KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACTORS AFFECTING COCOA PRODUCTION IN UPPER DENKYIRA WEST DISTRICT

BY

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DECLARATION

I hereby declare that this submission is my own work towards the MSc. Programme and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

This thesis is dedicated to my wife, Mrs. Gifty Amoah and her children Yvonne Kyekye Amoah, Priscilla Agyeiwaa and Elvis Opoku Amoah.

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ABSTRACT

Ghana is one of the largest suppliers of cocoa on the world market and the sector employs millions of people. For sixty-six (66) years, (1911 - 1977), Ghana was the leading producer of cocoa. Thereafter production continued to decline to the lowest in 1983/84. The people of Upper Denkyira West District in the Central Region are predominantly cocoa farmers. Most of these cocoa farmers own few acres of land. Farmers depend on yield per acre of cocoa farm for their survival. The objective of the study is to ascertain the factors affecting cocoa production in the Upper Denkyira West Districts of the Central Region of Ghana. Using structured questionnaires, a total of one hundred and fifty (150) cocoa farmers were selected from five (5) communities by simple random and purposive sampling techniques. Data was collected on the socio-economic or personal characteristics of cocoa farmers (gender, age, educational level, religious background, marital status years of farming and family size), output or yield of cocoa and other factors such as farm size, size of labour, years of cocoa trees in farm and others. Data was analyzed by using descriptive analysis, test of associations using Pearson Chi-square statistic and logistic regression model. The results revealed that out of (150), cocoa farmers 78% were predominantly males while 22% are females. The numbers of farmers was found to increase with age with majority of aged 44 years and above. Almost half of the farmers sampled were with no formal education. It was observed that gender and age was not associated with high output or yield of cocoa but the level of education, years of cocoa trees in farm, size of farm and size of labour showed significant effect on high output of cocoa.

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LIST OF ABBREVIATIONS

GDP	-	Gross Domestic Product
FoB	-	Free on Board
CODAPEC	-	Cocoa Diseases and Pests Control Programme
CRIG	-	Cocoa Research Institute of Ghana
COCOBOD	-	Ghana Cocoa Board
MOFA	-	Ministry of Food and Agriculture
ICCO	-	International Cocoa Organization
GNA	-	Ghana News Agency
MOF	-	Ministry of Finance
PBC	-	Produce Buying Company
LBC	-	Licensed Buying Company
PPRC	-	Producer Price Review Committee
QCD	-	Quality Control Division
CMC	-	Cocoa Marketing Company
CMB	-	Cocoa Marketing Board
AET	-	Agricultural Education and Training
OFY	-	Operation Feed Yourself
ERP	-	Economic Recovery Programme
IPM	-	Integrated Pest Management
CHTP	-	Cocoa High Technology Programme

CHAPTER ONE

INTRODUCTION

1.0 INTRODUCTION

Since independence, Agriculture has been the key player in Ghana's economic development and growth. Averagely, it accounts for about forty (40) percent of the country's gross domestic product (GDP) and generates fifty-five (55) percent of the foreign exchange earnings. The agriculture sector today employs about fifty-one (51) percent of the labour force in Ghana, and is the main source of income and sustainable employment for nearly seventy (70) percent of Ghanaian rural folks. The cocoa industry alone employs close to about sixty (60) percent of the national agricultural workforce in the country (Asuming-Brempong et al., 2006).

Undoubtedly, cocoa production is the predominant activity in the Ghanaian agricultural sector. During the 2002 season, cocoa made up for 22.4 percent of the total foreign exchange earnings for Ghana. This contributed sixty-three (63) percent of the entire foreign export earnings accrued from the agricultural sector. The "impressive growth performance" of the country's economy in 2003 was mainly attributed to an exceptionally strong output growth in the Agricultural sector, which not only made up for the services sector but moved the overall growth rate up from a projected 4.7 percent to 5.2 percent. In turn, an examination of the sector's performance was exclusively on account of cocoa production and marketing (Asuming-Brempong et al., 2006).

Ghana's cocoa production has over the years faced major challenges which have adversely contributed to the country losing her position as the leading producer of cocoa beans in the world. The key challenges include; Ghanaian farmers' discrimination towards agricultural policies, diseases and pests infestation, climate and soil quality, and the setting of cocoa producer price (Anim-Kwapong and Frimpong, 2005).

In order to boost annual production and the quality of yields, successive Governments since independence have introduced policies and programmes, which sought to tackle these major challenges bedeviling the industry. Governments have been committed to implementing policy measures within the cocoa sub-sector such as increased producer prices, effective diseases and pests control programme, bonus payment, hi-tech programme (subsidized fertilizer for application) and replanting of denuded areas to enable the sub-sector contribute significantly to the growth of the agricultural Gross Domestic Product (GDP), foreign exchange earnings, employment generation and poverty reduction in the country. It is hoped that these policies would contribute to higher production and higher revenue to the farmer, and help alleviate poverty. In addition, this would contribute to higher tax revenue to the government to embark on various developmental projects (Anim-Kwapong and Frimpong, 2005).

1.1 BACKGROUND OFTHE STUDY

Ghana is one of the largest suppliers of cocoa on the world market and its cocoa sector employs millions of people. It is not only small-scale farmers that are dependent on earnings from cocoa, but also the Ghanaian state (ICCO, 2006).

The first documented shipment of two bags of cocoa, which was sent to Hamburg-Germany, was in January 1893 (Asuming-Brempong et al., 2006). Since then, cocoa has been the main export crop and a major source of foreign exchange for the government of Ghana and income earner for farmers.

For Sixty-six (66) years, (1911-1977) Ghana was the leading producer of cocoa with the market shares ranging from 30-40 percent (Adjinah and Opoku, 2010). Records indicate that cocoa production increased from a level of 36.3 Metric Tones (MT) in 1891 to about 557,000MT in 1964/65 giving Ghana a global output share of about 33 percent and the leading producer of cocoa at the time (Adjinah and Opoku, 2010). Thereafter, production continued to drop and reached the lowest of 158,956MT in 1983/84, which constituted 9 percent of the world's production. The decline in production was significantly influenced by the 1983 devastating drought, poor farm maintenance practices, planting low-yielding varieties and the incidence of pests and diseases (Anon, 1999; Abekoe *et al.*, 2002). Poor farm maintenance practices are attributed to the low prices paid to Ghanaian cocoa farmers (Anon, 1999).

In 2001, cocoa export contributed 16 percent ($246.7 million) to total exports (AET Africa, 2011). The agriculture sector in 2002 employed about seventy (70) percent of the rural labour force, contributed forty-five (45) percent to GDP and accounted for over fifty-five (55) percent of the foreign exchange earnings (EPA, 2002). According to Dwinger (2010), cocoa contributed nine (9) percent of Ghana's gross domestic product (GDP) in 2008.

In an attempt to increase production, the government has been implementing policies aimed at reforming the cocoa sector since the early 1990s. In 1999, the government adopted a development strategy with the objective of improving the performance of the cocoa sector. Under this strategy, production levels were expected to reach 700,000 MT by the year 2010 (Anon, 1999). The resulting reforms have led to the liberalization of the internal marketing of cocoa and to increase in the producer price from 56 percent to 70 percent of the free on board (FOB) price over the period 1998/1999 – 2004/2005 (Anon, 1999). The FOB price is the price at which government sells cocoa to foreign buyers and includes profit margin and all costs incurred in buying and transporting the beans to the port.

In 2001, the government sprayed all cocoa farms under the Cocoa Diseases and Pests Control programme (CODAPEC) popularly called the Cocoa Mass Spraying Programme at no direct cost to the farmer. The programme was to assist all cocoa farmers in the country to fight the capsid/mirid and the black pod diseases. The aim of the programme was to increase cocoa production to 1,000,000 MT by 2012 (Adjinah and Opoku, 2010). The programme was introduced in the 2001/2002 cocoa season with a budget of about 32 million US Dollars (Exchange rate of 1 $US to 1.87 Ghana Cedis) (GNA, 2005). The programme covered all the six cocoa growing regions in Ghana, namely; Ashanti, Brong-Ahafo, Central, Eastern, Western and Volta regions. Since 2003, the government has also started an interest-free credit scheme called the Cocoa 'Hi-Tech' Programme, which aims at increasing productivity by providing fertilizers and pesticides. In its first year, 50,000 farmers benefited from this programme, and the number increased to 100,000 one year later. The 'Hi-Tech' Programme is managed jointly by the Cocoa Research Institute of Ghana (CRIG),Ghana Cocoa Board (COCOBOD) and Ministry of Food and Agriculture (MOFA).

Some of the cocoa farmers, however, wanted to do the spraying themselves complaining the government workers seemed to be too slow (Akosa, 2001). Each farm was supposed to be sprayed three times between June and October in case of black pod and twice between August and September in the case of mirids. On the contrary, spraying for mirid control were observed to have been done only once in the district per a growing season. It would therefore interest stakeholders to be aware of the effect the programme has on cocoa production, since there were claims that the spraying was not being done in line with what was recommended at the onset. A membership of ten (10) sprayers (gang) for black pod and six (6) for capsid programmes have a supervisor who is responsible for the general supervision at the unit level. Other objectives were to train farmers and technical personnel on the cultural methods of pest control, educate and train local sprayers on safe pesticide usage.

The farmers are responsible for the cultural practices (pruning, shade management, removal of black and other diseased pods), and provision of water for spraying and monitoring of spraying on the farm to ensure proper and satisfactory results.

1.2 STATEMENT OF THE PROBLEM

Cocoa (Theobroma cacao) belongs to the family Sterculiaceae, and out of the over twenty two (22) species of cocoa, it is only the Theobroma cacao, which is economically important and grown in Ghana as a major cash crop. It is grown commercially for the production of seeds for chocolate making (Mossu, 1992). Until recently when Ghana discovered oil and gas in commercial quantities, Cocoa, otherwise called the chocolate tree is Ghana's largest source of foreign exchange as about 96 percent of the raw beans have been exported to countries such as Germany, the Netherlands, the United Kingdom and the United States of America.

Ghana is one of the major producers of cocoa in the world. The crop contributed about 3.4 percent to total gross domestic product annually and an average of 29 percent to total export revenue between 1990 and 1999 (Anon, 2001) and 22 percent between 2000 and 2002 (Anon, 2003). However, production levels have consistently declined from 568,000MT in 1965 to its lowest level of 160,000 MT in 1983. Since the mid-1980s, production levels have risen gradually to an average of 400,000 MT during the late 1990s (Anon, 1999; Abekoe *et al.*, 2002), which still is considerably less than the production levels attained in the mid-1960s. The decrease in production in the early 1980s was attributed by government to adverse weather conditions that led to widespread bush fires, destroying many cocoa farms (Anon, 1999). Although some burned cocoa farms have been replanted with cocoa, other ones have been abandoned or the land has been used for the production of other crops, thereby reducing the area under cultivation (Anon, 1999).

Generally, yields of cocoa are lower in Ghana than in other major cocoa producing countries. Whilst the average cocoa yield in Malaysia is 1800 kg/ ha, and 800 kg/ ha in Ivory Coast, it is only 360 kg/ ha in Ghana (Anon, 1999). Reasons for the low productivity include poor farm maintenance practices, planting low-yielding varieties, and the incidence of pests and diseases (Anon, 1999; Abekoe *et al.*, 2002). Poor farm maintenance practices are attributed to the low prices paid to Ghanaian cocoa farmers (Anon, 1999). The above reasons largely represent the views and perceptions of policy makers and researchers, and not necessarily those of farmers.

In an attempt to increase production, the government has been implementing policies aimed at reforming the cocoa sector since the early 1990s. In 1999, the government adopted a development strategy with the objective of improving the performance of the cocoa sector. Under this strategy, production levels are expected to reach 700,000 MT by the year 2010 (Anon, 1999). The cocoa sector development strategy has also involved shifting responsibility for cocoa extension services from the Cocoa Services Division (CSD), a subsidiary of the Ghana Cocoa Board (COCOBOD) to the Ministry of Food and Agriculture (MOFA). The objective of obtaining the above output was not achieved despite these interventions. The focus of this thesis is to determine the socio-economic and other general factors that affect the output of cocoa in Upper Denkyira West District in the Central region of Ghana.

1.3 OBJECTIVES OF STUDY

The main objective of the study is to ascertain the factors affecting cocoa production in the Upper Denkyira West District of the central region of Ghana. The specific objectives are to:

(i) Determine the relationship between the output of cocoa production and socio-economic or personal characteristics of the cocoa farmers.

(ii) Determine the factors affecting cocoa production.

1.4 JUSTIFICATION OF THE STUDY

Cocoa has been the bedrock of the Ghanaian economy throughout the century. It continues to play major roles such as creating sustainable employment, foreign exchange earnings to the country, and providing a chunk source of government revenue. As a result of its vital contributions to the nation, policies or programmes initiated to revive the industry need to be assessed in order for stakeholders to make informed decisions. This study is of no exception as it helps the Government and Ghana COCOBOD with a means to evaluate the effectiveness of intervention programmes geared towards boosting cocoa production in Ghana. Moreover, this paper will also aid as a guide for Government and other cooperate institutions to assess the impact of control measures or events on any series of interest. The study would again add to the body of knowledge for other researchers to possibly build upon.

1.5 METHODOLOGY

Based on the objectives, data is collected on the socio-economic characteristics of cocoa farmers, output and factors affecting cocoa production. Data is obtained from primary source. The primary data consists of well-structured questionnaires made up of both open ended and close ended questions which is used to solicit information needed to persue the objectives of the research.

To acquire relevant information, purposive sampling method is used to select five (5) communities or villages in the Upper Denkyira West District in the central region of Ghana for study. Moreover simple random sampling is employed to select one hundred and fifty (150) cocoa farmers from these communities. Data is analyzed using descriptive analysis such as frequency, percentages, inferential statistics such chi-square test and logistic regression models. The analyses of these statistical techniques were made possible by The Scientific Product and Service Solution (SPSS) software.

1.6 SCOPE OF THE STUDY

Upper Denkyira West District is located in the Central Region of Ghana with Diaso as its district capital, which was carved out of the defunct Upper Denkyira District. It lies within latitude 5º 30'' and 6º 02'' North of the equator and longitude 1º W and 2º W of the Greenwich Meridian. The population of the district is about fifty two thousand (52,000) (Ghana Population and Housing census, 2000). The topography of the land area is undulating and falls under a forest-dissected plateau, rising to about 250 meters above sea level. The vegetation is semi-deciduous rain forest. The soils of the district are generally of the forest echosols. This series consist of brown to yellowish brown, slightly acidic and moderately well-drained clay developed on alluvium. There are also other soil types of Akroso series favorable for the plant growth. These are also rich in alluvial gold. The mean temperature ranges from 24ºC in the coolest month of July to about 29ºC in the hottest months of March-April, with a bi-modal rainfall pattern.

The good nature of the vegetation and soils tend to promote the cultivation of cash crops such as cocoa, oil palm, food crops (plantain, cassava, maize, and cocoyam), citrus. Other major economic activities in the district include mining on both small and large scale, and timber logging.

1.7 LIMITATIONS OF THE STUDY

A couple of limitations could be identified with this study. The first limitation has to do with respondents. Most of them, whom the researcher came across, were not able to write. The researcher had to interpret the questionnaire in the local language, and write the response given by the respondents. In addition the respondents prolonged a simple answer to a question just to impress. These consumed a lot of time allocated for the survey.

Moreover, the researcher had to meet a lot of dignitaries including agriculture supervisors, the assemblyman and the chiefs before permission could be granted to distribute questionnaire to farmers. This reduced the time the researcher had to conduct the survey, and in addition limited the number of respondents intended for the survey.

Lastly, resource constraint was a major problem in terms of travelling and lodging expenses to administer questionnaires in the study areas which was very far from the researcher's place of residents. Coupled with that, the survey areas were in five different communities or villages of distant places. This to a large extent affected the sample size that was intended for the research.

1.8 ORGANISATION OF THE STUDY

The study has been organized into five chapters. Chapter one introduces the study by providing the background of the study, problem statement, objectives of the study, methodology, justification and organization of the study. Chapter two reviews relevant literature on cocoa production in Ghana, marketing of cocoa, government agricultural intervention policies which includes trend in agricultural policies in Ghana, types of agricultural policies, cocoa yield in Ghana, causes of low cocoa production in Ghana. Chapter three presents the research methodology of the study. Chapter four presents the data collection and analysis of the data. Chapter five, the last chapter of the study, provides the summary of findings, conclusions and recommendations.

1.9 SUMMARY

In this chapter, we considered the background, problem statement and objectives of the study. Justification, methodology, scope and limitations of the study were also put forward. In the next chapter, we shall put forward relevant and adequate literature on the subject matter.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter recounts literature on studies done by other researchers and publications relevant to the current study. It informs readers about the historical development of cocoa sector in Ghana. It also looks at the cocoa production and marketing in Ghana, government agricultural intervention policies in the cocoa sector, cocoa and Ghana's economy, cocoa yield in Ghana, in which comparison of cocoa production in Ghana and other major producing countries are examined. It also reviews causes of low cocoa production in Ghana.

2.1 BRIEF HISTORY OF COCOA PRODUCTION IN GHANA.

Cocoa originated from Mexico and parts of tropical America (Manu, 1989). Cocoa, an important commercial crop of the equatorial region, is extensively planted in areas bordering the Gulf of Guinea in West Africa, which include countries like Ghana, Nigeria, Cote d'ivoire, Liberia, Sierra Leone, Togo and Dahomey (Kishore, 2010). Most cocoa is produced by around 1.6 million small farmers on plots of less than three hectares (ha) in the forest areas of the Ashanti, Brong-Ahafo, Central, Eastern, Western, and Volta regions of Ghana (ESDD, 2002). The first cocoa export to Europe from Veracruz to Cadiz dated back to 1585 (Mossu, 1992).

Ghana exported about 546.72 tones (T) of cocoa in 1900, 2,856.00T in 1905, over 26,520.00T in 1911 and in 1936, she exported 317,220T, representing half the total world production at the time (Manu, 1989).

In 1964/1965, Ghana became the leading producer of cocoa (Adjinah and Opoku, 2010). Cocoa production is carried out in about six out of the ten regions in the country namely the Volta region, Central region, Brong-Ahafo region, Eastern region, Ashanti region, and the Western region which supply about fifty (50) percent of annual production (Anim-Kwapong and Frimpong, 2005). Two main seasons have been identified in the production of cocoa in Ghana, the light crop season, which starts from September to June, and the main crop season which runs from October to May/June. The cultivation of cocoa involves a series of activities ranging from planting, maintenance, harvesting, drying and bagging the beans for marketing.

Cocoa production is carried by smallholder farmers, who normally grow food crops alongside the cocoa cultivation. Cultivation is done using simple tools like cutlass, and sometimes hoes for the land preparation ahead of the seedlings planting. Normally the seedlings are nursed by the subsistence farmer himself, but formerly it was supplied by the cocoa research institute of Ghana. In choosing the site for the farm, the farmer usually selects a place, which is a little bit far in the bush to reduce disturbances to the yield of the cocoa tree (Tudhope, 1909).

The bush is cleared in the same manner when the land is being prepared for the cultivation of food crop: clearing of weeds leaving few large trees standing, heaping and burning of the weeds. Larger trees are left to give shades to the new seedlings. In addition, the farmer starts by planting foodstuffs such as cocoyam, plantain and cassava. The young seedlings are then planted alongside the food crops. These are done to give a little bit of shades to the cocoa seedlings, since the young seedlings does not require too much of intense heat from the sun.

Planting is carried out using the hoe, and sometimes the cutlass. After planting, maintenance needs to be observed even at fruit bearing stage. The cocoa tree takes about 3-5years to bear fruit, depending on the variety.

There are three main types of varieties of cocoa cultivated in Ghana: Amelonado, Amazonia and Hybrid. The Amelona and the Amazonia take about five (5) years to bear fruit unlike the hybrid which requires only three (3) years of gestation period (COCOBOD, 2009; Tudhope, 1909). Within this period, maintenance is carried out by the farmer to ensure good yield. In this case, the farmer bore the cost of spraying, fertilizing, maintenance and weeding of the farm himself. However, according to Tudhope (1909), many well to do farmers give their farm on contract to caretakers to manage.

In that instance, the caretaker takes the responsibility of maintaining the farm whilst the owner gives expenditure out to the caretaker to carry out weeding, fertilizing and spraying of the farm. This goes on till the harvesting time (which is determine by the yellowish nature of the cocoa pods), when the yield is divided into three, where the caretaker receives one-third of the crop, while the remaining two-thirds goes to the owner. This is a form of sharecropping. In the Ghanaian language, it is called "Abusa", meaning division into three. In some communities, the owners pay some fixed proportion of the harvest to the caretaker (MOF, 1999).

After harvesting, which is usually done with cutlass, the pods are broken by means of cutting it into two with a cutlass or hitting it against a stone. The beans are then gathered and heaped in the farm for seven (7) days to ferment before it is carried to the house for drying. It is then bag in 62.5kg, which is sold to the Licensed Buying Companies, which have their purchasing clerks in the rural areas.

2.2 MARKETING OF COCOA

The marketing system of Cocoa in Ghana has two main components, the internal marketing system and the external marketing system. According to COCOBOD (2009), the internal marketing system has received some modification since 1992/93 light crop season. Formerly the Produce Buying Company (PBC), a subsidiary of the COCOBOD was the sole purchaser of cocoa beans directly from the farmers. However this has changed, many private companies have been given the license to purchase cocoa directly from the farmers. This was done to introduce competition into purchasing of cocoa, in order to bring some efficiency in the internal marketing system (COCOBOD, 2009).

In spite of this, it is undeniable fact that the Produce Buying Company (PBC) is still the largest purchaser of cocoa beans in Ghana, even though its market share has been limited to about 68 percent as at 1997/98 season (MOF, 1999). Again, COCOBOD continues to keep the activities of the private licensed buying companies in check to ensure healthy competition in the internal marketing system. In addition to the discussions of issues concerning the activities of the Licensed Buying Companies (LBC's), Thompson (2005) noted that the price paid to farmers by the Licensed Buying Companies (LBC's), is determine by COCOBOD Producer Price Review Committee (PPRC) which includes the Licensed Buying Companies (LBC's), Cocoa hauliers, Quality Control Division (QCD), Cocoa Marketing Company (CMC) and the Ghana Cocoa Board (COCOBOD). This is normally a percentage of the Free on Board (FoB) price, and it takes into accounts the cost of production to the farmer. And attempt is being made by the COCOBOD, to increase this to 70 percent in future (MOF, 1999). Currently the Licensed Buying Companies (LBC's) has increase to twenty-six (26). See Appendix.

After the purchase of the Cocoa beans from the farmer the quality of the beans is ensured by the Quality Control Divisions (QCDs), of COCOBOD, and this include the grading and sealing of the beans. Under the request of the COCOBOD, this is carried out by the Quality Control Divisions (QCD's), of the Licensed Buying Companies (LBC's), which forward the beans to COCOBOD for the sale and storage of the beans before it is exported by the Cocoa Marketing Company (CMC).

The availability of cash with regard to inputs such as labour and chemicals is important in production of cocoa are provided by the Licensed Buying Companies (LBCs). Farmers are generally liquidity constrained and need credit in order to maintain or expand production. The demand for credit is confirmed in interviews with farmers. Many Licensed Buying Companies (LBCs) are reluctant to provide credit to cocoa farmers since they mistrust farmers. If the Licensed Buying Companies (LBCs) give farmers credit in return for a guarantee of cocoa it cannot be guaranteed that the farmers will supply the cocoa to them and not to their competitors. Furthermore some the Licensed Buying Companies (LBCs) have experienced problems with theft, i.e. when farmers have not returned the loans. Hence most Licensed Buying Companies (LBCs) do not provide credit or only provide credit to large-scale farmers.

The beans is sold to both international and local companies for processing (COCOBOD, 2009). The external sale of cocoa is the sole responsibility of the Cocoa Marketing Company (CMC), and every effort push forward by various external agencies for liberalization of Ghana's external market of cocoa has been resisted by the Government of Ghana.

Prior to independence, the world market price of cocoa was high, enabling the Cocoa Marketing Board (CMB) to pay farmers relatively high producer prices. As a result, planting of cocoa trees, and hence the country's capacity for growing cocoa, increased substantially. From 1950 to 1960 production of cocoa doubled. Due to Ghana's large share of world cocoa exports (which averaged around 30 percent of the world market between 1911 and 1978), the production increase depressed world market prices. This price decrease affected farmers negatively, but from the government's point of view the loss of revenues due to lower prices was compensated for by an increased demand for cocoa. The use of fixed nominal producer prices and high domestic inflation led to a further decrease of the producer price. Despite the important role of the cocoa sector (at the time of independence, cocoa was the country's largest single source of government revenues), the government paid it very little attention. The negative impact of decreasing prices on production therefore became apparent only in the middle of the 1960s and was invigorated by increased smuggling of cocoa to Côte d'Ivoire, which offered farmers higher producer prices.

2.3 GOVERNMENT AGRICULTURAL INTERVENTION POLICIES

2.3.1 TRENDS IN AGRICULTURAL POLICIES IN GHANA

Mundia (1991) defined agricultural policy as an instrument used to influence the allocation of resources within the agriculture sector and among several sectors of an economy. From 1975 to 2008, various governments have embarked on policy initiatives with some being pushed forward by external agencies. Government provides extensions and inputs to farmers as well as bank and credit facilitators which are important actors on the market. Hence the cocoa sector consists of a chain of economic activities related to production, transportation, quality control and marketing of cocoa. These policies have intention of putting agricultural sector back on tract and improving upon on it. However most have failed due to inconsistencies in its implementation and failure to put in place certain institutional structures.

Even though 2001 was a year of total transformation of Agricultural policies in the cocoa sector, Nyanteng and Seini (2000) did not acknowledge that period. A contributing factor to this elimination was that, their paper was published before this remarkable period. To them agriculture policies can be analyzed by considering only the periods of 1970-82, and 1983-95, which is distinguished into pre-and post-structural adjustment periods. The period 1970-82, was not a smooth one as far as policies towards agriculture is concern. It saw political instability and rampant changes in economic policies which had a negative effect on Agriculture sector. In a bid to recover the economy, the private sector was chosen as the engine of development. Agricultural inputs like equipment and machines were subsidized. Moreover, farmers were assisted with extension services.

Coupled with that development boards were established for many commodities including cocoa. In addition, there was liberalization of the cocoa purchasing. This flourished the country with so many licensed buying companies (LBCs) (Nyanteng and Seini, 2000).

These policies were reversed after the economy went to the command type again. This was the period between 1976 and 1982. Policies in this period included a return to monopoly system of cocoa purchase, import controls, subsidization of imported consumer goods. In addition, operation feed yourself (OFY), a policy aim at achieving self sufficiency in food, was instituted. However, this period has been described by Nyanteng and Seini (2000) as a period of despair, as it was within this same period that saw farmers smuggling subsidized fertilizers and insecticides to obtain higher prices. One of the policies namely agriculture pricing policy channel revenue from out of agriculture in favour of urban consumers in a form of lower food prices (Hadjimichael et al., 1996). Moreover, there was frequent political anarchy through coup d'état, economic mismanagement and deterioration in terms of trade (Abizadeh and Yousefi, 1996).

The period 1983-95 saw the need to revamp the economy. As a result, Economic Recovery Programme (ERP) was lunched. This brought a new era for agriculture. However, subsidies on fertilizer, pesticides and farm equipment were removed (Naylor, 2000; Nyanteng and Seini, 2000). The period was organized into two stages. The main objective in the first phase was to stabilize the economy, and improve government finances. In agriculture, the main objectives was to attain self-sufficiency in cocoa production, build up buffer stock for maize and cereals, ensure food security and price stabilization, and to boost cocoa production that would increase foreign exchange earnings (Nyanteng and Seini, 2000).

In order to review the structures in the economy which was acting as a hindrance to growth, the second phase of the Economic Recovery Programme (ERP) was instituted. It concerned the restructuring of the state's institutions and practices especially in the cocoa sector. This was achieved with the assistance from the World Bank to increase efficiency in the production and marketing of cocoa. It was therefore dubbed the Structural Adjustment Programme (SAP). To complement this effort, cocoa farmers were given a greater share of the world price. Conversely, the size of the COCOBOD was reduced. Coupled with that the government no longer subsidized fertilizer, insecticides etc. (Naylor, 2000; Nyanteng and Seini, 2000). The sitting government continues to improve the cocoa sector with free distribution of spraying chemicals to cocoa farmers to improve the yield. Furthermore, the producer price of cocoa was increase in 2001 and October, 2009.

2.3.2 TYPES OF AGRICULTURAL POLICIES

2.3.2.1 AGRICULTURAL PRICING POLICY

Cuong (2000) defined pricing policy as a policy that concern the influence of the level of prices received by farmers and paid by consumers for farm products. However, agricultural price policy in simple terms can mean a government intervention that affects the prices of inputs and output of agriculture. The input price relates to fertilizers, studies of tractor prices, interest rates and wage rates (Rao, 1989). Krueger (1996) distinguished between direct and indirect government policies. To him direct policies are those that are aimed directly at agriculture and include taxes on exports, subsidies on prices, whilst the indirect policies are those aimed at either the economy in general or other parts of the economy but in the long run affect agriculture. They include exchange rate policies, restrictive import licensing, import prohibition. These policies inflate the prices of inputs and food that the farmer purchases. Cuong (2000) enumerated two types of interventions in agricultural price-direct and indirect. The direct include government procurement, import tariff, quota system and subsidies, while the indirect consist of exchange rate and credit policy. Under this policy the producer price of cocoa was increase in 2001 and October 2009.

2.3.2.2 COCOA DISEASE AND PEST CONTROL (CODAPEC) PROGRAMME

The government of Ghana through the Cocoa Board initiated a National Cocoa Disease and Pest Control (CODAPEC) programme, popularly called the Cocoa Mass Spraying Programme . This was done to control pests and diseases that affect cocoa production, and also to boost the morale of farmers to put in their maximum best in the cocoa industry.

Akosa (2001) found out that Mass Spraying was last undertaken in the 1960s when the country was the world number one producer of cocoa. The introduction of the mass spraying exercise between 1959 and 1962 is believed to have resulted in the high production of over 580,000MT recorded in the 1964/1965 season. Production dropped to the lowest level of one hundred and fifty-eight thousand, nine hundred and fifty six metric tonnes (158,956MT) in 1983/1984, which made Ghana, lost her enviable position as the world's number one producer to neighboring Cote d'ivoire. However, cocoa production rose to seven hundred and thirty-four thousand, six hundred and ninety- nine metric tonnes (734,699M T) in 2003/04 cocoa season (GNA, 2005).

2.3.2.3 COCOA HI-TECHNOLOGY PROGRAMME (CHTP)

In 2002/2003 cocoa season, there was also introduction of the Cocoa Hi-technology programme. Under this programme, farmers were supplied with packages of fungicides, pesticides and fertilizers to help increase their yields per a hectare of farm land. The fertilizers under the policy were supplied on credit basis by COCOBOD to beneficiary cocoa farmers in the initial stages. Payments were later made by the beneficiary farmers during the ensuing harvesting season in installments.

2.3.3 OBJECTIVES OF AGRICULTURAL POLICIES

Different objectives are outlined by different government towards agriculture in different country. Agricultural policy support in United Kingdom in the 1950s was intended to improve the net income of farmers so as to enhance their purchasing power. In addition, it was intended to encourage farmers to increase their output so that the country can be self-reliant and save its reserve (Drummond, 1951). To Mollett (1988), the main objectives of the agricultural policy is to stabilize prices for both producers and consumers, improve farmers income and also as output and export incentives. These are not different from Jabara's (1985) views on the objectives of agricultural policies in Kenya. To her, the government of Kenya intervene in the pricing and marketing of agricultural products in order to give producers acceptable and stable prices, and at the same time enable consumers to buy at reasonable cost. The intervention was also intended to protect domestic markets for import substitution crops.

Government in both developed and developing countries have intervened in the market of agriculture to stabilize prices, subsidize food, build irrigation dams and support the use of fertilizers. They have been motivated by the incompleteness of the insurance market to give farmers credit, provision of public goods like water projects, imperfect information, externalities and distribution of income (Stiglitz, 1987). Furthermore, in India, the main objective of the agricultural price policy was to target self-sufficiency in food production and to protect consumers (Vyas, 1994).

Mundia (1991) enumerated several objectives of the agricultural pricing policy. The main ones he mentioned are: to stabilize producers' income, allocate resources, bring about desired levels of income distribution and as a means to promote production.

Based on the various objectives mentioned by the above researchers, it can be concluded that the main idea behind intervention of governments in the production and marketing of Agricultural commodities is to motivate farmers to produce and also to stabilize their income levels. Consumers too are not left out, as they also enjoy subsidized price of food.

2.4 COCOA YIELD IN GHANA

Generally, yields of cocoa are lower in Ghana than in other major producing countries. Whilst the average cocoa yield in Malaysia stood at 1800Kg/ha and 800Kg/ha in Ivory Coast, it was only 360Kg/ha in Ghana (Anon, 1999).

Comparing the yields in Ghana with other major producers, it is observed that Ghana's yield in the cocoa sector has not been encouraging when head-to-head comparison is made with other major producing country like Cote d' Ivoire. Its output as at 1999 was 30 percent below that of Cote d'Ivoire, while on the average, it fell 13 percent below that of the Africa continent (MOF, 1999). Two main reasons have been identified for this down trend. The first reason is due to the old nature of significant percentage of the cocoa-tree stock (Anim-Kwapong and Frimpong, 2005) and the second reason has been given by MOF (1999) as the poor yielding of the variety of the cocoa tree. Most of the tree stocks, as the literature continues, are of the Amazonia and Amelonado varieties, which have a lower yield as compare to the hybrid.

Moreover, most major producing countries make use of better modern technology, which supersedes that of the method used in Ghana. Majority of farmers hardly make use of fertilizers and pesticides. This situation has calmed down with the introduction of the mass spraying programme in 2001/02 (Anim-Kwapong, 2005; MOF, 1999).

The characteristics of cocoa production in Ghana seem to merge with other producing country like Cote d' Ivoire when emphasis is placed on the type of soil and climate. Both countries have the same climate and soil type. All the cocoa growing areas lie in the forest belt. The difference in yield may, therefore, be attributed to the level of input application, the old nature of the trees, farmers' adherence to maintenance, and the acres of land farmers cultivate. Cultivation in Ghana has been on a smaller scale, and various attempts to embark on plantation in the 70s were failed as a result of difficulty in acquiring land, and in addition shortage of labour (MOF, 1999).

Table 2.1: Cocoa productions (thousand tonnes) of major producing countries in the World

Year / Countries	99/00	00/01	01/02	02/3	03/4	04/5	05/6	06/7
Brazil	124	163	124	163	163	171	162	126
Indonesia	410	392	455	410	430	460	530	490
Cote d'Ivoire	1409	1212	1265	1352	1407	1286	1408	1292
Ghana	437	395	341	497	737	599	740	614
Malaysia	45	35	25	36	34	29	30	31

Source: ICCO Annual Reports (2002, 2005, 2006, 2008)

However, production figures showed that yield has increased substantially in virtually all the districts across Ghana in recent times (Adjinah and Opoku, 2010). Research has shown that cocoa farmers can increase cocoa yield to 1000Kg/ha or more (Aneani et al., 2011). A look at table1 shows that Ghana's production has improved as compare to other major producing countries like Indonesia, Brazil and Malaysia. Apart from the 2001/02 production level which was lower than that of Indonesia, the country has performed better than these countries.

Bosompem et al., (2011) analysed the perceived impact of the Cocoa High Technology Programme (CHTP) on the livelihoods of cocoa farmers who adopted the technology using the Sustainable Livelihood Framework (SL) Approach. The observation was that the level of impact of the programme on farmers' livelihoods as a 'whole' though higher, was below the expectations of cocoa farmers. The study further revealed that farmers' yields were significantly improved by the CHTP. The results of stepwise multiple regression analysis revealed that fertilizer application, harvesting, fermentation and drying technologies and fungicide application were the best predictors of impact on livelihoods of cocoa farmers.

2.5 CAUSES OF LOW COCOA PRODUCTION IN GHANA

Ghana is a force to reckon, when it comes to the production of cocoa in the world, and the economy depends heavily on the foreign exchange proceeds derived from it. However production levels have not been consistent over the years except in the mid-1980s and early 2000 where the yield seems to have been on track, but this notwithstanding have some elements of inconsistency in it (Dormon et al., 2004).

The down trend has been perceived as due to a number of factors. First is drought, which is a major cause of low level of production in the cocoa sector. During this period bush fires become rampant, and this is triggered by the activities of Marijuana smokers, rat seekers and bad farming practices such as slash and burn method. These normally cause severe fire outbreak which can destroy lots of cocoa farms. This issue have been discussed by Thompson (2005) advocated that the prolonged drought in 1980s damaged an estimated 30-40 percent lots of Cocoa farms located in Volta, Ashanti and Brong-Ahafo regions of Ghana causing a drastic reduction in the output level of cocoa. As a result of that, most farmers became discouraged and abandoned their farms, others took the risk and engaged in replanting exercise.

In addition to drought, the second factor which is responsible for the low production of cocoa in Ghana is aging cocoa trees. This holds a general truth that, when organisms become old, they tend to diminish in their capacity to be productive. MOF (1999), confirmed this with a fact that an estimated thirty (30) percent of area under cocoa cultivation has been unproductive due to the old nature of the trees. Moreover the number of cocoa trees that are grown per hectare has not been encouraging, it has been lower than the recommended number.

Several statistical methods and models have being used in some studies to investigate the causes of low production of cocoa in Ghana. For instance, in a study by Uwagboe et al., (2012), the decline in productivity of cocoa is attributed largely to pest and diseases. In their research the socio-economic factors and Integrated Pest Management Utilization among cocoa farmers, systematic sampling used in picking the respondents. Also structure questionnaire was used to elicit information from the respondents, which were presented with charts, frequency, percentages and analyzed with chi-square. The study revealed that out of sixty (60) farmers, ninety (90) percent were males who were in their prime age and 73.3% had formal education. Utilization of Integrated Pest Management was high (75.0%), which signifies that most farmers have adopted the technique. The study further showed that sex, education and memberships of associations contributes to farmer's high utilization of Integrated Pest Management (IPM).

Similarly, in the study by Dormon et al., (2004), a diagnostic study was carried out to understand farmers' views on the problems of cocoa production in three villages in the

Suhum-Kraboa Coaltar District, Eastern Region, Ghana. An action research approach was followed to gather and analyze qualitative data. It was concluded that low productivity was identified as the main problem and the causes were classified into biological and socio-economic factors. The biological factors include the incidence of pests and diseases. The socio- economic causes were indirect and include the low producer price and the lack of amenities like electricity, which leads to migration , as a result there is labour shortages and high labour cost. It was further concluded from study that the biological and socio-economic causes of low productivity are related in such a manner that taking them separately will not overcome the problem unless both are tackled in a holistic way.

Kyei et al., (2011) analysed the factors that affect the technical efficiency of cocoa farmers in the Offinso of District in Ghana and the basic socio-economic variables that affect their performances. Primary data was collected by the use of questionnaires. Statistical tool was used to estimate the stochastic inefficiency determinants based on farmers. Analyses showed that the model of production were statistically significant at 0.00. Input factors stated include labour, quantity of fertilizer, pesticides, modern equipments, age of trees and farm sizes. It was concluded that labour, capital and age of farm would lead to increase in output. Inefficiency would decrease drastically if variable such as educational level, farming experience and family size of the farmer are increased.

Anim – Kwapong and Frimpong (2005), uses multiple regression analysis to analyze the impact of climate change on cocoa production. The multiple regression analysis showed that over 60 percent of the variation in dry cocoa beans could be explained by a combination of the preceding year's total annual rainfall, total rainfall in the two driest month and total sunshine duration. Other factors that affect cocoa yield include drought (prolonged dry seasons), low soil fertility, pests, diseases, lack of access to improved planting materials, and low income of most farmers. The analysis further showed that given the low incomes of most farmers, the low motivation to further invest in cocoa and the lack of formal credit, most farmers cannot adopt recommended practices to mitigate the impact of climate change on cocoa production.

2.6 LOGISTIC REGRESSION MODEL

Logistic regression model has long been recognized as an important statistical tool for analysing dichotomous response data. Historically, logistic regression was proposed in the late 1960s as an alternative to ordinary linear regression in analysing and prediction of dichotomous outcome (Cabrera, 1994). It has been used in a wide range of fields, including engineering, agriculture, medical, humanities etc.

In one current study by Asenso-Okyere, et al., (2013), logistic regression model was used to determine the factors that significantly affect the decision to let a child attend school exclusively or do some work on the cocoa farm in cocoa communities in Ghana. The study was based on 2007 cocoa sector survey. In the study, the logistic regression model revealed that the factors that were found to positively and significantly influence farmer's decision to let the child attend school exclusively were: main source of drinking water being borehole, sex of a child, age of a child, and household heads living in the Ashanti cocoa region.

Also, using a survey of two hundred and forty-three (243) farmers to ascertain the factors that make farmers choose which marketing channel they would like to use in order to commercialize their cocoa, Higuchi (2010) developed a bivariate logistic regression model to analyze and examine the effect of each explanatory variable on the dichotomous dependent variable. Membership in Acopagro or distribution of their products through intermediaries was used as the dichotomous dependent variable.

In another study by Mapa et al., (2012), logistic regression model was used to show what determines the states of high poverty in the Philippines. The model showed that a one-percent increase in agricultural output in the previous quarter reduces the probability of being in the high state of poverty by about eight (8) percentage points, all things being the same. Again the study showed that poverty incidence in the country is dynamic and frequent monitoring through self-rated poverty surveys is important in order to assess the effectiveness of the government programs in reducing poverty. It was finally concluded in the study that self-rated poverty surveys can complement the official statistics on poverty incidence.

Also Raut (2011) used binary logistic regression model and linear regression model to study the factors influencing the adoption of agricultural intensification (AI) and extent of agricultural intensification respectively at household level in the Ansikhola watershed in the central mid-hills of Nepal. Data used in the study were collected from a survey of three hundred and ten (310) households, four key informant interviews, and two focus group discussions. The results revealed that six-three (63) percent of the sampled households practice agricultural intensification, with differences in the area under cropping intensification. Additionally, the binary logistic regression model results showed that irrigation facility, higher crop yield, landholding size, access to credit, and distance to chemical fertilizer store have significant influences on adoption of agricultural intensification. Likewise, the linear regression model results showed that total amount of fertilizer application, net income from cereals and vegetables, and distance to the chemical fertilizer store have significant influences on the extent of agricultural intensification. It was finally concluded that this study results could contribute to formulating policies based on farmers' need, interest, and capacity in promoting sustainable agricultural intensification.

In order to evaluate different gully location methods, Katie (2011) developed a gully prediction model based on logistic regression using 360 sites visited, and fifty two gullies identified. Logistic regression model was developed using topographic, landuse/landcover, and soil variables. However, tests for multicollinearity were used to reduce the input variables such that each model input had a unique effect on the model output. The logistic regression determined that available water content was one of the most important factors affecting the formation of gullies. Additional important factors included particle size classification, runoff class, erosion class, and drainage class. Of the one thousand, five hundred and seventy-seven (1577) watersheds evaluated for the Fort Riley area, one hundred and ninety-two (192) watersheds were predicted to have gullies. Model accuracy was approximately seventy-nine (79) percent with an error of omission or false positive value of ten (10) percent and an error of commission or false negative value of eleven (11) percent.

At Imo state in Nigeria, Amanze, et al., (2010) developed a logistic regression model to determine the factors influencing the use of fertilizer in arable crop production among smallholder farmers, and determined socio-economic characteristics of smallholder arable crop production farmers. A multistage random sampling technique was adopted in selecting six Local Government Areas (LGAs), two communities from each selected LGA, two villages from each selected communities and five farmers from each selected village and data were collected with the aid of a well-structured questionnaire from one hundred and twelve farmers. Results of the logistic regression model showed that output of crop, level of education, farm size and price of fertilizer were important factors influencing farmers' use of fertilizer in arable crop production while gender, age and household size were not. The result further showed that the average age of the farmers were 54.3years, 52.7% of them were males. The farmers spent about 8.5years in school and 20.6 years was their average farming experience. They have an average farm size of 1.3ha and household size of seven (7) persons.

Abeniyi, et al., (2010) investigated the usage of fertilizer for cocoa production at the Cross River State in Nigeria. In their study, purposive random sampling technique was used to select three cocoa producing Local Government Areas (LGAs) in the study area. Also simple random sampling technique was used to select one hundred and seven (107) respondents from the three LGAs in the state. However, data collected were analysed using descriptive statistics and logistic regression model. Results showed that 98.13% of the respondents were not using fertilizer for cocoa production. Also, results from the logistic regression model revealed that farmer's level of education ($p<0.01$), cocoa farm size ($p<0.01$), association membership of farmers ($p<0.1$) and cocoa output ($p<0.01$) are significant factors determining the probability of a farmer to use fertilizer for cocoa production. Moreover, they further concluded that majority of cocoa farmers in the study area do not use fertilizer for cocoa production and it is therefore recommended that farmers should be enlightened on the need to use fertilizer (when required) to enhance their production.

2.7 SUMMARY

In this chapter, we considered cocoa production in Ghana, marketing of cocoa, government agricultural intervention policies which include trends in agricultural policies in Ghana, types of agricultural policies and objectives of agricultural policies, cocoa yield in Ghana, causes of low cocoa production in Ghana. In the next chapter, we shall put forward the research methodology of the study.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

Data can easily be analyzed with little knowledge about the statistical and mathematical concepts behind it due to technological and engineering advancement, precisely in the field of computer science. Meanwhile, it is very important that one acquires the best of knowledge and understanding about the theoretical and conceptual framework of the statistical method to be used in order to analyze the data effectively. This chapter is therefore focused on the theoretical and conceptual framework of using logistic regression methods for analyzing categorical data.

3.1 SAMPLING TECHNIQUE AND DATA COLLECTION

The data for the study was obtained from primary source through the administration of structured and semi-structured questionnaires. This was used to obtain relevant information from cocoa farmers in the study area namely Anyanfuri, Gyaman, Nkotumso, Dominase and Nkroful were selected using purposive sampling technique. Random sampling was used to select one hundred and fifty (150) cocoa farmers from these communities. The data provided information on the socio-economic characteristics of the cocoa farmers (gender, age, education level, religious background, marital status, years of farming and family size), output or yield of cocoa and other factors such as farm size, input sources, land, labour, tenure, capital/credit facilities, road accessibilities, number of extension contacts, pests and diseases, and years of cocoa trees in the farm, mass spraying exercise, farming practices and cultural practices used.

3.2 MEASUREMENT OF VARIAB LES

Studies have indicated that the key determinants or factors that affect output of cocoa includes size of farm, sources of labour, inability to buy inputs, such as fertilizers and chemicals, availability and quality of extension officers, diseases and pests affecting crops farming practices and cultural practices years of cocoa trees in farms, age, level of education and farmers family size. The study used data on technical coefficient (input-output) of cocoa production. The input factors include land, labour, years of cocoa trees. Socio-economic variables are made up of farmer's gender, age, level of education, marital status religious background and family size.

- Land variables were per total land area in acres cultivated by the farmer which indicate the size of farm. The size of farm or land is expected to have a positive effect on output as the farmer devotes more of his total available land to cocoa cultivation; there is the likelihood that cocoa output would increase.

- Labour calculations made were based on the total number of people employed to work on a given size of land in a particular crop season.

- The farmers' educational level was determined by the number of years spent in school. Educational status is assumed to have influence on the output positivity because it will help farmers access new crop and adapt to new technology that would help to increase cocoa output.

- Family size was determined by the number of people living in the household during the crop year. It is assumed that the more adult household members a farmer have, the more household labour would be available to him.

- It is assumed that cocoa output is affected by gender of the farmer. Since cocoa farming is dominated by male farmers, it is assumed that output would be higher for male farmers than their female counterparts, all things being equal. This is because women have less access to credit and land as collateral than men, as well as relying mostly on hired labour which is scarce due to migration of the rural youth to urban areas to seek for jobs with relatively better remuneration (MASDAR, 1998).

- The age of the cocoa farmer is predicted to have a negative impact on output as the age increases the physical strength tends to reduce and this assumed to impact negatively on the output. However farmers with more experience in cocoa farming are able to apply their cropping experience in the cultivation of cocoa and this would increase their ability to adopt cocoa technologies and would therefore increase their output.

- With aging farm, there is the likelihood that the output / yield would decline.

The outputs of various farmers were measured by their total yield in bags per acre per crop season.

3.3 METHOD OF DATA ANAYLSIS

3.3.1 ANALYTICAL FRAMEWORK

Descriptive and exploratory analysis of the survey data were done based on factors such as gender, age, level of education of the farmers, religious background, marital status and family size. However, the actual analysis was aimed at finding out whether the output /yield of cocoa was affected by factors such gender, age, level of education of the farmers, years of cocoa farming, size of cocoa farm and size of labour.

The data collected was treated categorically. However non parametric statistical method especially chi-square and log-likelihood tests were utilized. Statistics involving nonparametric methods do not depend on any assumptions about the parameters of the parent population and generally assume data are only measured at nominal or ordinal level. The data collected was analyzed using the Scientific Product and Service Solution software version 16 (SPSS Inc, Chicago, IL, USA).

3.3.2 EMPIRICAL MODEL

Logistic Regression model was used to investigate the factors that affect the cocoa output. It is used in the study to predict the relative likelihood of an event happening. The aim of using logistic regression model is to identify the best fitting model that describes the relationship between a binary or dichotomous dependent variable and a set of independent or explanatory variables. The dependent variable is the population proportion or probability that the resulting outcome is equal to 1. Parameters obtained for independent variables can be used to estimate the odds ratio for each of the independent variables in the model.

The model was chosen because it handles dependent variable which is binary or dichotomous (having two outcomes), (Al-karabe lieh et al., 2009). The model involves a dependent variable (Y) and a set of explanatory /independent variables (X_i) that might influence the final probability Pi (π). These explanatory variables can be thought of as been in a k vector X_i. The value of Y has binary response variables which denotes the categories 1 and 0. It uses the generic term "success" and "failure" for the two outcomes. In the study, we code Y =1, (success) where the output/yield is high and Y = 0 (failure) where the output is low. The outcome is binomial having unknown parameter, therefore we use maximum likelihood method to estimate the parameters.

3.3 MAXIMUM LIKELIHOOD ESTIMATION METHOD (MLE)

In practice the parameter values for the binomial and multinomial distributions are unknown. Using sample data, we estimate the parameters. The estimation method for the binomial parameter is called maximum likelihood. The idea is to use a value in the parameter space that corresponds to the largest likelihood for the observed data as an estimate of the unknown parameter. Since we are estimating the parameter for binomial function we solve for the maximum likelihood estimator for the Bernoulli parameter π,which have a function

$f(\pi, x) = \pi^x(1 - \pi)^{1-x}$ the likelihood function is given by

$$L(\pi, x) = \prod_{i=1}^{n} \pi^x(1-\pi)^{1-x}$$

$$= \pi^{\sum_{i=1}^{n} x_i}(1-\pi)^{n-\sum_{i=1}^{n} x_i} \qquad (3.1)$$

Solving for the log likelihood function we have

$$l(\pi, x) = \ln\left[\pi^{\sum_{i=1}^{n} x_i}(1-\pi)^{n-\sum_{i=1}^{n} x_i}\right]$$

$$= \sum_{i=1}^{n} x_i ln\pi + ln(1-\pi)^{n-\sum_{i-1}^{n} x_i}$$

$$= \sum_{i=1}^{n} xln\pi + (n - \sum_{i=1}^{n} x_i)\, ln(1-\pi) \qquad (3.2)$$

Calculating the score function. The score function is the partial derivative with respect to the log-likelihood function.

$$S(\pi, x) = \frac{\partial}{\partial \pi} l(\pi, x_i)$$

$$= \frac{\partial}{\partial \pi}\left[\sum_{i=1}^{n} x_i\, ln\pi + n - \sum_{i=1}^{n} x_i\, ln(1-\pi)\right]$$

$$= \left[\frac{x}{\pi} + \frac{x-n}{1-\pi}\right] \qquad (3.3)$$

Let $I(\pi, x)$ be the information function. It is the $function$, that prove that the score function $s(\pi, x)$ is greater than zero.

$$I(\pi, x) = -\frac{\partial}{\partial \pi}\left[\frac{x}{\pi} + \frac{x-n}{1-\pi}\right]$$

$$= -\left[\frac{-x}{\pi^2} + \frac{x-n}{(1-\pi)^2}\right]$$

$$= \frac{x}{\pi^2} + \frac{n-x}{(1-\pi)^2} > 0 \qquad (3.4)$$

Solving for the maximum likelihood (ML) estimator is given as

$$s(\pi, x) = 0$$

$$S(\pi, x) = \frac{\partial}{\partial \pi} l(\pi, x_i)$$

$$= \frac{\partial}{\partial \pi}\left[\sum_{i=1}^{n} x_i\, ln\pi + n - \sum_{i=1}^{n} x_i\, ln(1-\pi)\right]$$

$$= \left[\frac{x}{\pi} + \frac{x-n}{1-\pi}\right]$$

$$\frac{x}{\pi} + \frac{x-n}{1-\pi} = 0$$

$$x(1-\pi) + \pi(x-n) = 0$$

$$x - x\pi + x\pi - n\pi = 0$$

$$n\pi = x$$

$$\hat{\pi} = \frac{x}{n}$$

Where $\hat{\pi}$ is the estimator of the parameter π.

Let $\pi = \hat{P} = \frac{x}{n}$ be the Maximum Likelihood (ML) estimate for π where p is the sample proportion and $\bar{x} = \frac{x}{n}$ is the mean for the binomial distribution and n is the number of trials. As the number of trials increases the sample proportion trends to be closer to the parameter π. In general, for binomial outcome of Y success in n trials, the maximum likelihood estimate of

$\pi = \frac{Y}{n}$, where π the probability of success for the n trials and p is the sample proportion of success for the n trials. Let π represent the probability that the success outcome occurs in the population. The probability of "failure' outcome is then (1− π). Thus we define a dichotomous outcome variable as

$$Y = \begin{cases} 1 \; if\ the\ outcome\ is\ a\ success \\ 0 \; if\ the\ outcome\ is\ a\ failure \end{cases}$$

The model is in the form $\pi = \mathrm{E}\left[\left({Y_i}/{n_i}\right)\backslash X_i\right]$, where n_i is the number of trials.

Since the relationship between the dependent variables and the independent variables are not linear ,the model for π is fitted by using the transformation of π called the logarithms of the odds of the success outcome. The odds are defined as the probability of a success outcome divided by the probability of a failure outcome. The formula is given by

$$\text{Odds} = \frac{\Pr(success)}{\Pr(failure)} = \frac{\Pr(success)}{1-\Pr(success)} = \frac{\pi}{1-\pi} \quad (3.5)$$

The value of π is within interval (0, 1) and the odds can take values with the interval (0, ∞)

Writing in terms of estimated sample proportion (p)

$$odds = \frac{p}{1-p}$$

The odds are non-negative and interpreted as number of times a success is more likely than a failure. The logistic regression model is written in terms of the logarithms of the odds of the success outcome called logit. The logits of the unknown binomial probabilities (π) are modeled as a linear function of the independent variables (X_i)

3.4 LOGISTIC FUNCTION

The logistic function is given by

$$\hat{\pi}_i = \frac{e^u}{1+e^u} \quad (3.6)$$

where $\hat{\pi}_i$ is the estimated probability that the ith case is in a category and u is the regular linear regression equation.

$u = b_0 + b_1x_1 + b_2x_2 + \cdots + b_kx_k$, where b_0 is constant and $b_1, b_2, \ldots, b_k$ are coefficients of the independent variables.

Rewriting (3.6), the logistic regression equation is given as

$$\hat{\pi}_i = \frac{e^{b_o+b_1x_1}}{1+e^{b_0+b_1x_1}} \qquad (3.7)\text{, for a single predictor.}$$

This means that the probability of a success (Y=1) given the predictor variable x is a non-linear function.

In (3.7), b_0 is the regression constant and b_1 is the regression slope.

Writing the logistic regression in terms of odds ratio for success is

$$\frac{\hat{\pi}}{1-\hat{\pi}} = \frac{e^{b_o+b_1x_1}}{1+e^{b_0+b_1x_1}} \div \left(1 - \frac{e^{b_o+b_1x_1}}{1+e^{b_0+b_1x_1}}\right)$$

$$= \left(\frac{e^{b_o+b_1x_1}}{1+e^{b_0+b_1x_1}}\right) \div \left(\frac{1(1+e^{b_o+b_1x_1}) - (e^{b_o+b_1x_1})}{1+e^{b_0+b_1x_1}}\right)$$

$$= \left(\frac{e^{b_o+b_1x_1}}{1+e^{b_0+b_1x_1}}\right) \div \left(\frac{1+(e^{b_o+b_1x_1}) - (e^{b_o+b_1x_1})}{1+e^{b_0+b_1x_1}}\right)$$

$$= \frac{e^{b_o+b_1x_1}}{1+e^{b_0+b_1x_1}} \div \left(\frac{1}{1+e^{b_0+b_1x_1}}\right)$$

$$= \frac{e^{b_o+b_1x_1}}{1+e^{b_0+b_1x_1}} \times \frac{1+e^{b_0+b_1x_1}}{1}$$

$$= e^{b_o+b_1x_1}$$

Therefore $$\frac{\hat{\pi}}{1-\hat{\pi}} = e^{b_o+b_1x_1} \qquad (3.8)$$

Since the logistic regression model is written in terms the log of the odds called logit, taking natural log of both sides in (4),we have

$$\ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = ln(e^{b_o+b_1x_1})$$

$\ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = b_o + b_1 x_1$ (3.9), for a single predictor.

This means $\text{logit}(\hat{\pi}) = ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = b_0 + b_1 x_1$, for a single predictor.

For multiple predictors

$$logit\ (\hat{\pi}) = ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = b_0 + b_1 X_1 b_2 X_2 + \cdots . b_k X_k \tag{3.10}$$

Where b_0 is the regression constant and $b_1, b_2 \ldots . b_k$ are the regression slopes.

Writing (5) in terms of estimate sample proportion (p) we have

$$logit(p) = ln\frac{p}{1-p} = b_0 + b_1 X_1 b_2 X_2 + \cdots . b_k X_k \tag{3.11}$$

From (7) the logistic regression model in terms of logit transformation of the odds is given as

Logit (p) = $\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 \beta_2 X_2 + \cdots . \beta_k X_k$

Where β_0 is the model constant , $\beta_{1,}\ \beta_{2,} \ldots, \beta_k$ are the parameters of the independent variables and X_k the set of independent variables (k=1, 2…,n).

The range of logistic function is between 0 and 1, which makes it suitable for the use as probability model, representing individual risk.

3.5 FITTING A GOOD MODEL

Suppose the model contains explanatory effects (terms variables specified in the model). For the i^{th}observation, let π be the estimated probability of the observed response. The three goodness-of-fit test criteria usually used for comparing different models for the same data in LOGISTIC procedure are:

- Likelihood Test Criterion
- Wald Test Criterion
- AIC: Akaike Information Criterion

3.5.1 LIKELIHOOD TEST CRITERION

The likelihood ratio test is performed to see whether the inclusion of an explanatory variable in a model tell us more about the outcome variable than a model that does not include that variable. The likelihood ratio (LR) test is based on likelihood function. The likelihood ratio (LR) test statistic is given by

-2log $\left(\frac{L0}{L1}\right)$ = -2 [$\log(L0) - log(L1)$] = -2 ($L0 - L1$), where L_1 = maximized value of the likelihood function for the full model and

Lo =maximized value of the likelihood function for the reduced model.

For each model it fits, SPSS calculates the statistic which is -2* log likelihood (known as -2LL). This statistic is called the scaled deviance and it measures the degree of discrepancy between the observation values and the predicted values from the model. The SPSS (Software) gives the value for -2LL in the "Omnibus Tests of model coefficient" table. This value is then compared with the table value from a chi-squared distributed with "p" degrees of freedom. If the value is greater than the table value, the null hypothesis is than rejected. The SPSS provides a p – value (in the "sig" column). If this p – value is less than 0.05, then we reject the null hypothesis at 5% level of significance and conclude that the inclusion of the explanatory variable is better at predicting the outcome variable than when it is not included.

3.5.2 THE WALD TEST

This test estimates of the coefficients (i.e. the β's) in logistic regression. Using the Wald test we calculate the Wald statistic, which is the square of this ratio,

$\left(\frac{b_1}{s_{b1}}\right)^2$.

This is performed in SPSS using the method of Maximum Likelihood Estimation (MLE). The standard errors are also computed by SPSS, and their estimation also relies on MLE theory.

If the null hypothesis that $\beta_1 = 0$ is true, then this statistic has a **chi-squared** distribution with "p" degrees of freedom. The SPSS calculates this statistic and displays it in the "Variables in the Equation" along with an associated p-value. The p – value less than 0.05 indicates that the coefficient β, is significant at 5% level in predicting the outcome variable.

In most cases likelihood ratio test and wald test lead to the same conclusion. However in some cases the Wald test produces a test statistic that is non-significant when the likelihood ratio test indicates in that the variable should be kept in the model. This is because the estimated standard errors are too large and this happens when the absolute value of the coefficient becomes large so that the ratio (wald statistic) becomes too small.

3.5.3 AKAIKE INFORMATION CRITERION (AIC)

Akaike Information Criterion is another tool for model selection. Given a set data set, several competing models may be ranked according to their AIC values; the smaller AIC values represent better fits in model. AIC judges a model by how close its fitted values tend to the true values in the terms of a certain expected value. It is defined as shown in the Equation:

$$AIC = 2k - 2\ln(L) \qquad (3.12)$$

where k is the number of parameters in the model and L is maximized value of the likelihood function for the estimated model, which follows a standard normal distribution N (μ, σ^2), having mean(μ) and standard deviation (σ^2).

The function is given by f(x,μ, σ^2) $= \frac{1}{\sigma\sqrt{2\pi}} \exp -1/_2 \left(\frac{x-\mu}{\sigma}\right)^2$

The likelihood function is

$$L(x,\mu, \sigma^2) = \prod_{i=1}^{n} \frac{1}{\sigma\sqrt{2\pi}} \exp - \frac{1}{2\sigma^2}(x-\mu)^2 \tag{3.13}$$

$$= \left(\frac{1}{\sigma\sqrt{2\pi}}\right)^n \exp - \frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i - \mu)^2$$

$$= \left(\sigma\sqrt{2\pi}\right)^{-n} \exp - \frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i - \mu)^2 \tag{3.14}$$

The log likelihood function is

$$l(x,\mu, \sigma^2) = \ln\left[\left(\sigma\sqrt{2\pi}\right)^{-n} \exp - \frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i - \mu)^2\right]$$

$$= - n \ln\left(\sigma\sqrt{2\pi}\right) + \ln\left(\exp - \frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i - \mu)^2\right)$$

$$= - n \ln\left(\sigma\sqrt{2\pi}\right) - \frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i - \mu)^2$$

$$\ln L = - n \ln\left(\sigma\sqrt{2\pi}\right) - \frac{1}{2}\sum_{i=1}^{n}\left(\frac{x_i - \mu}{\sigma}\right)^2 \tag{3.15}$$

Since $- n \ln\left(\sigma\sqrt{2\pi}\right)$ is a constant represented by C

Rewriting (3.15),we have

$$\ln L = C - \frac{1}{2}\sum_{i=1}^{n}\left(\frac{x_i - \mu}{\sigma}\right)^2 \tag{3.16}$$

But $\frac{1}{2}\sum_{i=1}^{n}\left(\frac{x_i - \mu}{\sigma}\right)^2$ is the chi- square for the normal distribution, we rewrite (3.16) as

$$\text{In L} = C - \chi^2/_2 \tag{3.17}$$

where C is a constant, using Akaike information criterion. In the model substituting (3.17) into (3.12), we have

$$AIC = 2k - 2\left(C - \chi^2/_2\right)$$

$$= 2k - 2C + (\chi^2)$$

By ignoring the constant means AIC = $2k + \chi^2$ for model comparism.

The AIC takes into account both the statistical goodness of fit and the number of parameters that have to be estimated to achieve this particular degree of fit. Lower values of the AIC indicates the preferred model, that is, the one with the fewest parameters that still provides an adequate fit to the data.

3.6 MEASURES OF THE PROPORTION OF VARIATION

The statistic R^2 gives the proportion of variation in the outcome variable being explained by the model. The variations given by SPSS called the Nagelkerke's R^2 (adjusted R^2) and Cox and Snell's R^2. Cox and Snell's R^2 has the disadvantage that for discrete models (such as logistic regression) it may not achieve the maximum value of one, even when the model predicts all the outcomes perfectly but Nagelkerke's R^2 reach a maximum value of one.

3.7 STRATEGY FOR MODEL SELECTION

The technique used in analyzing the data (logistic regression) is backward stepwise regression. This is where the analysis begins with full or saturated model and variables are removed from the model in an iterative process. The fit of the model is tested after elimination of each value to ensure the model still adequately fits the data when no more variables can be eliminated from the model the analysis has been completed.

3.8 INTERPRETATION OF LOGISTIC MODEL

The logistic regression model can be written on three different scales namely logit, odds, and probability. It can therefore be interpreted on these different scales.

The logistic model in the form of logit for multiple predictors is in the form

$$logit\ (Y) = ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = b_0 + b_1X_1b_2X_2 + \cdots . b_kX_k \tag{3.18}$$

where b_0 is the regression constant and $b_1, b_2 \ldots . b_k$ are the regression slopes, is interpreted as is that a unit change in $X_1, X_2, \ldots X_k$ increases the log odds (logit) of Y by $b_1, b_2 \ldots, b_k$, on average .

The model $logit\ (Y) = ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = b_0 + b_1X_1b_2X_2 + \cdots . b_kX_k$ can also be written in the form of odds model by taking the exponent of both sides, we have

$$e^{ln(Y)} = e^{ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right)} = e^{b_0+b_1X_1b_2X_2+\cdots . b_kX_k}$$

$$Y = \frac{\hat{\pi}}{1-\hat{\pi}} = e^{b_0+b_1X_1b_2X_2+\cdots . b_kX_k}$$

$$= e^{b_o}\ e^{b_1}\ e^{b_2} \ldots e^{b_k}$$

The odds that a response is positive (i.e Y =1), when x =0 is e^{b_0}. As x_1 increase by 1 unit the odds that y =1 changes by a multiplicative factor e^{b_1}. This factor is called an odds ratio , and is computed by SPSS and displayed in the final column (labelled Exp(B)) of the "Variables in the Equation" table.

Finally, the model $\frac{\hat{\pi}}{1-\hat{\pi}} = e^{b_0+b_1X_1b_2X_2+\cdots . b_kX_k}$ can also be written on the probability scale, as $\hat{\pi} = \frac{e^{b_0+b_1X_1b_2X_2+\cdots . b_kX_k}}{1+e^{b_0+b_1X_1b_2X_2+\cdots . b_kX_k}}$ (3.19)

Thus, we can predict the probability ($\hat{\pi}$) of the dependent variable for any given independent variable.

3.9 TEST OF ASSOCIATIONS

The evidence of association between two qualitative variables can be performed using chi-square test of association. In order to determine the discrepancy between the sample and the theoretical distribution, we need a test statistic that measures the "goodness of fit" between the observed frequencies and the expected frequencies under the null hypothesis. This test was developed by Karl Pearson in the early 1900s cited in Agresti (2007). This test is known as Pearson chi-square statistic. The formula for this statistic is

$$\chi^2 = \sum_{i=1}^{I}\sum_{j=1}^{J}\left[\frac{O_{ij} - E_{ij}}{E_{ij}}\right]^2$$

With $(I-1)(J-1)$ degrees of freedom ,where O_{ij} is the observed cell counts and E_{ij} is the estimated expected cell counts under the null hypothesis Ho. Small value of χ^2 imply good fits and big values imply poor fits.

An alternative test statistic for testing the null hypothesis Ho for independence is the likelihood ratio statistic. This test determines the parameter values that maximize the likelihood function under the assumption that the null hypothesis Ho is true. It also determines the values that maximize it under the more general condition that the hypothesis Ho may or may not be true.

Likelihood ratio statistic for two way contingency table is given as

$$G^2 = 2\sum_{i=1}^{I}\sum_{j=1}^{J} O_{ij} log\left(\frac{O_{ij}}{E_{ij}}\right)$$

with $(I-1)(J-1)$ degrees of freedom.

The Pearson chi – square and the likelihood ratio statistic provide separate test statistics but they share many properties and usually provide the same conclusion. Taking decision concerning these two methods ,the null hypothesis Ho is rejected when the calculated chi-square (χ^2 cal) is greater than the value read from tables (χ^2 table) and the likelihood ratio statistic calculated is greater than the value read from table.[i.e G^2 cal > G^2 table(χ^2 table)].

A quotation made by Bradford H.A (1965) "Like fire, the chi-square statistic is an excellent servant and a bad master". Both the chi-square and the likelihood ratio test statistics merely indicate the degree of evidence of the association. Thus they do not study the nature of the association. Also the chi-square tests do not depend on the order in which the rows and the columns are listed. Lastly the chi-square tests required large sample size. (ie the expected cell counts are greater than five, E_{ij}> 5).

3. 10 SUMMARY

In this chapter, we considered the introduction, sampling technique and data collection, measurement of variables method of analysis which includes the analytical framework, empirical model, maximum likelihood estimation method, logistic function, fitting a good model, measures of the proportion of variation, strategy for model selection, interpretation of logistic model and test of associations. In the next chapter, we shall put forward the data analysis and results of the study. This includes introduction, descriptive analysis, analysis of statistical association logistic regression model for the variables affecting the output of cocoa and model summary.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

4.0 INTRODUCTION

This chapter shows the results and the analysis of the study. It begins with descriptive analysis on the demographic characteristics of farmers. Tests of associations were also performed by making use of the Pearson Chi-Square statistic. Finally, further analysis was carried out to analyze the effect of demographic characteristics and other factors on the yield of cocoa using the Logistic regression model. A 5% level of statistical significance was used throughout the analysis.

4.1 DESCRIPTIVE ANALYSIS

Table 4.1: Demographic Characteristics of Farmers

Characteristics of Farmers	Frequency	Percentage
Gender		
Male	117	78.0
Female	33	22.0
Age		
Less than 18 years	8	5.3
18-30 years	38	25.3
31-43 years	39	26.0
44 and above	65	43.3
Educational Level		
Illiterate	72	48.0
Primary	19	12.7
MSLC/JHS	45	30.0
Technical/SHS	11	7.3
Vocational	3	2.0

Religious Background		
Christian	112	74.7
Islam	22	14.7
Traditional	16	10.7
Marital Status		
Single	8	5.3
Married	100	66.7
Divorce	22	14.7
Widow/Widower	20	13.3
Family Size		
None	23	15.3
1-3	72	48.0
4-6	39	26.0
7 or more	16	10.7
Total Number of Farmers	150	100.0

(Source: Field Survey, 2012)

Table 4.1 shows the demographic characteristics of the 150 farmers who were interviewed. Of these 78.0% were male and 22.0% were female. Most of the farmers were aged 44 years and above (43.3%), followed by those aged 31-43 years (26.0%) and those in the age group 18-30 years (25.3%). Also, only 5.3% of this population was aged less than 18 years.

Among these farmers, 48.0% had no formal education and 12.7% had primary education. Those with MSLC/JHS education and technical/SHS education constituted 30.0% and 7.3% respectively. However, only 2.0% had vocational education.

The farmers were predominantly Christians (74.7%), with few of them in the Islamic (14.7%) and the Traditional religion (10.7%). Also, majority of them were married (66.7%), followed by those who were divorced (14.7%). This was followed by the widows/widowers (13.3%) and few of them were not married (5.3%).

Another demographic characteristic that was considered in the study was the family of the farmers. Farmers with 1-3 formed the majority with a percentage of 48.0, followed by those with 4-6 which accounted for 26.0%. Also, this was followed by those who never had any (15.3%) and lastly, those with 7 or more number of children (10.7%).

4.2 ANALYSIS OF STATISTICAL ASSOCIATIONS

Table 4.2: Chi-Square test of association for the output of cocoa and size of farm (acres)

Farm Size	Yield of Cocoa			Pearson Chi-Square
	Low	High	Total	χ^2=10.207
1-10 acres	46	84	130	$\mathrm{P-value} = 0.001$
11-20 acres	0	20	20	
Total	46	104	150	

H_0: There is no association between the output of cocoa and the size of farm.

H_A: Association exists between the output of cocoa and the size of farm.

Table 4.2 presents the results of the Pearson Chi-Square test of association between the output of cocoa and the size of farm in acres. The results provide a test for the above stated hypothesis. The Chi-Square value of 10.207 with p-value of 0.001 indicates that the test is statistically significant at 5% level. This therefore leads to the rejection of the null hypothesis in favor of the alternative which brings out the implication that, there exists an association between the yield of cocoa and the size of farm. On the other hand, this implies the output of cocoa depends on the size of farm.

Table 4.3: Logistic Regression Model for the variables affecting the output of cocoa

Parameter	Estimate	Standard Error	Wald	P-Value	Odds
Constant	-27.017	7653.164	0.000	0.997	0.000
Gender	1.148	0.674	2.900	0.089	3.151
Age	0.065	0.289	0.051	0.821	1.068
Educational level	0.891	0.207	18.501	0.000	2.438
Years of Cocoa trees	-0.212	0.066	10.438	0.001	0.809
Size of farm	0.947	0.318	19.031	0.000	2.578
Size of labour	0.427	0.120	12.578	0.000	1.533

Table 4.3 displays the results of the logistic regression model. In this model gender, age, educational level of cocoa farmers, the number of years of cocoa trees, size of cocoa farm and size of labour were used as independent variables. The dependent variable was the output of cocoa which was measured on a dichotomous scale (i.e. low and high).

The constant with p-value of 0.997 and odds ratio of 0.000 indicates that the constant has no effect on the output of cocoa. Also, gender with p-value of 0.089 suggests that gender is not significantly associated with the output of cocoa. This simply implies that gender has no effect on the output of cocoa. Similarly, the p-value of 0.821 for age indicates that age is not associated with the output of cocoa.

However, the entire remaining variables were significantly associated with the output of cocoa. The p-values of the resulting variables, i.e. educational level (p-value = 0.000), years of cocoa trees in the farm (p-value = 0.001), size of farm (p-value = 0.000) and size of labour (p-value = 0.000) suggest very strong associations. The parameter estimate of 0.891 for educational level suggest that every increase in the level of education of farmers increases the estimated odds of obtaining high output of cocoa by $\exp(0.891) = 2.438$. Moreover, the parameter estimate of -0.212 for years of cocoa trees in the farm depicts that a one year increase in the age of the cocoa trees decreases the odds of obtaining high output of cocoa by $\exp(-0.212) = 0.809$. Also, the size of farm was associated with a parameter estimate of 0.947. This suggests that when the size of farm is increased by 1 acre the estimated odds of obtaining high output of cocoa increases by $\exp(0.947) = 2.578$. Finally, the parameter estimate of 0.427 for the size of labour indicates that increasing the number of labour by one person increases the odds of obtaining high output of cocoa by $\exp(0.427) = 1.533$.

However, the logistic regression model developed in this thesis is given by Equation 4.1.

$$P(Y = 1) = \frac{e^{0.891 \times Edu - 0.212 \times YCT + 0.947 \times SF + 0.427 \times SL}}{1 + e^{0.891 \times Edu - 0.212 \times YCT + 0.947 \times SF + 0.427 \times SL}} \qquad (4.1)$$

Where Edu = educational status, YCT = years of cocoa trees, SF = size of farm and SL = size of labour. Also, $P(Y = 1)$ denote the probability of obtaining high output of cocoa.

However, the probability of obtaining low output is $P(Y = 0) = 1 - P(Y = 1)$ which is given by Equation 4.2.

$$P(Y=0)=1-\frac{e^{0.891\times Edu-0.212\times YCT+0.947\times SF+0.427\times SL}}{1+e^{0.891\times Edu-0.212\times YCT+0.947\times SF+0.427\times SL}} \quad (4.2)$$

From Equation 4.1, the estimated probability of obtaining a high of output of cocoa for a farmer with formal education (i.e. Edu = 1), when the effect of other variables are controlled is

$$P(Y=1)=\frac{e^{0.891\times 1-0.212\times 0+0.947\times 0+0.427\times 0}}{1+e^{0.891\times 1-0.212\times 0+0.947\times 0+0.427\times 0}}=\frac{e^{0.891\times 1}}{1+e^{0.891\times 1}}=0.709$$

Also, using the same equation, the estimated probability of obtaining a low of output of cocoa for a farmer with formal education (i.e. Edu = 1), when the effect of other variables are controlled is

$$P(Y=0)=1-\frac{e^{0.891\times 1}}{1+e^{0.891\times 1}}=0.291$$

These figures, therefore suggest that it is probable to obtain high output of cocoa than low output, if the farmer has formal education.

On the other hand, if the farmer has no formal education (i.e. Edu = 0), and the effect of other variables are controlled then the estimated probability of obtaining high output of cocoa is

$$P(Y=1)=\frac{e^{0.891\times 0}}{1+e^{0.891\times 0}}=0.50$$

Also,

$$P(Y=0)=1-\frac{e^{0.891\times 0}}{1+e^{0.891\times 0}}=0.50$$

gives the probability of obtaining low output of cocoa, if the farmer has no formal education. These suggest that the probability of obtaining high yield is likely as low yield when the farmer has no formal education. Similarly, controlling the effect of other variables, the probability of obtaining high output of cocoa, when the cocoa trees have being in existence for 10 years and 15 years are

$$P(Y=1)=\frac{e^{-0.212\times 10}}{1+e^{-0.212\times 10}}=0.107$$

and

$$P(Y=1)=\frac{e^{-0.212\times 15}}{1+e^{-0.212\times 15}}=0.040$$

respectively. From these results, it is evident that the probability of obtaining high output of cocoa decreases with increasing years of cocoa trees.

Table 4.4: Goodness of fit test of the Logistic Regression model

Test	**Value**	**P-Value**
Chi-Square	78.195	0.000

The goodness of fit test of the fitted logistic regression model is shown in Table 4.4. From the table, a Chi-Square value of 78.195 with p–value of 0.000 indicates that the fitted model as a whole fits significantly better than an empty model, therefore resulting to the rejection of the null hypothesis. This brings out the implication that there exist a significant relationship between the output of cocoa and at least one of the study independent variables.

4.5 MODEL SUMMARY

TABLE 4.5 Measures of the Proportion of Variation Explained By the Model

Step	-2 Log Likelihood	Cox and Snell R- Square	Nagelkerke R-Square
1	106.728	0.406	0.573
2	109.779	0.406	0.573

R- Square give the proportion of variation in the outcome variable being explained by the model. Using Nagelkerke R-Square, it indicate that the model explains 57% of the variation in the data.

4.6 SUMMARY

In this chapter, we considered the introduction, descriptive analysis, analysis of statistical association logistic regression model for the variables affecting the output of cocoa and model summary. In the next chapter, we shall put forward the data analysis and results of the study. This includes summary for conclusion and recommendations.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.0 INTRODUCTION

In this chapter, the conclusions were made based on the study findings and the recommendations were also made based on the conclusions drawn.

5.1 CONCLUSIONS

In this thesis, we studied the demographic background of cocoa farmers in the Upper Denkyira West District to determine whether there exist an association between size of farm and the output of cocoa. Finally the factors affecting cocoa production in the Upper Denkyira West District were also studied. The study used a sample of 150 cocoa farmers.

In our sample, the cocoa farmers were predominantly males, with only few being females. The number of farmers was found to increase with age with majority of them aged 44 years and above. Furthermore, farmers with no formal education were nearly half of our sample, however, the absolute number of farmers with formal education were more than those without formal education.

Finally, the results obtained from the logistic regression model showed that gender and age of farmers were not associated with the high output of cocoa in Upper Denkyira West district. However, the educational level was the only demographic variable which showed significant effect on the high output of cocoa. We found that every increase in the level of education farmers increases their odds of obtaining high output by 2.438. Also, other variables including years of cocoa trees in farm, size of farm and size of labour showed significant effect on the high output of cocoa. The odds of obtaining high output of cocoa were found to decrease with increasing age (in years) of cocoa trees by 0.809. Additionally, the odds of obtaining high output of cocoa were found to increase with increasing size of farm and size of labour by 2.578 and 1.533 respectively.

5.2 RECOMMENDATIONS

There is the need to encourage women, as well as the youth to engage in cocoa farming in the Upper Denkyira West District. District authorities and traditional heads should assist and provide them with the necessary tools, machinery, land, loans and other materials that could as assist them in their farming activities.

Also, because education appear to be an integral part of cocoa farming in the district, then it is very important to educate farmers periodically on the appropriate techniques of farm.

Finally, district authorities and traditional heads should lease out lands in low terms in order to assist farmers to expand their farms. Also, farmers should for associations so that they can assist themselves.

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APPENDICES

APPENDIX I

LIST OF LICENSED BUYING COMPANIES IN GHANA (LBC)

Abapa Golden Limited

Aboafo Buying Companies

Adwumapa Buying Company

AkuafoAdafo

Allied Commodities Limited

Armajaro

CDH Commodities

Cocoa Merchants Ghana

Diaby Company

Deo Jean Company

Duapa Buyers Company

Evadox Company

Farmers Alliance

Federated Commodities

Ghana Cocoa Marketing Association

Kuapa Cocoa Limited

Marpie Enterprise Limited

Olam Ghana

Produce Buying Company

Royal Commodities Limited

Sika Aba Limited

SompaKokoo

Trans Royal Ghana Limited

Universal Cooperative Limited

Yayra Glover Limited

Total ……………………………………………………………………………………………26

Source: COCOBOD, 2010

APPENDIX II

QUESTONNAIRE ON FACTORS AFFECTING COCOA PRODUCTION IN UPPER WEST DISTRICT

PERSONAL CHARACTERISTCS

NAME OF COMMMUNITY …………………………………………………………..

1. Gender of respondent Male [ ] Female [ ]
2. Age of respondent in years less than18 [ ] 18-30 [ ] 31-43 [ ]

   44 and above [ ]
3. Marital status of respondent Single [ ] Married [ ] Divorce [ ]

   Separated [ ] Widow/Widower [ ]
4. Religious background of respondent Christian [ ] Islam [ ] Traditional [ ]

   Others [ ].
5. Educational status of respondent. Illiterate [ ] Non Formal [ ] Primary [ ]

   MSLC / JHS [ ] Technical/SHS [ ] Vocational [ ] Tertiary [ ]
6. Size of the family None [ ] 1-3 [ ] 4-6 [ ] 7 or More [ ]
7. Occupation Major……………………… Minor……………………….
8. How many years have you been in Cocoa farming? ....
9. What type of crop do you cultivate in addition to cocoa farming?

   i. ……………………………..

   ii. ……………………………..

   iii. ………………………………

   iv. ……………………………

FACTORS AFFECTING COCOA PRODUCTION

10. What is the size of your farm (acres)? 1-10 [ ] 11-20 [ ] 21-30 [ ] more than 30 [ ]

11. Land tenure Own Land [ ] Share Crop (Abunu) [ ] Share Crop (Abusa) [ ] Absentee Farmer [ ] Hiring [ ] Inheritance [ ]

12. What are the sources of labour? Family [ ] Hiring [ ] Friends [ ]

13. Indicate your level of satisfaction of labour force. Not Satisfaction [ ] Satisfied [ ] Very Satisfied [ ]

14. What size of labour do you normally use in your farm?

....

15. If you have received input which type tick appropriately?

INPUT	YES	NO
Fertilizer		
Chemicals		
Improved seeds		
Credit/ loans		

16. For fertilizer indicate the quality used in your farm in kilograms…………….

17. For chemicals indicate the type and cost………………………………..

18. For credit/loans indicate the source relatives [ ] friends [ ] community [ ] organizations [ ] Bank / credit unions [ ]

19. Do you have extension officer who assist you in your farming activities?

Yes [ ] No [ ]

20. If yes, how many time do you receive visitations from these officer in a year?

1[ ] 2 [ ] 3 [ ] 4 or more [ ]

21. Years of cocoa trees in the farm 3-5 years [ ] 6-10 years [ ]

more than 10 years [ ]

22. Which of the following farming practices do you use? Intercropping [ ]

Mixed cropping [ ] Mono cropping [ ] Shifting cultivation [ ]

23. Which of the following cultural practices are adopted in your farm?

Prunning [ ] Weeding [ ] Removing of mistletoes [ ]

Removal of basal suckers [ ]

24. Which of the following parts and diseases affect your crops?

Mistletoes [ ] Capsids [ ] Swollen Shoot [ ] Termites [ ]

Black pod [ ] Die back [ ] Stem borers [ ]

25. Do you have any co-operative societies in your community? Yes [ ] No [ ]

26. If yes do you belong to any of the co-operative societies? Yes [ ] No [ ]

27. If yes what benefit(s) do you get from this organization?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

28. Indicate your level of satisfaction about the roads linking you farms to the market centers. Not satisfied [ ] Quiet satisfied [ ] satisfied [ ] very satisfied [ ].

29. How many bags do you currently get after harvesting your cocoa?

    ....

30. How much do you earn after selling your cocoa? State the amount in

    Gh¢……………...

MODEL SUMMARY

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	**106.728[a]**	**.406**	**.573**
2	**106.779[a]**	**.406**	**.573**

VARIABLES IN THE EQUATION

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Gender	**1.148**	**.674**	**2.900**	**1**	**.089**	**3.151**
	Age	**.065**	**.289**	**.051**	**1**	**.821**	**1.068**
	Educacat	**.891**	**.207**	**18.501**	**1**	**.000**	**2.438**
	YrCocoaFm	**.212**	**.066**	**10.438**	**1**	**.001**	**1.236**
	SizeFarm	**.947**	**.318**	**19.031**	**1**	**.000**	**2.578**
	SizeLabour	**.427**	**.120**	**12.578**	**1**	**.000**	**1.533**
	Constant	**-27.017**	**7653.164**	**.000**	**1**	**.997**	**.000**