/71	130434	112076	73805	59813	36153	15348	427629
1971/72	148935	116916	76224	62762	47516	10107	462460
1972/73	125649	112754	74578	43469	43129	22118	421697
1973/74	106977	78502	65617	47707	41338	14489	354630
1974/75	109802	81533	73393	50766	52106	14009	381609
1975/76	124334	88480	69201	38547	40343	9228	370133
1977/78	89619	69541	41289	21553	41968	7369	271339
1978/79	86913	50408	50200	25700	45873	5980	265074
1979/80	100363	74894	45051	19034	52301	4776	296419
1980/81	91537	47598	46632	25563	45148	1496	257974
1981/82	70790	49747	36890	22069	43703	1683	224882

1982/83	55310	35174	31254	17604	35109	3776	178227
1983/84	47059	29685	25504	13818	40161	2659	158886
1984/85	44692	28629	28009	18754	51412	1018	172514
1985/86	54466	36474	34612	27636	64731	1115	219034
1986/87	56870	32643	33399	26912	76038	1903	227765
1987/88	49766	28796	29951	19115	58738	1805	188171
1988/89	76268	48647	39193	28423	105894	1676	300101
1989/90	72124	45126	33296	31208	111513	1785	295052
1990/91	60958	42016	32261	26517	128955	2645	293352
1991/92	52467	33734	26196	19356	109469	1595	242817
1992/93	65353	37014	34608	29587	143288	2273	312123
1993/94	47172	30927	25372	21936	128323	924	254654
1994/95	64026	37014	33667	20518	153162	1068	309455
1995/96	81977	39048	38932	36410	206570	906	403843
1996/97	64534	34195	34306	22415	165361	1678	322489
1997/98	78909	39898	29468	29468	216955	976	395674
1998/99	74390	40212	40503	29653	210545	2060	397363
1999/00	82068	39310	41526	31360	240331	2351	436946
2000/01	72993	33110	46226	32136	203626	1681	389772
2001/02	56983	31354	39348	29992	181865	1021	340563
2002/03	82445	45308	51604	39989	276587	913	496846
2003/04	121269	69695	68634	55819	419650	1909	736976
2004/05	90535	55025	48868	59308	344246	1336	599318
2005/06	133026	72766	55871	55497	422223	1075	740458
2006/07	95427	65629	51132	43757	357827	761	614533
2007/08	125270	66921	55916	62378	369458	838	680781
2008/09	110643	61562	63405	60686	413395	951	710642
2009/10	116538	60600	55736	57562	359910	595	650941
2010/11	168916	101302	78928	76863	583589	3241	1012839
2011/12	134295	76511	67713	71760	525237	3833	879349
2012/13	137379	88034	75912	71540	458107	4495	835467
2013/14	156902	87116	80692	85446	483279	3481	896916
2014/15	136134	81896	68415	70690	380469	2650	740254
2015/16	133462	74943	75787	75870	415302	2680	778044

Source: COCOBOD, 2018

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