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KUMASI

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ASSESSMENT OF FARMERS RESPONSE TO GOOD AGRICULTURAL PRACTICES (GAP) TRAINING BY (CHED) AND ITS EFFECT ON THE QUALITY OF COCOA BEANS IN NKAWIE COCOA DISTRICT

BY

KINGSLEY OWUSU- APPIAH

JULY, 2016

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NOVEMBER, 2016

DECLARATION

I, Kingsley Owusu- Appiah declare that this project work was undertaken entirely by my own effort and that the results are based on my own research and observations except for references to other academic literacy works and project report, which have been properly cited and dully acknowledged.

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Dr. B. K. Maalekuu ………………………… …..……………………
(HEAD OF DEPARTMENT) Signature Date

DEDICATION

I dedicate this Thesis to God Almighty, who gave me life and strength throughout my study and my family especially my lovely daughter Lorrita Appiah, thanks so much for your patience and love during my busy schedules. To Dr. Awunyo-Vito Dadson, thank you so much for your guidance during my studies on campus.

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ABSTRACT

The adoption of good agricultural Practices (GAP) in cocoa farming is a means for achieving high productivity. The length of time that a cocoa farm remains productive and financially viable is determined by the application of good agricultural practices. Growing consumer concerns about food safety have put pressure on agricultural commodity markets to pay more attention to produce quality. Notwithstanding the good reputation of Ghana's cocoa and the efforts to maintain quality, there are indications that quality can be compromised. This study was therefore carried out to assess farmers response to GAP training by Cocoa Health and Extension Division (CHED) and its effect on the quality of cocoa beans produced in Nkawie cocoa district. Primary data was sourced from field survey through the administration of well-structured questionnaires to (50) cocoa farmers (25 untrained farmers and 25 trained by Cocoa Health and Extension

Division. Each community had ten (10) farmers, five for trained and the other five untrained. Pesticide residue analysis and cut test was also carried out on samples of cocoa sourced from the two farmer groups. The result on the field survey indicates that about (24%) of the CHED trained farmers do not raise cocoa seedlings before planting and an appreciable number also do not line and peg before transplanting seedlings. However, about (80%) of the trained farmer remove mistletoes whiles about (82%) stored their agro-chemicals in safe places before and after use. Few (32%) of the trained farmers did bean separation after drying of cocoa beans. However, majority (88%) of them removed foreign materials from the beans during drying. The major challenges facing the farmer with regards to the CHED training programme were lack of extension teaching materials (50%) and language barrier (37.50%).The cocoa samples produced from the two farmer groups were all of high quality, however those from the CHED farmers were classified as grade I and the untrained farmers grade II based on the cut test. Chlorpyrifos was the only active ingredient detected from all the cocoa sourced from the two farmer group however, the concentration from both samples were within the EU permissible maximum residual level of 0.10 mg/kg for chlorpyrifos**.**

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CHAPTER ONE

1.0 INTRODUCTION

Cocoa is cultivated in plantations in the tropical regions throughout the world such as Ivory Coast, Ghana, Nigeria, Cameroon, Indonesia, Brazil, Ecuador, Papua New Guinea, Venezuela and Malaysia (Beckett, 1994). Cocoa is one of the important cash crops cultivated in Ghana. Its cultivation is a major source of income for most farmers in the moist semi-deciduous forest zone in the country. It is also the driving force and backbone of Ghana's economy (Masdar, 1997). The crop is one of the major sources of government's foreign exchange earnings. According to Vos and Krauss (2002), cocoa is a fundamental component of the rural livelihood system. Cocoa cultivation is a 'way of Life' and the farmers are very much attached to the crop socio-culturally.

The average yield of cocoa, estimated at 391kg/ha in Ghana, is low as compared to major cocoa producing countries, such as Ivory Coast and Brazil with a yield from 600-800 kg/ha (MASDAR Consultancy Report, 1998). This is a major source of concern and hence the main reasons for the adoption of good agricultural practices by the Cocoa Health and Extension Division (CHED). The major factors accounting for the low cocoa yields in Ghana are declining poor farm maintenance, soil fertility, scarcity of new virgin forest lands for cultivation, poor seeds, low yielding varieties, ineffective pests and diseases control, old age of cocoa trees, bushfires and low technology adoption rates (Ministry of Finance Report, 1998 and Ampofo, 1997). The adoption of improved cocoa cultivation practices would be influenced by the level of security of land tenure and, more recently, tree tenure, with sharing of ownership and benefit in the candidate trees as well as in the other products of the farm.

These issues raise concerns about land tenure and its impact on land use and on natural resource management in Ghana and Africa in general. Different studies and surveys show differences in the farming practices regarding growing, fermenting and drying the cocoa beans; not only between countries, but also between farmers within the same country. Most of the cocoa beans produced worldwide are produced by small-sized farmers, and then combined in larger and larger batches until the chocolate manufactureris reached. As the farmers' activities are responsible for defining many of the qualitative characteristics of the cocoa beans, it is easy to imagine that the chocolate manufacturers often receive very heterogeneous batches of cocoa beans due to the various farming practices (Motamayor *et al*., 2008).

Growing consumer concerns about food safety have put pressure on agricultural commodity markets to pay more attention to produce quality (Auriol and Schilizzi, 2003). Notwithstanding the good reputation of Ghana's cocoa and the efforts to maintain quality, there are indications that quality can be compromised. The problem with the quality of cocoa beans at the production level is caused by an increase in the proportion of purple beans, arising from poor farming practices, harvest and post-harvest practices (ICCO, 2012). Commodity quality assurance begins at the farm, where smallholders continuously make production decisions that influence food safety. Cocoa is Ghana's most important agricultural commodity and cocoa beans exported from Ghana are known for their consistent quality. However, at farm level, there is evidence to suggest that farmers can do more to enhance the quality of their produce (Laven *et al*., 2007, Osei, 2007).

Cocoa Health and Extension Division (CHED) of COCOBOD has over the years provided various training aiming at improving farmers' knowledge and decision-making capacity which is expected to lead to a change in production practices leading to yield increase, lower pesticide use and ultimately, general bean quality. Currently, changes in regulations in the European Union (EU), North America and Japan have called for a reflection on crop protection practices in cocoa and other commodity crops (ICCO, 2012).It is in this light that this research sought to assess the response of farmers to good agricultural practices (GAP) training by (CHED) and their effect on the quality of cocoa beans produced in Nkawie cocoa district. Specifically the objectives were to;

- Assess the respondent perception about the CHED training programme
- Identify the challenges CHED trainees face with regards to the training
- Assess the effect of CHED training on bean quality in the Nkawie cocoa district.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 HISTORY OF COCOA IN GHANA

Cocoa was believed to have been brought to the colonial Gold Coast as Ghana was then known - from Fernando Po, an island in the Gulf of Guinea, off the coast of Gabon, in 1879 and from Sao Tome in 1886, records show that in 1891, only twelve years after it first arrived in Ghana, cocoa was being exported as a cash crop (Acquaah, 1999, Adjinah and Opoku, 2010). The Bassel

Missionaries first introduced cocoa in Ghana in 1857, by planting the seeds they received from Surinam at Akropong (Gordon, 1976b; Grossman-Greene and Bayer, 2009). Unfortunately these seeds could not survive hence they tried again with seeds from Cape Palmas the following year (Grossman-Greene and Bayer, 2009).By 1861 these seeds have turned to ten young trees but only one survived by 1863 due to action of termites and beetles. Pods from this tree were distributed to other Basel mission stations at Aburi, Mampong and Krobo-Odumase in the Eastern Region where most of these plants survived (Grossman-Greene and Bayer, 2009). The Dutch, Swiss, and English though played various roles. Ghanaians believe that it was through the instrumentality of Tetteh Quarshie, a Ga blacksmith from Christainborg that the crop was disseminated and later developed in Ghana (Dand, 1997; Grossman-Greene and Bayer, 2009; Leiter and Harding, 2004). Quarshie is believed to have introduced the crop from Fernando Po to Ghana around 1879. He established cocoa nursery in Mampong- Akwapim and when matured sold pods and seedlings to local farmers (Leiter and Harding, 2004; Grossman-Greene and Bayer, 2009). These trees became the parent trees for Ghana‘s cocoa industry (Grossman-Greene and Bayer, 2009). From Akwapim, cocoa farming spread to Ashanti, BrongAhafo, Central and Western Regions, and Ghana exported her first batch of cocoa beans 80 pounds worth in 1891. By 1910-1911 Ghana was the leading producer of cocoa, producing about 40,000 tons per year (Grossman-Greene and Bayer, 2009). This trend continued till after independence in 1957, and the level did follow the upward tradgetory expected (Leiter and Harding, 2004). According to Stephen Hymer, ―the industry was developed by Ghanaian capital, Ghanaian enterprises and Ghanaian technology with little help from the colonial government (Leiter and Harding, 2004; Grossman-Greene and Bayer, 2009). Cocoa farms in Ghana are mostly small size, on individual or family owned plots rarely exceeding three acres till date; there are no large plantations owned by expatriates, multinationals or corporate entities in Ghana (Grossman-Greene and Bayer, 2009). There are also few but very large plantations, owned by local individuals who have employed caretaker farmers in various parts of the Country where, cocoa production is favourable. Perhaps the area where the colonial government had to work hard to develop the growth of the crop was Ashanti (Leiter and Harding 2004). Men in Ashanti did not engage in farming, the women engaged in subsistence farming; so as an inducement the colonial government established model farms allowing anyone who put in 1000 plants the opportunity to buy a Dane gun, one keg of gunpowder and two lead bars (Leiter and Harding, 2004). This contributed to the success in the cocoa sector around 1910-1911 as stated above; by 1939, cocoa accounted for about 80% of the country‘s total exports (Leiter and Harding, 2004).

The country continued to be the leading producer of cocoa, producing about 570,000 tons annually in the mid-1960s (Gordon, 1976b; Leiter and Harding, 2004).This success was without recourse to extension services and other infrastructural development, it is difficult to understand why the British were eager to advance the production of the cash crop yet unwilling to create the necessary conditions for this success to be achieved, Berry in 1992 described the colonial administrators as having ―lived on a shoe-string‖(Gordon, 1976b; Leiter and Harding, 2004).

They posted limited personnel to the sector, yet they were expected to raise enough revenue to cover their administrative cost since they were not prepared to subsidize recurrent or capital cost (Leiter and Harding, 2004). The administrators did not understand that the traditional method of production used by indigenes was well adapted to plentiful supply of land coupled with inadequate labour; they therefore characterized these practices as unskillful, uninventive, crude, neglectful and disorganized hence believed they resulted in the production of poor quality produce leading to low pricing of commodities from Africa in Europe (Hopkins, 1973; Leiter and Harding, 2004).

Official policy therefore, wavered between encouraging and limiting export crop production, cocoa production was further confused and constrained with colonial policies, and problems associated with land tenure system; to bring about justice they established a rigid judicial system in Ghana (Berry, 1992; Leiter and Harding, 2004). In a bid to secure good price for the produce, coastal tradesmen, producers and wealthy farmers staged a boycott from 1937-

1938 to as they call it ―break the hold European (mainly British) expatriate firms had on the marketing of peasant-produced cocoa overseas‖ (Howard, 1976; Grossman-Greene and Bayer, 2009). A group of officials who were charged to investigate the drastic decline in cocoa production around 1943 reported that, farmers only collected available crops from the trees without maintaining their farms because they were poorly compensated for their produce. This led to the spread of two major diseases (capsid pest and cocoa swollen shoot virus disease) (Danquah, 2004; Grossman-Greene and Bayer, 2009). It was so serious that the colonial government‗s report on the Gold Coast in 1947 projected that ―if left unchecked, the cocoa industry would disappear in 20years (Danquah, 2004; Grossman-Greene and Bayer, 2009).From the 1910/1911 cocoa season, Ghana became the leading cocoa producer in the world, a position it held until 1977, when it was overtaken by the Ivory Coast. The country went from being the number one cocoa producer to a period in the early 80s when, as a result of drought, bushfires, low producer prices, diseases and general economic malaise, Ghana fell to the twelfth position and produced less than 160,000 metric tons in the 1983/1984 cocoa season (Adjinah and Opoku, 2010).

2.2 IMPORTANCE OF COCOA TO THE ECONOMY

In Ghana, cocoa has played an important role in the economy of the country for over one century. Cocoa became attractive as a cash crop in Ghana because of the lower cost involved in its cultivation, compared to a popular crop like palm, as well as the favorable natural conditions that existed in the forest belts. Cocoa could be grown along with other crops and when soil conditions deteriorated the land could be left to the cocoa trees and other tracts tilled in the shifting cultivation systems of farming (Acquaah, 1999). Because of the prominence that the crop had begun to gain in the economy, even before World War II, government was seriously alarmed when the swollen shoot disease was discovered in 1936. In the process of combating this disease, a permanent research center was established at Tafo, in the Eastern Region, and product quality inspectorate, grading of beans, extension services and proper engagement of farmers in the growth of the crop were initiated (Acquaah, 1999). Since then government has continued to offer technical assistance, financial incentives and inputs like fertilizer and pesticides to cocoa farmers. Over the last decade, as a result of government intervention, cocoa production has rising reaching a peak of 740 thousand metric tons in the 2005/2006 season (Aryeetey *et al*, 2007). Constituting 7.3% of the Gross Domestic Product of the country, it is second only to gold, which first overtook cocoa as the highest foreign exchange earner in 1992; a trend which still continues.

Agriculture contributes about 35% of Ghana's Gross Domestic Product (GDP) and 60 % of total employment. The Cocoa Industry is the single largest contributor to agricultural GDP (16.5 %).

It is estimated that about 65% of the country's agricultural workforce work either directly or indirectly in the cocoa industry. In Ghana cocoa is grown on small farms owned by individuals and families in the forest zones of Ashanti, Brong Ahafo, Western, Eastern and Volta Regions. Thus the livelihood of about two million farmers and their dependents, mostly in the rural areas, depend directly on cocoa (Opoku *et. al*, 2006).

Cocoa has historically been a key economic sector and a major source of export and fiscal earnings (Bulir 1998; McKay and Arytee 2005). In recent years, cocoa production doubled, from

395,000 tons in 2000 to 740,000 tons in 2005, contributing 28 percent of agricultural growth in 2006 up from 19 in 2001 (Bogetic *et al*. 2007). Earlier evidence of the relatively low supply elasticities of cocoa producers in Ghana makes this development even more impressive (Abdulai and Rieder 1995). The boost in production has led to an increase of cocoa's share in agricultural GDP from 13.7 percent in 2000-2004 to 18.9 percent in 2005/2006. Producer prices rose by about 260 percent between 2000 and 2006, largely driven by the surge in world prices before 2003 and the reduced marketing margins since then. Together, both developments have led to an increase in producers' share of world prices from about 50 percent in 2002 to 75 percent in 2005/2006.Earlier studies found a strong correlation between producer prices and the supply of cocoa in Ghana (Abdulai and Rieder 1995), and the recent price increase is likely to have made a significant contribution to the strong cocoa performance. Growth in yields, almost 40 percent between 2000 and 2004, has slowed in recent years. The Cocoa Board's promotion of technological packages and the increased access to credit, together with a partial liberalization of cocoa marketing, are likely to have raised productivity. Vigneri (2007) identified higher input of family labor into production and favorable weather conditions as major causes for yield increases. Despite the recent increase in yields, huge potential exists for further improvements: FAO and the Ministry of Food and Agriculture (MOFA) estimate that achievable yields for cocoa are around 1-1.5 tons per hectare, more than double the average yields in 2005 (FAO 2005; MOFA 2007).

Cocoa exports, the second most important export good for Ghana, have more than doubled between 2002 and 2006. In 2005, cocoa beans (24.3 percent) and cocoa products (3.8 percent) accounted for about 28 percent of total exports, slightly behind gold and significantly behind forestry products

(15 percent) (BoG, 2007). Cocoa accounts for about half of agricultural exports, including forestry and fishery. In comparison, the two major non-traditional agricultural export commodities, palm oil and fruits, together account for only about 4 percent of total agricultural exports.

Despite cocoa's rapid export growth, Ghana's trade deficit has widened to about 28 percent of GDP, because of rapidly rising imports. Linkages of cocoa production to other sectors of the economy, including cocoa processing (cocoa milling and cocoa butter production), other food industries (beverages, bakery, chocolate products), trade, transportation, and other marketing activities, offer additional potential for growth. However, the share of low income, cocoaproducing countries in cocoa processing remains low. Africa accounts for only 15 percent of world grindings in 2005/06, while Europe slightly increased its share in world grindings from 41 percent in 2004/05 to 42 percent in 2005/06 (ICCO, 2007). But Côte d'Ivoire and Malaysia are exceptions and remained the top processing countries among the cocoa-producing countries, grinding about 48 percent at origin. The share of cocoa processed in Ghana, however, remains small and below.

2.3 VARIETIES OF COCOA

The cocoa tree belongs to the genus *Theobroma cacao*. Within this genus different subspecies can be identified. According to literature, these subspecies can be classified within four cultivars: Criollo, Forastero, Trinitario and Nacional (Rosoux and Collin, 2004). However, in the literature cocoa beans might be named differently, depending on origin, commercial names, habits and so on. Generally, there are three varieties of cocoa namely criollo, forastero and trinitario.

2.3.1 Criollo

The word *criollo* means “native”, as it is distributed from southern Mexico to South America, north and west of the Andes. The fruits are oblong to ovoid in shape, tapering to a point and have five or ten longitudinal ridges. Seeds have yellowish white cotyledons. Criollo is most commonly farmed in south-central America. A niche variety called Sanchez is produced in the Dominican Republic. This variety is specially known to be produced with a very short or absent fermentation step.

2.3.2 Forastero

The word *forastero* means “foreign”, as it was introduced to Mesoamerica from the Amazon basin. The fruits are ellipsoid to round in shape, lacking a pointed tip, and may be furrowed but have a smooth surface. The seeds have violet cotyledons. Forasteros are considered to have inferior quality despite the fact that they are higher yielding and more vigorous than criollos.

About 80 to 90 percent of cocoa production is based on the forastero form, due to its superior yield, vigor, and disease resistance. ‘Amelonado’ which is the major West African cultivar, is the predominant type grown worldwide. The Forastero cultivar includes two subgroups, Amelonado and Amazon, these latter might be divided further into Lower Amazon and Upper Amazon, depending on its origin.

2.3.3 Trinitario

These are hybrids of criollo and forastero forms, which originated in Trinidad, and are sometimes classified as a subgroup of the forasteros. Since they are hybrids, they are highly variable from seed, unless the seed is derived from known crosses. The seed quality is intermediate between that of the criollos and the forasteros (Rieger, 2012)

2.4 PESTS AND DISEASES OF COCOA IN GHANA

The general pest control strategy is for the intervention to destroy the pests feasting on the crops but at the same time not to damage the produce so much as to render them unhealthy. Good agricultural practice (GAP) requires good timing and proper application. The crops are sprayed on the advice of specialists at an opportune time in the reproductive cycle of the pest, when the highest numbers could be eliminated. The cocoa tree and its pod can be attacked by different species of insects, fungal diseases and rodents (Afrane and Ntiamoah, 2011).The most important of these are *Phytophthora* pod rot, commonly called "black pod", and locally known as '*akate*'; and the swollen shoot virus, also known locally as '*cocoasasabro*'. The black pod rot, a fungal disease which appears as characteristic brown necrotic lesions on the pod's surface and as rotting of the beans, does the most damage to cocoa. An estimated 30% of annual cocoa production is lost to it, especially during years of high rainfall. Other estimates put the loss specifically at 450 thousand metric tons annually, while 250, 200 and 50 thousand MT are lost to witches' broom, capsids, and the swollen shoot virus (CSSV), respectively (Afrane and Ntiamoah, 2011). Witches' broom and frosty pod rot are predominant in Latin America, while the black pod and CSSV are common in West Africa. These diseases are counted by breeding disease-resistance species, sanitation and the use of fungicides (Opoku *et al*, 2007).Most insects which attack cocoa are of the *miridiae* family. This is a large family of insects of which capsids, the most wellknown, have achieved their notoriety from the degree of havoc they can wreck on cash crops like cocoa. They feed on plants by piercing the tissue and sucking their juices. Capsids are small, terrestrial insects, usually ovalshaped or elongate and measuring less than 12 mm. They were identified as pests at the turn of the last century and are the main insects that feed on cocoa in Africa (Mahot *et al*., 2005).

2.4.1 Pest

The major pest that attack cocoa include mirids (capsids), stem borers, shield bugs, leaf defoliators, pod bearers, rodents and termites. Mirids, also known as capsids, are major pests that affect cocoa in Ghana. These insects pierce the surface of cocoa stems, branches and pods using their needle-like mouthpart and also suck the sap of the cocoa tree. There are four species found on cocoa but the most predominant types found in Ghana are *Distantiella theobroma* (black capsid) and *Sahlbergella singularis (brown capsid). Helopeltis species (cocoa mosquito) and Bryocoropsis* species are less important, except in instances of occasional localized outbreaks. They attack crops from the establishment stage.

Stem borers are now a very seriously and widespread pest in Ghana (Adu-Acheampong *et al*; 2001).They are considered to be an emerging pest of cocoa in Ghana. Losses from this insect are usually low but a high number can seriously affect yield and tree health. The shield bugs (*bathycoelia thalassina)* are insects that feed on cocoa pods. They pierce the pod husk with their mouth parts and suck out the sap of the beans. As a result young pods turn yellow and then black, large pods stop growing and becomes yellow (Boateng, 2012).When the sap is sucked from the pods, the beans remain caked in the pods thereby making it difficult to remove and this contributes to postharvest losses.

The leaf defoliators are the most common insects that feed on soft leaves of cocoa. When they feed on the leaves, they prevent them from receiving adequate sunlight, which aids in the process of photosynthesis. Cocoa pod borer attacks both young and matured pods. A common symptom of infested pods is unevenness and premature ripening. Infestation of young pods results in heavy losses because the quantity and quality of the bean becomes seriously affected (COPAL, 2011). Rodents that attack cocoa include mice, rats and squirrels. They chew the cocoa husk and feed on the beans within the pods. Rodents are mostly found in farms with a lot of overhead shade trees and farms that are not well maintained, such as those with lots of undergrowth which provides hiding places for them. Termites may live either in the canopy or in the underground. They attack seedlings or young trees at the base. The damage also extends to suckers of fullgrown trees. In full-grown trees, some types of termites attack injured and dead wood, whist other types chew into the roots and tunnel up into the branch (Boateng, 2012).

2.4.2 Diseases

The major diseases in cocoa include black pod, swollen shoot, witches broom, frosty pod rot and vascular steak dieback. Cocoa Swollen Shoot Virus (CSSV) disease still poses a serious threat to Ghana's cocoa industry. The disease has caused enormous devastation of cocoa farms in Ghana since its discovery in 1936 and over 200 million visibly infected and 'contact' trees have been cut out from about 130,000 hectares of land during the past fifty (50) years as control measure (Ampofo, 1997). The swollen shoot disease is an infectious virus disease which spreads in cocoa farms if not controlled early, and also affects cocoa trees causing defoliation, reduction in yield and death of the cocoa tree. It also causes swellings on the chupons and fan branches of the cocoa tree.

Black pod disease is caused by the fungus *Phytophthora* species. Pod losses due to Black pod diseases are about 4.9-19% in infections caused by *Phytophthora palmivora* and 60-100% when caused by *Phytophthora megakarya.* Generally, losses due to *P. megakarya* range from 60-80% in newly affected farms to about 100% in old affected farms in the black pod season (Opoku, 2004).Witches broom disease which is a fungal disease, attacks actively growing tissues such as the shoots, pods and flowers, causing cocoa trees to produce branches with no fruits and ineffective leaves. The pods show distortion and present green patches that give the appearance of uneven ripening (COPAL, 2011). Frosty pod rot infects only actively growing pod tissues, especially young pods. The time from infection to the appearance of symptoms is about 1-3 months. The most outstanding symptom is the white fungal mat on the pod surface (COPAL, 2011). 'Chlorosis' of a leaf on the second or third flushes behind the tip is the initial characteristic symptom of the vascular- streak dieback disease. The fungus may spread internally to other branches or the trunk, usually causing death of the tree. When an infected leaf falls during the rainy season, hyphea may emerge from the leaf scar and develop into a basidiocarp, evident as a white, flat, velvety coating over the leaf scar and adjacent bark (COPAL, 2011).

2.5 GOOD AGRONOMIC PRACTICES

The length of time that a cocoa farm remains productive and financially viable is determined by the application of good agricultural practices (ICCO, 2008). Good agricultural practices in cocoa towards increased production include weeding, pruning, thinning, mistletoe removal, removal of infected pods, shade management, spraying among other things. It is therefore important to maintain a high standard of farm management to prevent diseases and insect attacks, as well as to ensure an appropriate response to specific outbreaks when they do occur (ICCO, 2008). In establishing cocoa farms, most farmers clear and/or burn existing forest, and in the process either thin or completely eliminates the over-story trees to make growing space for their cocoa and food crops. Most farmers who establish their farms this way often do not follow the appropriate recommended planting arrangements of the different components of plants per unit area (Conservation Alliance, 2013).

For over- aged and low yielding cocoa farms, the farmer may have to decide to regenerate his plantation. A healthy cocoa tree produces a minimum of 25 pods per year, which yield at least one kilo of dry cocoa beans per tree (Conservation Alliance, 2013).Trees producing ten or less pods a year are unproductive and should be replaced. In addition, if trees have reached an age of over 30 years, they should be replaced. When replanting or establishing a new plantation it is very important to do a proper planning especially with regard to the source of the planting material. The farmer has to make a living from his plantation for most of his life. Therefore, the selection of the planting material will affect the farmer's income and the wellbeing of his family for many years. Cocoa pods on farms may have been produced from natural or uncontrolled pollination. The sources of the pollen are not known. Using seeds from such pods as planting material may lead to poor quality and reduced yield of the cocoa plants. It is better to obtain cocoa planting materials from accredited seed producers or the Seed Production Unit of
COCOBOD.

Planting materials from accredited institutions guarantee a high rate of quality fruits and yield. Hence, before planting cocoa in the field the following activities should to be carried out properly;

- Land preparation
- Lining and pegging
- Spacing
- Planting temporary shade

- Mulching
- Pruning
- Pest and disease management
- Variety and sources of cocoa planting materials
- Weed management
- Soil fertility management
- Raising nursery and its management

2.6 POSTHARVEST ACTIVITIES

2.6.1 Harvesting of Cocoa Pods

Cocoa pods are harvested regularly to prevent over-ripe pods. During harvesting, only ripe and matured pods are picked. Unripe pods cannot undergo the fermentation process, and over ripe pods also often become dry (Barclays Bank 1970). Diseased and damaged pods are also discarded and not included in the harvest. The ripe pods are judged by their colour during harvesting. It is necessary to use sharp harvesting tools, in order not to cause damage to the cushions of the tree (Mikkelsen, 2010). Damaging the cushions serve as a potential point of entry for fungi. Care is taken when cutting the stem of the pod to avoid injuring the junction of the stem with the tree, as this is where future flowers and pods will emerge (Dand, 1999; wood and lass, 2001). Different harvesting equipment should therefore be used to remove diseased pods from the tree in order to help prevent the spread of the disease. Also when pods are left too long on trees, beans start to germinate and this affects the quality and flavour of cocoa. Harvested pods should be kept for about three days before breaking. Pods are usually opened using a cutlass; however, care is taken in order not to cut beans since this affects their quality. During pod breaking, beans that are caked in pods, germinated beans and wet beans are sorted out and dried separately.

2.6.2 Fermentation

Fermentation is brought about by micro-organisms and the most prominent ones are the yeast and the acetic acid bacteria. During this process, the yeast converts the sugar (i.e. the pulp surrounding the beans which is sugary) into alcohol and the acetic acid bacteria converts alcohol into acetic acid. During this reaction, a lot of heat is generated and this kills the living cells in the beans including the eye which would have germinated. There are several methods used in fermenting cocoa beans and these include the heap, basket, tray and box fermentation methods. Cocoa beans are fermented in order to Kill the embryo and stop germination, remove pulp to enable beans dry properly, get the proper taste, colour and flavour associated with cocoa products.

Beans are fermented for a period of six days depending on the fermentation method used. With the exception of the tray fermentation method, beans are turned every two days until fermentation is complete. Basket fermentation is usually used when beans are in smaller volumes. Before the fermentation begins, the sides of the basket are lined with banana leaves, but the bottom remains uncovered to let the sweating drain away easily. The basket is mounted on a board. Beans are then poured into the basket and covered with banana leaves. Short sticks are placed on the leaves to support them and hold them in place.

Heap fermentation is mostly used by farmers because it is a cheap method that produces well fermented beans, when it is done properly (Are and Gwynne-Jones, 1974). With this method, short sticks are arranged in a circular form on the ground with banana leaves placed on them to overlap each other. The sticks are used to raise the centre to enhance easy drainage of the sweating. Beans are poured in the centre and covered with banana leaves. This is supported by placing short sticks on them from behind. Tray fermentation is done by arranging the trays in stack on a slab. The bottom tray is placed on a slab to avoid the ground absorbing the produced heat, to allow the sweating to drain away, and to promote air circulation. The trays are stacked in piles, 3 - 12 trays high. The top tray is covered with banana leaves and supported with short sticks placed on them. No turning is done with this fermentation method and beans are fermented for five days (Lopez and Dimick, 1995)

Finally, with the box fermentation method, boxes are arranged in a form of tiers (3 tiers). The beans to be fermented is put in the uppermost box and covered with banana leaves with pieces of wood placed on them to hold them in place. After two days of fermentation, the beans is scraped into the second box in a horizontal pattern and covered again with banana leaves. On the fourth day, beans are scraped again into the third box which is the last box in a vertical pattern and covered. Sun drying is done during the sixth day.

2.6.3 Drying

After fermentation, the water content of the beans is about 60 %, and it must be reduced to less than 7.5 % during drying to avoid spontaneous mould and bacterial growth under storage and transport (Takrama and Adomako, 1996). Drying of beans takes a period of about 10 -14 days depending on the atmospheric conditions and volume of beans per square area on drying mat. Well dried beans will crack easily when squeezed between the fingers and can easily be cut with a knife (Amoa-Awua *et al*., 2007). Methods of drying cocoa beans are usually either by sundrying or artificial drying. Sun drying is the natural means of drying beans in the sun on raffia mats. It is simple and cheap but it is also labour-intensive and there is much concern for a stable weather condition. The mats are placed on a raised platform to protect the cocoa beans against animals and foreign materials. There is also the frequent stirring of beans on mat to facilitate drying (Are and Gwynne-Jones, 1974: Mossu, 1992).

Artificial dryers include the use of ovens in drying cocoa beans.The beans are spread in trays, allowing the air to permeate through a ladder system (Mossu, 1992). Using this method, it is very important that the cocoa beans are not contaminated with smoke from the fire, since dry beans easily absorb flavours and aromas from the environment (Barclays Bank, 1970).

2.7 OVERVIEW OF PESTICIDE

A pesticide is any substance or mixture of substances intended for preventing, or controlling any pest including vectors of human or animal diseases, unwanted species of plants or animals causing harm during, or otherwise interfering with, the production, processing, storage, or marketing of agricultural commodities, wood and wood products, or animal feedstuffs, or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies (FAO, 1989). The term pesticide is also defined by FAO in collaboration with UNDP (1991) as chemicals designed to combat the attacks of various pests and vectors on agricultural crops, domestic animals and human beings.

2.7.1 Classification of Pesticides

There are different types of pesticides and their classification is based on the target organism.

Based on the target organism, Draggan and Miller (2012), classified pesticides as follows:

- Algicides - Control algae in lakes, canals, swimming pools, water tanks, and other sites.
- Antifouling agents - Kill or repel organisms that attach to underwater surfaces, such as boat bottoms.

- Antimicrobials - Kill microorganisms (such as bacteria and viruses).
- Attractants - Attract pests (for example, to lure an insect or rodent to a trap). (However, food is not considered a pesticide when used as an attractant.)
- Biocides - Kill microorganisms.
- Disinfectants and sanitizers - Kill or inactivate disease-producing microorganisms on inanimate objects.
- Fungicides - Kill fungi (including blights, mildews, molds, and rusts).
- Fumigants - Produce gas or vapor intended to destroy pests in buildings or soil.
- Herbicides - Kill weeds and other plants that grow where they are not wanted.
- Insecticides - Kill insects and other arthropods.
- Miticides (also called acaricides) - Kill mites that feed on plants and animals.
- Microbial pesticides - Microorganisms that kill, inhibit, or out compete pests, including insects or other microorganisms.
- Ovicides - Kill eggs of insects and mites.
- Pheromones - Biochemicals used to disrupt the mating behavior of insects.
- Repellents - Repel pests, including insects (such as mosquitoes) and birds.
- Rodenticides - Control mice and other rodents.
- Molluscicides - Kill snails and slugs.
- Nematicides - Kill nematodes (microscopic, worm-like organisms that feed on plant roots).

Another classification of pesticides is based on their chemical structure. The groups are:

Inorganic pesticides: They include arsenic, copper and mercury compounds. Highly toxic biocides and have the ability of remaining in the environment for extended periods of time. They are generally neurotoxins and even a single dose may cause permanent damage (Cunningham *et al.*, 2003).

Natural organic pesticides: They are mainly plant extracts. Some examples are nicotine and nicotinoid alkaloids from tobacco, rotenone from the roots of derris and cube' plants and pyrethrum, a complex of chemicals extracted from *Chrysanthem umcinerariae folium* (Cunningham *et al.*, 2003). Even if natural, many of these compounds are toxic to humans and other life forms. Rotenone has been linked to nerve damage and Parkinson's disease (IPM of Alaska, 2003).

Fumigants: Fumigants are generally small molecules such as carbon tetrachloride, carbon disulfide, ethylene dichloride, ethylene dibromides that gasify easily and penetrate rapidly into some materials. They are used to sterilize soil and prevent degradation of stored grain. These compounds are very dangerous for workers, and their use has been severely restricted (Cunningham *et al.*, 2003).

Chlorinated hydrocarbons: They are synthetic organics containing chlorine. They inhibit nerve membrane ion transport and block nerve signal transmission. They may be persistent in the environment and are subjected to bioaccumulation. Many have been banned or restricted throughout the world, but some continue to be actively used. They include DDT, Chlordane, Aldrin, Para dichlorobenzene, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid (Cunningham *et al.*, 2003).

Organophosphates: Synthetic organics containing phosphorus complexes. They inhibit cholinesterase, an enzyme that regulates the peripheral nervous system. Extremely toxic to mammals, birds and fish (generally 10-100 times more poisonous than most chlorinated hydrocarbons) (Cunningham *et al.*, 2003). They degrade easily, so their bioaccumulation is rare. Some examples are parathion, malathion, dichlorvos, dimethyldichlorovinylphosphate (DDVP) and tetraethylpyrophosphate (TEPP).

Carbamates: Derivates of carbamide acid, they act in the same way as organophosphates and have low bioaccumulation rates. Generally toxic to bees. They include carbaryl, aldicarb, aminocarb and carbofuran.

Microbial agents/biological controls: These are living organisms that control pests. Bacteria, viruses and insects have been used as 'natural' controls. They can act in 4 ways: as parasites of the pest, as predators, as pathogens or as weed feeders (Weeden*et al.*, 2005).

2.8 EFFECTS OF PESTICIDE USE ON PUBLIC HEALTH AND ENVIRONMENT

Pesticide use is associated with risk and can be hazardous if not handled properly. Cocoa farmers using pesticides containing Aldrin, Gamma BHC, Cuprous oxide, Copper sulphate, Paraquat dichloride etc. face constant exposure to these pesticides (Fajewonyomi, 1995). According to Takagi *et al*.,(1997), risks associated with pesticide can be in a form of; risk associated with human beings. That is, toxicity categorized as acute toxicity, chronic toxicity, carcinogenicity, tetratogenicity and biological concentration. Human exposure to pesticides is an important health and social issue as it usually results in serious health problems such as epilepsy, stroke, respiratory disorders, cancer, leukamia, brain and liver tumours, convulsions etc. Death has been known to occur in some places as a result of exposures to these pesticides. They can also be in a form of risk associated with the environment: These manifests in the disturbance of the ecosystem, principally in the form of pollution of river water, groundwater, drinking water, soil and air, reduction of fish and wildlife populations, destruction of natural vegetation etc.

Cocoa farmers and farm workers comes into contact with pesticides during the application process or when entering recently treated areas. There is a high probability that pesticide use and pesticide – induced side effects (costs) will grow more rapidly in developing countries as a whole than in the developed ones (Yudelman *et al*., 1998). This is because of weak regulations banning the importation and use of dangerous chemicals and the inactivity or absence of government and non - government environmental control agencies. Despite the fact that the Dirty Dozen pesticides are banned, severely restricted or unregistered in many countries and despite their having been listed as hazardous by the World Health Organization (WHO), Fajewonyomi (1995) stated that many of them are still widely promoted and applied especially in developing countries where weak controls and dangerous work conditions make their impact even more devastating.

Papworth and Paharia (1978) stated that since pesticides by their very nature are toxic and can be hazardous to users if not handled properly, their regulation through registration is of great value to developing countries. It is not the increasing use of pesticides that warrants regulation through suitable legislations but the tendency, through ignorance, for overuse, misuse or abuse of pesticides. Snelson (1978), stated that registration' as used in this context implies the acceptance by a statutory authority of extensive document proof submitted in support of all claims for efficacy and safety made for the reposed product. Registration enables authorities to exercise control on use levels claims, labeling, packaging and advertising and thus to ensure that the interest of end users are well protected. After discovering that application of pesticides causes severe contamination of vegetables with residues in HoChin Minh city, Vietman, Nguyem *et al*. (1998) suggested that instruction sessions should be organized by the local authorities to show farmers how to correctly apply pesticides on their vegetable fields, set up demonstration field using insecticides correctly, distribute leaflets on accurate and safe use of insecticides on vegetables to all vegetable growers, run broadcast from the city broadcasting outfit to educate farmers about safe and accurate application of pesticides to protect their own health and that of consumers. Wetterson (1988) reported that a number of governments and companies within the agrochemical industry provide little, if any, health and safety information on pesticides beyond a label, which reaches pesticide users in the field. In some countries, the labels may be in a language not understood by the users who may not be literate. Despite the good results of using pesticides in agriculture and public health, their use is usually accompanied with deleterious environmental and public health effects. Pesticides hold a unique position among environmental contaminants due to their high biological activity and toxicity (acute and chronic). Although some pesticides are described to be selective in their modes of action, their selectivity is only limited to test animals. Thus pesticides can be best described as biocides (capable of harming all forms of life other than the target pest) (Zacharia, 2011).

2.9 PESTICIDE USE IN COCOA PRODUCTION IN GHANA

Like all living organisms, the cocoa plant can also be attacked by a wide range of pests and diseases. When this happens expected production targets are not met, and the economies of the producer nations are adversely affected. Preventive and curative measures are therefore necessary in the cocoa industry to maintain and even increase output (Akrofi and Baah, 2007).

While non-chemical means of managing pests and diseases in the industry are widely recommended for health and other reasons, the use of some amounts of chemicals in the form of fertilizers, insecticides and fungicides is unavoidable in the effective management of cocoa farms (Moy and Wessel, 2000; Opoku *et al*., 2006; Adjinah and Opoku, 2010). Their use is therefore expected to increase with time. Indeed in the twenty-year period from 1986-2006, the use of fertilizer world-wide increased by almost 250 % (UNDP, 1991). The same trend applies to pesticides, although they are more difficult to monitor partly because of the secrecy that goes with the continued production and use of banned substances. The trends suggest quite clearly however, that much of the increase in world food production can be attributed to the response of crops to increased use of fertilizers and pesticides (UNDP, 1991). Fortunately, there has always been a clear appreciation of the potential deleterious effects of the chemicals used in the cocoa industry since the 60s, and standards have been set by FAO and WHO for acceptable levels of residues in the beans exported to other countries.

Pesticides have been used in the public health sector for disease vector control and in agriculture to control and eradicate crop pests for the past several decades in Ghana (Owusu-Ansah *et al*., 2010). The majority of pesticides used in agriculture are employed in the forest zones located in the Ashanti, Brong Ahafo, Western, and Eastern Regions of Ghana. Endosulfan, marketed as thiodan, is widely used in cotton growing areas on vegetable farms, and on coffee plantations.

Organ chlorine pesticides such as DDT, lindane and endosulfan are also employed to control ectoparasites of farm animals and pets in Ghana (Owusu-Ansah *et al*., 2010).

Cocoa farmers use a wide range of pesticides to limit losses from pests and diseases in cocoa agriculture. Prominent among these are: Copper sulphate (a fungicide popular in the treatment of black pod infection; Benzene Hexachloride (BHC) (an insecticide for control of cocoa mirids); Aldrin/Dieldrin or Aldrex 40 (to control mealy bugs); Carbamate Unden, (an insecticide which is effective in controlling cocoa mirids in West African countries) (Owusu-Ansah *et al*., 2010). Others are Kokotine, Apeco, Perenox, Arkotine, Didimac 25, Basudin and Brestan. Pesticide use is associated with risk and can be hazardous if not handled properly. Cocoa farmers using pesticides containing Aldrin, Gamma BHC, Cuprous oxide, Copper sulphate, etc. face constant exposure to these pesticides. Since 1957 when Lindane was recommended, spraying with synthetic insecticides has been the only effective method for controlling capsids on cocoa in West Africa. Presently, spray treatment with Gammalin 20 (Lindane) at 280g a.i. /ha or 1.4 litres/ ha and Unden 20 (Propoxur) at 210 g a.i. / ha or 1.1 litres/ ha applied at monthly intervals from August to December, is the only protection measure recommended in Ghana (Owusu-Ansah *et al*., 2010).

Although the organochlorines are banned from importation, sales and use in Ghana, there are evidence of their continued usage and presence in the ecosystem. Work already done in somefarming communities in the Ashanti Region of Ghana and some other countries indicate the presence of organochlorine pesticide residues in fish, vegetables, water, sediments, and mother's milk and blood samples (Owusu-Ansah *et al*., 2010). Lindane is listed among the Prior Informed Consent (PIC) pesticides, and all agricultural uses of lindane have been banned in 52 countries due to its hazardous nature.

Many organ chlorines which over the years have been linked to major health and environmental problems have been banned or are no longer used. Included in this catalogue are aldrin, dieldrin and endrin which have virtually disappeared, and DDT, heptachlor and toxaphene which have been banned in many countries but are still used quite extensively particularly in some developing countries.

The goal of maintaining high levels of agricultural productivity and profitability while reducing pesticides use presents a significant challenge. There are repeated cases of excessive levels of pesticide residues being found in agricultural produce and the safety of these products has become an issue of concern. Changes in regulations in the European Union (EU), North America and Japan have called for a reflection on crop protection practices in cocoa and other commodity crops (ICCO, 2007). The quality of cocoa imported into the EU and elsewhere is assessed based on traces of pesticides and other substances that have been used in the supply chain.

The cocoa bean has a high content of butter or fat which absorbs the active ingredients in insecticides. The acceptable levels of active ingredients in foods are determined by the committee on Pesticide Residue of FAO/WHO, known as the Codex Alimentarius Commission, CAC. Created in 1963 the CAC implements the Joint FAO/WHO Food Standards Programme which is aimed at protecting the health of consumers and ensuring fair trade practices in the international food trade (Moy and Wessel, 2000). The commission has set maximum levels of residue poisons in commodities going through the international market, including cocoa. If for any reason the residual levels in any commodity exceed the Codex levels, that particular commodity could be rejected by the importing country.

Secondly, the accumulation of any chemicals in the cocoa fat may change the taste of the beans and eventually that of the chocolate made from them. It is therefore, the task of entomologists to ensure that recommended chemicals do not leave any residues, and that the dosage is the minimum that would give the optimum control under the agricultural conditions in the country. In Ghana, significant gains have been made in the control of pests and diseases of the cocoa industry through the nationwide use of pesticides under government sponsorship and supervision. The growing global concerns about the effects of the increasing use of agricultural chemicals on farmers, consumers of agricultural produce and the ecology require a reexamination of the issues related to their application in the cocoa industry(Owusu-Ansah*et al*., 2010).

2.10 OVERVIEW OF QUALITY STANDARDS IN THE COCOA INDUSTRY

Consumers of cocoa and cocoa products all over the world are becoming increasingly aware of food safety concerns as related to the use of chemicals in the production and processing of cocoa and as related to other issues and procedures that may be detrimental to their health. As a result, some countries have enacted legislative and regulatory measures and established sanitary and phytosanitary standards that have to be met by imported food or food substances, in order to continue to have access to their markets. The food safety concerns that affect cocoa are pesticides residues, Ochratoxin "A" (OTA), Polycyclic Aromatic Hydrocarbons (PAH), Free Fatty Acid (FFA), heavy metals such as lead, cadmium and others substances.

In the EU, measures have been taken for the following contaminants: mycotoxins (aflatoxins, ochratoxin A, fusarium-toxins, patulin), 'heavy' metals (cadmium, lead, mercury, inorganic tin), dioxins and PCBs, polycyclic aromatic hydrocarbons (PAH), 3-MCPD and nitrates) (Bateman, 2010).In September 2008, a European Union Legislation on Maximum Residue Levels (MRLs) on Pesticides (Regulation 149/2008/EEC) came into effect. The Regulation set maximum levels on the amount of pesticides permitted on imported foods including cocoa beans. Consequently, all cocoa beans imported into the EU from September 2008 must conform to the new Regulation. In the U.S.A, the Environmental Protection Agency (EPA) established the Food Quality Protection Act of 1996 which regulates the amount of pesticide residues permitted on food for consumption. The EPA also requires that all approved pesticides are clearly labeled with instructions for proper use, handling, storage and disposal. In Japan, the Ministry of Health, Labor and Welfare (MHLW) established a new legislation that came into effect from May 2006, setting new MRLs for food products. Cocoa is of vital importance to the economies of the producing countries in Africa namely, Cameroon, Côte d'Ivoire, Ghana, Nigeria and Togo. In 2008, these countries exported about 1.3 million tons of cocoa beans to the EU and about 0.3 million tons to the USA, representing about 50 % and 9 % of total world exports respectively. The crop contributes major proportions of national foreign exchange earnings and regionally, providing employment to millions of people in Africa. But cocoa is still produced predominantly by a large number of resource-poor smallholder farmers. Therefore, the SPS regulations of cocoa consuming countries have the potential of constituting a trade barrier, as most cocoa producing countries may not have the capacity to adequately meet these SPS regulations. This will disrupt cocoa trade, limit market access and have a significant economic impact on cocoa producing countries.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY AREA

The Nkawie Cocoa District can be located within the Atwima Nwabiagya District (political District). The Atwima Nwabiagya District was established in 2004 by Legislative Instrument 1738. It covers an estimated area of 294.84 sq. km and the district capital is Nkawie. The district lies approximately on latitude 6º 32'N and 6º 75'N and between longitude 1º 45' and 2º 00' western part of the region and shares common boundaries with Ahafo Ano South and Atwima Mponua Districts (to the West), Offinso Municipal (to the North), Amansie–West and Atwima Kwanwoma Districts (to the South), Kumasi Metropolis and Afigya Kwabre Districts (to the East). The District covers an estimated area of 294.84 sq km. The population of the Atwima Nwabiagya district is 149,025 with majority (68.5%) of the population living in rural localities. Females constitute more than half (51.7%) of the population of the district resulting in a sex ratio of 93.3 (Population and Housing Census, 2010).

The district lies within the wet semi-equatorial zone marked by double maximum rainfall ranging between 170 cm and 185 cm per annum. The major rainfall season is from mid-March to July and minor season is between September and mid-November. Rainfall in the district is not distributed evenly throughout the year. Its density and pattern are also becoming unpredictable and this poses considerable risk to rain-fed agriculture. Temperature is fairly uniform ranging between 27ºC (August) and 31ºC (March) and a mean relative humidity of between 87 - 91 per cent. The lowest relative humidity usually occurs in February/April when it averages between 83

-87% in the morning and 48-67% in the afternoon. The district has an undulating topography with an average height of 77 metres above sea level. There are highlands with varied steep and gentle slopes. The highest points in the district can be found in the Barekese and Tabere areas. There are a number of valleys without- flowing streams, which provide opportunities for agricultural production. The Offin and Owabi are the main rivers which drain the surface area of the district. There are however, several streams in the district such as Kobi and Dwahyen. Two major dams, Owabi and Barekese have been constructed across the Owabi and the Offin rivers respectively and supply an appreciable amount of pipe borne water to the residents of Kumasi and its environs including some settlements in the district.

3.1.1 Location of Experiment Work

The physical analysis (cut test) of the dried cocoa beans was carried out at the laboratory of the Quality Control Division of COCOBOD, Nkawie District whiles the pesticide residue was carried out at Ghana Standards Authority, Accra.

3.2 RESEARCH DESIGN

This section discusses how data for this study was collected and analyzed. These included the data collection through questionnaire administration, sampling methods and frame and data analysis. The study was conducted in two parts; the field survey and laboratory work.

3.3 SAMPLE COLLECTION

A five (5kg) of dried cocoa beans was randomly picked from each farmer group (trained and untrained) for further analysis. In all two hundred and fifty (250 kilos) of dried cocoa beans was obtained from all the farmers. Each farmer group (trained cocoa farmers from CHED and untrained cocoa farmers) contributed (125 kilos of cocoa beans, approximately 2 bags for each farmer group).

3.4 SAMPLE SIZE AND SAMPLING TECHNIQUE

The sample frame for the study comprised of farmers from five cocoa farming communities. A non-probability (Judgmental or Purposive) sampling procedure was used. Five major cocoa growing communities in the Nkawie cocoa district were selected for the study.

3.4.1 Field Survey

Primary data was derived from interviewing (50) cocoa farmers (25 untrained farmers and 25 trained by Cocoa Health and Extension Division). Each community had ten (10) farmers, five for trained and the other five untrained. Field data was obtained through structured questionnaires administration and personal observations. The secondary data was sourced from institutions such as, Quality Control Company Ltd, relevant journals, dissertations and other publications.

3.4.1.1 Questionnaire design and administration

Open and close type questions were used in conducting the field survey (Appendix A'). It was categorized into various sections focusing on the socio-demographic features, farm production characteristics, training and participation in CHED programmes cultural practices and postharvest activities, agro-chemical usage, cocoa beans quality. Prior to the questionnaire administration, a focused group discussion was undertaken to explain the purpose of the study and the questionnaire to them. Cocoa farmers who could read were given the questions to answer (but with guidance) while those who could not read and understand were interviewed. Pre-testing of the questionnaire was done in two other communities to help fine tune the questions and improve on the skills of the questionnaire administrators in order to have reliable and efficient data. The secondary data sources consisted of a desk study of books, dissertations, journals, correspondence, relevant information from the Quality Control Company Limited.

3.4.1.2 Experimental design

The laboratory experiment was laid in a completely randomized design and comprised of two treatments (trained cocoa farmers from CHED and untrained cocoa farmers).

3.5 LABORATORY ANALYSIS

3.5.1. Determination of pesticide residue levels in cocoa beans

3.5.1.1 Substance analyzed

Cocoa beans both from trained and untrained farmers' were extracted from their pods and dried. The shells were removed without heating using the procedure described by Syoku-An (2006) and pulverized into particles that was passed through a 420-μm standard sieve.

3.5.1.2 Extraction procedure

During the extraction, 20 ml of water was added to 10.0 gm of the sample and allowed to stand for 15 minutes. Fifty milliliters (50 ml) of acetonitrile was added and the sample homogenized. The sample was filtered by suction. Twenty milliliters (20 ml) ofacetonitrile was then added to the residue on the filter paper. This was followed by homogenization and suction filtration. Both filtrates were mixed and acetonitrile added to make a 100 ml solution. Twenty milliliters (20 ml) of the extracted solution was measured and 10 gm of sodium chloride and 20 ml of 0.5

mol/Lphosphate buffer (pH 7.0) added. This was homogenized for 10 minutes and allowed to stand until the solution was clearly separated into layers. The aqueous layer was then discarded. An octadecylsilanized silica gel mini column (1000 mg) was conditioned with 10 ml of acetonitrile. The above-mentioned acetonitrile layer was applied to the column. The column was eluted with 2 ml of acetonitrile and the entire volume of effluent was then collected. The effluent was dried over sodium sulfate (anhydrous) and filtered. The filtrate was concentrated to dryness at 40°C and the residue dissolved in 2 ml ofacetonitrile/toluene (3:1).

3.5.1.3 Clean-up

A graphite carbon/aminopropylsilanized silica gel layered mini column (500 mg/500 mg) was conditioned with 10 ml of acetonitrile/toluene (3:1) and the solution obtained during the extraction step was applied to the column. The column was eluted with 20 ml of acetonitrile/toluene (3:1) and the entire volume of effluent collected. The effluent was concentrated to 1 ml at 40°C. 10 ml of acetone was added to the concentrated solution and concentrated to 1 ml at 40°C. Thereafter, 5 ml of acetone was added to the concentrated solution and concentrated to dryness. The residue was dissolved in acetone/*n*-hexane (1:1) tomake a 1 ml solution. This was used as the test solution.

3.5.1.4 Calibration curves

An acetone solution of the reference standard (Syoku-An, 2006) was prepared for each of the agricultural chemicals, and all were mixed.

Portions of the mixture were diluted with acetone/*n*-hexane (1:1) to the appropriate concentrations of the reference standards (Syoku-An, 2006).Two µL of each diluted portion was injected into a

Gas Chromatography (GC)/ Mass Selective Detector (MSD). Peaks in the resulting chromatograms were used toprepare calibration curves.

3.5.1.5 Determination

Two (2) µl of the test solution was injected into the GC/MSD for analysis. The content of each of the agricultural **c**hemicals was determined, using GC/MSD results and the calibration curve prepared.

3.5.1.6 Confirmation of results

GC/MSD measurements were prepared to confirm the results.

3.5.1.7 Measuring conditions

Summary of the typical GC/MSD conditions used for the quantification of the pesticide standards are stated below; the standardized conditions spelt out by Syoku-An (2006) were observed as follows; measurements of the pesticide were carried out on a Varian CP-3800 gas

chromatography equipped with an Electron Capture Detector (ECD) with a CombiPALAutosampler. The chromatographic separation was done on an EZ of 30 m + 10 m capillary column guard with 0.25 mm internal diameter fused silica capillary coated with VF-5 ms (0.25µm film thickness) from VarainInc or equivalent. Detector temperature of 300 0C, injector (a pulsed splitless mode) 250 0 C, oven ; 50°C (1 min) - 25°C/min heating - 125°C (0 min) - 10°C/min heating - 300°C (10 min).With an injection volume of 1 µL and helium as gas carrier.Ionization mode (voltage): EI (70 eV). Major monitoring ions (*m/z*), expected retention times and limits of quantitation were also in conformity with what was spelt out by Syoku-An

(2006).

3.5.2 Physical Analysis

3.5. 2.1 Cut test analysis

Cut test analyses were conducted on all the cocoa samples collected. Defective beans; made up of mouldy, germinated, slaty, purple, weevil, other defects, total mouldy, total slaty, total purple, all other defects and tolerance level. Further analyses were conducted to determine the grade of the samples in accordance with Regulation 11 of the Cocoa Industry Regulation (Consolidated) Decree (1968).

3.6 DATA ANALYSIS

The data collected was subjected to descriptive analysis with the use of bar charts and frequency distribution tables. Statistical tools (SPSS version 20 and MS excel) were used to produce graphs and frequency distribution tables with all the data pre-coded before the analysis. Data from the cut test and pesticide residue level was analyzed using Statistic 9 statistical Package. Differences among

CHAPTER FOUR

4.0 RESULTS

4.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

4.1.1 Gender Dynamics of Trained and Untrained cocoa farmers

Majority of the trained cocoa farmers were males representing (80%) of the population while (20%) were females. As regards the untrained cocoa farmers, (88%) of them were maleswhile (12 %) were females.

4.1.2 Age Dynamics of Trained and Untrained cocoa farmers

From Table 4.1 it could be inferred that, majority (48%) of the untrained cocoa farmers were above 51 years whiles the trained farmers were (28%). The lowest (4%) age group for the untrained farmers was within the age range of 21-30 years whereas the trained farmers below 20 were (8%). Trained farmers in the range of 31 – 50 years were (64%) whiles that of the untrained had (48%).

4.1.3 Educational Background of Respondents

It was revealed that majority of the farmers had Primary/JHS education with percentages of (68%) for trained and (60%) for untrained cocoa farmers. Eight (8) percent of the trained cocoa farmers had non- formal education whiles that of the untrained had (16%). Four and Eight percent were recorded respectively for trained and untrained cocoa farmers interms of SSSCE/GCE education. With regards to farmers that had no formal education (20%) and (16%) were recorded respectively for trained and untrained farmers.

Table 4.1: Background information of respondents

Variable	Trained Farmers (n=25) (%)	Untrained Farmers (n=25) (%)
Gender		
Male (%)	80	88
Female (%)	20	12
Age (years)		
21 – 30	8	4
31- 40	32	28
41 -50	32	20
51 and above	28	48

Level of Education		
None (%)	20	16
Primary/JHS (%)	68	60
SSSCE/GCE (%)	4	8
Non-formal (%)	8	16

4.2 FARM PRODUCTION CHARACTERISTICS

The farmers had good experience in cultivating cocoa having spent an average of 17 and 16 years respectively for trained and untrained. Majority of the trained (76%) and untrained farmers (52%) belonged to a farmer group or association. The result showed that on an average each farmer had (2) farms. A sizable number of trained farmers, on average have (9 acres) of cocoa farm whereas the untrained had (8 acres). For the 2013/2014 cocoa season, (19 bags) of cocoa were recorded on an average for each farmer for both farmer groups. However, (14 bags) and (18bags) were recorded per farmer (trained) during the 2011/2012 and 2012/2013 cocoa season whereas (13 bags) and (16bags) were obtained on avaerage for untrained farmers for the

2011/2012 and 2012/2013 cocoa season.

Table 4.2: Farmer Production Characteristics

Variable	Trained Farmers (n=25)	Untrained Farmers (n=25)
Farming experience (years)	17 years	16 years
Member of farmers group (%)		
Yes	76	52
No	24	48
Number of farms	2	2
Farm size (acres)	9	8
Bags harvested (Average Production)		
Production 2011/2012 (bags)	14	13
Production 2012/2013 (bags)	18	16
Production 2013/2014 (bags)	19	19

4.3 AGRONOMIC PRACTICES OF FARMERS

Various agronomic practices done by farmers in the district have been presented in Table 4.3. Majority of the trained farmers raised their seedlings in the nursery (76%) and also practiced lining and pegging (68%) compared to their colleagues who are not part of the CHED trainings. The study showed that majority of both group of farmers always controlled weeds, removed unwanted basal chupons and mistletoes from their farm as shown in Table 4.3.With regards to regular practice of pruning and shade management, about (84%) and (68%) of trained farmers were recorded respectively whiles the untrained farmers were (72%) and (78%) respectively.

Both group of farmers did regular harvesting of cocoa pods with (92%) and (75%) from trained and untrained farmers respectively. A greater number of farmers from both farmers groups always used recommended agro-chemicals inputs as (98%) and (68%) respectively of trained and untrained farmers used it. On agrochemical storage and usage, a greater number (92%) of the trained farmer's stores agro-chemicals before usage whiles that of the untrained farmers were (88%). Majority (92%) of the trained farmers sprays insecticide and fungicide to control pest and black pod disease with (92%) whiles that from the untrained farmers were (85%).

Table 4.3: Agronomic Practices of Farmers

Cultural practices/activities	Trained Farmers	Untrained Farmers
Raising cocoa seedlings before planting	76%	52%
Line and peg before transplanting seedlings	68%	36%
Brushing of cocoa farm	88%	80%
Chemical weed control	84%	56%
Removal of unwanted basal chupons	80%	80%
Mistletoe removal	80%	88%
Provide shade where necessary	68%	68%
Pruning	84%	72%

Harvest ripe cocoa pods regularly	92%	75%
Agro-chemical usage		
Use of recommended inputs	98%	96%
Storage of agro-chemicals in safe places until when needed	92%	88%
Safe disposal of agro-chemicals and its containers	92%	84%
Spray insecticide to control pests	92%	85%
Spray fungicides to control blackpod	92%	84%

4.4 POSTHARVEST HANDLING PRACTICES

From the result of the study on materials that were removed from cocoa beans before they were sold, majority (68%) of the trained farmers removed black beans whiles (32%) did not remove black beans before they were sold. For the untrained farmers, (64%) removed black beans whiles (36%) did not. As regard foreign materials and deformed beans, (76%) and (84%) of trained farmers respectively removed them from the dry beans before they are sold. However, (26%) and (16%) did not remove foreign material and also deformed beans before they are sold. On the part of the untrained farmers, (68%), (64%) and (88%) respectively removed black, deformed and foreign materials form the dry beans before they are sold.

Among the trained farmers, all (100%) used the recommended method (mat) for drying cocoa beans. Majority (92%) of the untrained farmers also used drying mat while (8%) of them used other means to dry their cocoa beans. On the storage of bagged cocoa beans, (88%) of the trained farmers put their bagged cocoa on pallets whiles (12%) did not put them on pallets. On the part of the untrained farmers (36%) put their bagged beans on pallets whiles (64%) did not.

On the complaints received from purchasing clerks on beans quality; the results showed that (34%) of the trained farmers received complaints whiles (66%) did not received any complaints on beans quality their purchasing clerks. When the untrained farmers were asked about the complaints they receive from purchasing clerks on the quality of their produce, majority (64%) of them said they did not receive any complains while (36%) received complains.

When the trained farmers were asked on how they identified dried cocoa beans, majority (80%) break or crack the beans, (8%) base their assessment on the sound of the beans when rub on the mat, (4%) on the chocolate flavor the beans gives and last (4%) on when the shells of beans peeled off when rubbed. On the part of the untrained farmers, they asses the dryness of the beans by breaking or cracking the beans (84%), based on the sound of the beans when rub on the mat (8%) the chocolate flavor the beans give(4%) and when the shells of beans peeled off when rubbed (4%)

Table 4.4: Post harvest Handling Practices

Materials removed	**Trained (%)**		**Untrained (%)**	
	Yes	**No**	**Yes**	**No**
Black beans	68	32	64	36
Flat/deformed beans	84	16	68	32
Foreign materials	76	24	88	12
Material for drying cocoa beans				
Drying mat	100	0	92	8
Separation of beans & Storage				
Storage of bagged cocoa on pallets	88	12	36	64
Complaints on beans quality/Rejection				
Received complaints from PCs	34	66	36	64
Assessment for dryness of cocoa beans				
Breaking/cracking/cutting the beans	80	20	84	16
Sound of the beans when rubbed on the mat	8	92	8	92
Beans give chocolate flavor	4	86	4	96

The shells of the beans peel off when rubbed	8	92	4	96

4.5 CHALLENGES OF THE (CHED) TRAINING PROGRAMME

The result from the study revealed that the cocoa farmers that were trained by the Cocoa Health and Extension Division (CHED) faced some challenges. The major challenges encountered included; language barrier, poor approach of extension teaching methods, credibility of the extension agent, Lack of extension teaching materials and inadequate farm visits by extension agents. Among these challenges the most dominant was lack of extension teaching materials, as (50%) of the trained farmers had no access to extension teaching materials. Also, appreciable number of the trained farmers (37.5%) complained that language barrier was a major challenge. It was also revealed that the credibility of the extension agent was also a major concern to the trained farmers as (16.7%) were of the view that some of the extension agents were not credible.

Only few (4%) of the trained farmers said that some of the extension agents do not regularly visit their farms.

Table 4.5: Major challenges of (CHED) training programme

Challenges	**Yes (%)**	**No (%)**
Language barrier	37.5%	62.5%
Poor approach of extension teaching methods	29.2%	70.8%
Credibility of the extension agent	16.7%	83.3%
Lack of extension teaching materials	50%	50%
Inadequate farm visits by extension agents	4%	96%

4.6 PHYSICAL ANALYSIS (CUT TEST)

4.6.1. Mould, Total mouldiness and Other Defect

The cocoa beans from both farmer groups (trained by CHED and untrained farmers) had no incidence of mould, total mouldiness and other defect.

4.6.2 Germinated beans

There was no significant difference ($p>0.01$) between beans from trained and untrained with respect to percentage germinated beans. The percentage of germinated beans of the cocoa samples from both farmer groups were (2.00%) for those trained by CHED and that of untrained farmers was (2.66%) as shown in Table 4.5

4.6.3 Slatty beans

Significant difference ($p<0.01$) existed among the cocoa beans from the two farmer groups. The percentage of slatty beans sample from the trained farmers was (2.66%) and that from the untrained was (5.66%).

4.6.4 Purple beans

The highest percentage of purpled beans was from the untrained farmers (11.00) whilst the lowest was from that of the trained farmers (4.00).

4.6.5 Weevil led beans

The trained farmers had the lowest percentage of cocoa beans with weevils (0.66%) the highest (3.66%) coming from the untrained farmers.

4.6.6 Total Slatty beans

Significant differences ($p<0.01$) occurred among the farmer groups. The highest (5.66%) percentage of total slat beans was recorded in samples from the untrained farmer's whiles the lowest (3.00%) was observed in the trained farmers

4.6.7 All other defect beans

No significant differences ($p>0.01$) existed among the farmer groups in terms of all other defects. However, the highest (6.33%) was observed in the untrained farmer group whiles the lowest (2.66%) was from the farmers trained by CHED

4.6.8 Tolerance level of beans

It was observed from this study that all the cocoa samples were highly tolerant (high purity level). Although, no significant differences ($p>0.01$) existed among the two farmer groups, the highest (94.33%) tolerance level was from the trained farmers and the lowest (88.00%) was from that of untrained.

4.6.9 Grade of beans

Cocoa samples from farmers trained by (CHED) were observed to be in grade (I) whiles that from the untrained farmers was in grade (II).

4.6.10 Moisture content of cocoa beans

The moisture content for the cocoa beans for both farmer groups were within the recommended ranged (5 -7.5%) as farmers trained by CHED had the least (5.33%) moisture content and the highest (7.33%) was recorded by the untrained farmers.

Table 4.6: Cut test results of dried cocoa beans obtained from farmers trained by CHED and other non-members

Farmer Group	M	G	S	P	W	OD	TM	TS	AOD	TL	GRADE	MC
Farmers Trained by CHED	**Not detected**	2.00a	2.66b	4.00b	0.66b	**-**	**-**	3.00b	2.66a	94.33a	I	5.33a
Non-trained farmers	**Not detected**	2.66a	5.66a	11.00a	3.66a	**-**	**-**	5.66a	6.33a	88.00a	II	7.33a
LSD	**-**	4.85	2.17	3.75	2.17	**-**	**-**	1.53	5.74	7.19	**-**	2.17
CV	**-**	55.33	13.86	13.33	26.65	**-**	**-**	9.42	33.95	2.10	**-**	9.12

M-Mould, **G**-Germinated, **S**-Slate, **P**-Purple, **W**-Weevil, **OD**-Other defects, **TM**- Total mould,

TS- Total slate, **AOD**- All other defects, **TL**- Tolerance level, MC-Moisture content

CHAPTER FIVE

5.0 DISCUSSION

5.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Cocoa farming in the Nkawie cocoa districts was male dominated as (80%) and (88%) represented males for trained and untrained farmers whiles the females were (20%) and (12%) for trained and untrained respectively. Farming activities such as weeding, bush burning, spraying and pruning are all laborious in nature and this may have been the reason why there are few women. It was observed that majority of the farmer groups had primary and secondary education with (68%) and (60%) for trained and untrained farmers, respectively. This implies that, the literacy level of the farmers was quite high; hence their ability to read and understand labels and basic instructions would not be limited. Farmers would therefore be able to appreciate technology for adoption. Results obtained further showed that few farmers had no formal education with (8%) and (16%) for trained and untrained farmers respectively. This may be due to the fact that majority of them are from rural cocoa towns were access to education is very difficult. Also, an appreciable number of the farmers had no form of education. The trained farmers had (20%) and the untrained (16%). This implies that, the farmers in the CHED programme will find it difficult to adopt technology and could lead to some farmers not appreciating the programme. This was evident as (37.5%) of the trained farmers complained of the language barrier and poor approach of extension teaching methods (29.20%) as depicted in Table 4.5

5.2 FARM PRODUCTION CHARACTERISTICS

Majority of farmers having a lot of experience (averagely 17 years) in cocoa farming could be related to the fact that majority of the youth continue farming after JHS/SHS education. Also, most of them continue as a business or as part time work when they drop out from school. Majority (52-

76%) of the farmers join some form of farmer group. The laborious nature of cocoa farming compels most rural farmers to form cooperative, in order to help each other, especially, in wedding, harvesting of cocoa and pod breaking. Most farmers who are not part of the CHED programme may take advantage and learn from their trained colleague. This was expected as the field survey revealed that (60%) of the untrained farmers always used the recommended inputs and (88%) also removed foreign materials from cocoa during drying. It was also revealed from the field survey that on average each farmer had two farms with a farm size of (9 acres) for trained and (8 acres) for untrained. In cocoa rural settings, cocoa growing is the dominant activity hence access to more farms is limited. In addition, the land tenure system in Ghana which poses difficulties for land acquisition explains why no farmer had more than 10 acres of farm. The limitation on land for farming partly accounts for the low annual yields of cocoa currently.

As far as number of cocoa bags harvested was concerned, from 2011 to 2014 cocoa season, each farmer harvest on average (14-19 bags). With regards to cocoa production for 2011/2012 and 2013/2014 cocoa season, no significant differences were observed between the trained and untrained farmers. However, during the 2012/2013 cocoa season, on average each trained farmer produced (18bags) of cocoa whiles that of the untrained were (16 bags). In this study it was observed that there was a general increase in yield for both farmer group though the farmers expected more. This may due to some practices not properly adhered to by both farmer groups. It was clear from the field survey that (20%) and (2%) of the trained farmers do not reomove mistletoe and also do not use the recommended inputs whereas (12%) and (4%) were recorded respectively for non- mistletoe removal and un-use of recommended inputs for the untrained farmers. These may impede production and may affect harvest of cocoa pods.

5.3 AGRONOMIC PRACTICES OF FARMERS

Good agronomic practices such as pruning, removal of mistletoes, lining and pegging, removal of unwanted basal chupons are principal part of good agricultural practices which is also linked with increase yield. Results from the study indicate that majority of the trained farmers always adopt these cultural practices training provided by CHED extension agents. Extension education communication methods play a very important role in the delivery of extension messages to cocoa farmers. Many farmers have been using some of these cocoa technologies extended to them through extension education by extension agents. The methods used have influences on farmers' understanding and adoption of technologies (Dankwa, 2001).

It was revealed from the study that, CHED trained farmers had considerable number of experience in farming as the average years in farming was 17 years. This may account for their adoption to the various cultural practices technologies introduced by the extension agents. Studies have shown that experience in farming is also a key factor in adoption of extension technologies. Results from the study showed that most of the untrained farmers do not practice lining and pegging as well as raising of cocoa seedlings before planting. This may be attributed to lack of extension education as lining and pegging and raising of seedling involves some technical skills.

Education is usually related to how farmers are receptive to advice from an extension agency and also be able to deal with technical recommendations that require a certain level of literacy and indirectly the farmer's managerial ability (Dankwa, 2001). The result on the agro-chemical usage indicates that on average the farmers are adhering to agro-chemical usage. About (60%) of untrained farmers using the recommended inputs was even encouraging and supports the fact that the farmers somehow have some level of education. A small percentage (29%) of the untrained farmer's not spraying insecticide to control pest may be due to the fact that they are not registered members of the (CHED) programme and therefore do not receive much education from the extension officers. In some cases, the (CHED) farmers were favoured during the distribution of agro-chemicals hence few non- trained farmers have access to the agro-chemicals.

Appreciable number of trained farmers disposing off agro-chemicals and its containers on farms may be attributed to behavioral characters (Dankwa, 2001). A group of farmers may be taught by one extension officer, but their practices such as cocoa fermentation, drying and pod breaking may differ. This may be the reason why about (8%) of the trained farmers do not properly disposed off agro-chemical containers. Also, a few (2%) of the trained farmers do not use the recommended inputs. Some of the trained and untrained farmers not regularly adhering to insecticide and fungicide application may also be due to the high cost of these chemicals. It was revealed from the study that most of the farmers were knowledgeable in good agricultural practices. However, the high cost of these agro-chemicals sometimes repels some farmers from their regular usage.

5.4 POST HARVEST HANDLING PRACTICES

Post-harvest handling practices are one of the important activities in the cocoa supply chain. Results from the study shows that majority of the farmers from both CHED trained and untrained do beans sorting, use proper material for drying as well as proper storage. This accounted for the grade I and grade II cocoa obtained from CHED trained and untrained farmers respectively. Amoah (1998) opined that post-harvest practices such as breaking of pods, fermentation of beans, drying of beans, proper bagging and storage are essential for improving physical quality of cocoa beans and also reduce levels of contaminants.

The study also showed that all (100%) of the CHED trained farmers use dry mats to dry their cocoa in the sun. Raffia mats can be used as a drying platform to produce beans of good internal quality. Many authors have established that sun drying is best for good quality beans.

5.5 CHALLENGES FACED BY (CHED) TRAINING PROGRAM

In extension education, methods of communication plays a very important role in the delivery of recommended messages to cocoa farmers as the methods used have influences on farmers' understanding and adoption of technologies. The result from the study revealed that the cocoa farmers that were trained by the Cocoa Health and Extension Division (CHED) were faced with some challenges. The major challenges encountered included; language barrier, poor approach of extension teaching methods, credibility of the extension agent, lack of extension teaching materials and inadequate farm visits by extension agents. These challenges faced by the farmers may be due to their low level of education as the study indicated that majority (88 %) of the farmers level of education were below SSSCE.

Education may make a farmer more receptive to advice from an extension agency and also be able to deal with technical recommendations that require a certain level of literacy and indirectly the farmer's managerial ability (Dankwa, 2001).Therefore a farmer with a higher level of education is expected to be able to participate in more extension activities than one with a lower level of education.

Credibility of the extension worker was also a challenge to a section of the farmers as this affects extension delivery process.

Mensah (2006) reported that the efficiency of every extension system also depends on the credibility of the extension agents as it goes a long way to affect the innovations disseminated to farmers. In Nigeria, Adisa and Adeloye (2012) also found credibility of the extension agent to be one of the factors that hinders cocoa extension education delivery.

Inadequate farm visits by extension agents was also cited as one of the challenges faced. This assertion means that farmer prefer regular farm visits as a method of extension delivery. Most farmers preferred the farm visits since they had the opportunity to ask practical questions in the field, build their confidence and also received ready answers (Dankwa, 2001).

Lack of extension teaching materials was the major challenged faced by the farmers as (50%) of them supported it. It was revealed from the field survey that majority of the farmers were adult (30 and above). For extension education delivery to be more effective especially for adult, demonstration during farm visit is essential, since farmers usually learn quickly with one what they have experimented on. Various authors have cited that farm trials and demonstrations is the commonest means to deliver extension education. Lack of extension teaching materials may also be attributed to the high ratio of extension officers to farmers. In some cocoa district one extension officer covers about forty (40) communities, this makes extension education difficult.
Even in some cases, where extension teaching materials are available, the schedule of the extension officer is so tight that the time allocated to a group of farmers is inadequate for demonstration purposes.

5.6 PHYSICAL ASSESSMENT OF DRIED COCOA BEANS

The quality of cocoa beans exported is an important factor to consider in the cocoa industry, this affects the quality of the end product it is used to produce. Dried cocoa beans should be of good quality and free from all forms of defects and off flavours. Defectiveness among cocoa beans includes flat, mouldy and geminated beans (Are and Gwynne-Jones, 1974). Moisture content of cocoa beans from the non- farmers was (7.33 %) whereas that of the CHED farmers were (5.33).The moisture content of the cocoa beans produced from the two farmer groups (CHED farmers and non- CHED farmers) were within 6-8 % which is the recommended moisture range for dried cocoa beans (Amoa- Awua *et al.*,2007).

Cut test results on dried beans obtained from CHED farmers showed that the cocoa beans were of Grade I quality cocoa whiles that form non- CHED farmers are classified as Grade II cocoa. The findings from this study are in conformity to that reported by Boateng (2012). Grade 1 cocoa are thoroughly dry, free from foreign matter, smoky beans and any evidence of adulteration, and contain not more than 3 % by count of mouldy beans, not more than 3% by count of slaty beans, and not more than 3 % by count of all other defects (Boateng, 2012).The results from the study indicated that farmers trained by CHED conform to the required number of days for fermentation, beans turning and other agronomic practices required to obtain Grade 1 cocoa. The conformity of the CHED farmers to the good agricultural practices may also be related to the fact that most (96%) of the extension officers of CHED regularly visited the farmers and help them to adopt new methods.

Grade II cocoa describes cocoa which is thoroughly dry, free from foreign matter, smoky beans and evidence of adulteration, and contains not more than 4% by count of mouldy beans, not more than 8% by count of slaty beans, and not more than 6% by count of all other defects (Boateng, 2012). Non- CHED farmers produced Grade II cocoa beans and this may be attributed to insufficient know how and no training received by farmers. Lack of information on good fermentation practices may have led to high purple levels, all other defects and high moisture content. A combination of these quality factors may be the reason for the cocoa beans being classified as a Grade II. Non- CHED farmers not conforming to any standards and no form of education on good agricultural practices may have resulted in the production of cocoa beans containing more than 3% mould, slat and other defect and this may even lead to some form of bean rejection. This was not surprising as an appreciable percentage (36%) of the field surveyed complained of bean rejection by the purchasing clerk. Also from the field survey it was revealed that majority (76%) of the farmers were not used to sorting and grading before they are sent to purchasing clerks. These among other factors may have contributed to beans been classified as Grade II.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

It was observed that various trainings provided by Cocoa Health and Extension Division (CHED) have had a positive impact on the farmers as most farmers confessed that the trainings were beneficial. Inadequate extension teaching materials, language barrier and poor approach of extension teaching methods were the major challenges as far as the (CHED) training program is concerned. It was further observed that the cocoa beans produced from both farmer groups were all of good quality although the trained farmers were classified as grade I and that of untrained as grade II. The moisture content of the cocoa beans produced from the two farmer groups (CHED farmers and non- CHED farmers) were within (6-8 %) which is the recommended moisture ranged for all dried cocoa beans. There were no presence of moldy beans and other defects in all the cocoa samples.

6.2 RECOMMENDATION

Based on the findings of the study, the following recommendations were made;

- Regular monitoring of the trained farmers in compliance to the (CHED) training manual will be helpful as far as the training programme is concerned.
- The extension officers must also be monitored so that there can be regular farm visit.
- The CHED training programme should be extended to other cocoa growing communities

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