MANUAL
FOR COCOA EXTENSION IN GHANA



Cocoa Health and Extention Division [CHED] | World Cocoa Foundation [WCF] © 2016

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USAID FROM THE AMERICAN PEOPLE

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the sustainable trade initiative

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COCOA HEALTH AND EXTENSION DIVISION

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USAID

THE SUSTAINABLE TRADE INITIATIVE

ACKNOWLEDGEMENT

We express our sincerest gratitude to all who in diverse ways contributed to the development of the manuals and guides for cocoa extension in Ghana.

Our partners especially, WCF, USAID, IDH and COCOBOD who provided financial support for the production of the manuals and guides.

The National Experts' listed below are highly commended for the development of the materials under very challenging circumstances. We are grateful to them.

We also thank all stakeholders involved in discussions leading to the production and reviewing the drafts. It is our fervent hope that they will continue to offer their expertise and time to improve extension delivery for cocoa and its associated crops in Ghana.

NATIONAL EXPERTS' COMMITTEE

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PREFACE

For sustainable production of cocoa it is the view of the Cocoa Health and Extension Division (CHED) of the COCOBOD to have highly trained and motivated human resource to facilitate the processes, which can lead to increased and sustained cocoa production. Though there are a lot of training materials available to train the Ghanaian small holder cocoa farmers, some of the information provided by such materials conflict with the recommendations based on scientific research findings. Such materials tend to confuse the farmer and end up undermining the trust reposed in the agents of extension delivery to farmers. This state of affair has plagued extension delivery for a considerable length of time. Most stakeholders in the cocoa industry have identified the constraint posed by the multiplicity of confusing messages delivered to farmers. The need for harmonising extension messages has become a priority activity for CHED and its partner organizations that have interest in facilitating increased productivity and sustainability of cocoa in Ghana. A common goal is to facilitate the production of an extension manual, illustrative guide and a step by step training guide with modules on basic cocoa extension to meet the rapid growth for knowledge and skills in the cocoa industry. There has been the need for a closer collaboration between CHED and major partners to engage national experts to produce a harmonized manual containing standard initiatives, messages and best practices for cocoa production and post production handling of high grade cocoa beans. It is hoped that this manual also helps to increase productivity of the cocoa sector, as certification is also covered in the manual to add premium to cocoa produced in Ghana. It is our view that only a productive cocoa farm will attract the younger farmer generation to carry on with cocoa production as a viable business option.

This manual is intended for professional cocoa extension agents, field supervisors and trainers who have a degree or diploma in agriculture and are involved in training of other trainers and/or farmers.
This extension manual can mainly be used by the master trainers, practitioners and extension officers with direct contact with cocoa farmers. If used by master trainers, this manual can also serve to train farmers directly.
Special guidelines have been developed separately for Extension agents/facilitators and lead farmers to train farmers.

The extension manual is supported by a training guide in modules, and an illustrative production guide for use by farmers. These materials help the trainer to structure the delivery of the training sessions to enhance achievement of the most impact of the training.

It is the wish of COCOBOD in general and CHED in particular, that this collaboration with its partners,is to achieve the highest level of training for extension officers who are capable of facilitating farmer adoption of technologically advanced knowledge and skills to sustain the cocoa industry.

It is our fervent hope that the developed materials will contribute to the removal of multiplicity of extension messages, which confuse the cocoa farmer. It is also our wish that the materials containing harmonized messages are used by stakeholders for cocoa extension in Ghana

Executive Director,
Cocoa Health and Extension Division (CHED).
DR. FRANCIS BAAH.

INTRODUCTION AND BACKGROUND INFORMATION ON COCOA PRODUCTION

1.0

INTRODUCTION

1.1 HISTORY OF COCOA IN GHANA

▪ Cocoa was introduced into Ghana in 1879 from Fernando Po by Tetteh Quarshie.

▪ Within three decades of its introduction, cocoa had become the main export commodity of the then Gold Coast.

▪ By 1936, Ghana was producing about 50% of the world's output of cocoa beans.

▪ Ghana remained the world's leading producer of cocoa until 1977 when she was overtaken by Brazil.

▪ Brazil was later overtaken by Cote d'Ivoire in 1979.

▪ Ghana currently produces about 20% of the world's output and it is the second leading producer/exporter of cocoa beans after Cote d'Ivoire. **(Fig. 1.1)**

1.2 COCOA SECTOR IN GHANA

▪ The cocoa industry has been the mainstay of Ghana's economy for a century, contributing 6 to 7% of GDP.

▪ Cocoa employs, directly and indirectly, over 2 million people (about 7% of Ghana's population).

▪ It is the leading foreign exchange earning agricultural commodity accounting for over 30%of the earnings of the agricultural sector.

▪ Cocoa generates about 25% of merchandise exports revenue.

▪ The export tax on cocoa forms a significant proportion of Government revenue.

▪ Cocoa contributes significantly to socio economic development by providing infrastructure in the form of roads, education and health facilities.

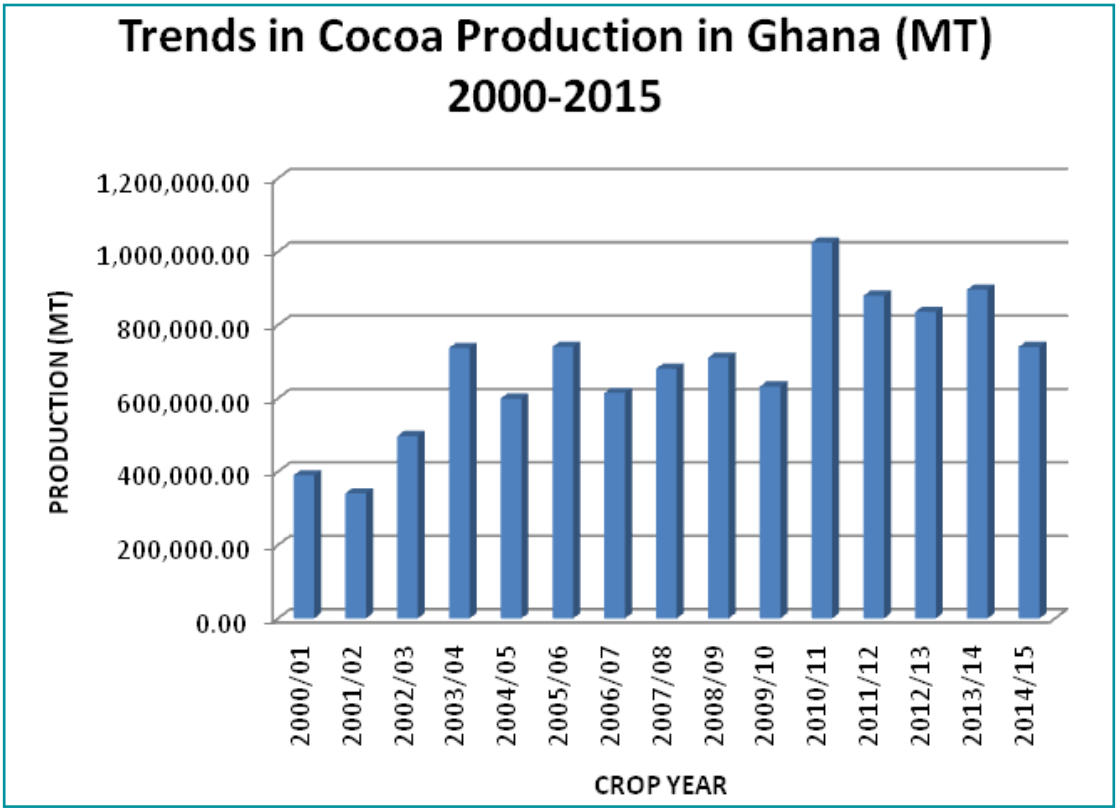


Fig.1.1. Cocoa Production on Ghana, 2000/01 -2014/15.

1.3 GHANA COCOA BOARD

The Government in 1947 established the then Cocoa Marketing Board which is now known as Ghana Cocoa Board (COCOBOD) to provide marketing services to cocoa farmers. Ghana Cocoa Board is the statutory public institution that regulates and monitors the operations of Ghana's cocoa industry. The functions of COCOBOD centre on the production, research, extension, quality control and internal and external marketing of cocoa.

In order to achieve its objectives and perform its functions effectively and efficiently, COCOBOD is organized into a Head Office which coordinates the activities of five specialized subsidiaries/divisions grouped into pre harvest and post-harvest sectors:

PRE-HARVEST SECTOR FUNCTIONS

The Pre-harvest Sector functions, which are performed by the Cocoa Research Institute of Ghana (CRIG), the Seed Production Division (SPD) and the Cocoa Health and Extension Division (CHED), deal with fundamental on farm issues.

COCOA RESEARCH INSTITUTE OF GHANA

Cocoa Research Institute of Ghana undertakes agronomic research into problems relating to sustainable production of cocoa and other COCOBOD mandate crops (Shea, Cashew, Coffee and Kola). It produces elite planting materials for SPD and also provides information and advice on matters relating to the production of cocoa and other mandated related crops. It also establishes strong linkage with extension for effective transfer of research findings, new findings, new technologies and agronomic practices to farmers.

SEED PRODUCTION DIVISION

The Seed Production Division is responsible for the multiplication and distribution of improved cocoa and coffee planting materials to farmers in the most efficient and cost effective manner.

THE COCOA HEALTH AND EXTENSION DIVISION (CHED)

CHED is responsible for the control of the Cocoa Swollen Shoot Virus Disease, rehabilitation of old and unproductive cocoa farms and extension services in Ghana. The Division has the oversight and management responsibility of the new Cocoa Extension System which operates in the context of a Public Private Partnership. It provides an efficient and cost effective extension to cocoa farmers by assisting them to acquire knowledge and skills in good agricultural practices. Farmers are also trained in basic economics to orientate them to consider farming as a business venture which is impacting positively on farmers' productivity.

POST-HARVEST SECTOR FUNCTIONS

The post-harvest sector functions are undertaken by the Quality Control Company Limited (QCC) and the Cocoa Marketing Company (GH) Limited (CMC)

QUALITY CONTROL COMPANY

The QCC is responsible for the inspection, grading and sealing of cocoa, coffee and sheanuts for the local and international markets and also responsible for the disinfestation of produce.

COCOA MARKETING COMPANY OF GHANA (CMC)

The CMC performs the external marketing function of the board as well as the takeover function within the internal marketing system.

1.4 CHALLENGES AND THREATS TO SUSTAINABLE COCOA PRODUCTION:

Inspite of governments' interventions in the cocoa sector as well as the crop's contribution to the national GDP and socio economic development, yield per unit area on farms is relatively low. This low productivity is due to many challenges including the following:

Tree stock:

- Old age of trees (most cocoa farms are over 30 years old)
- Predominance of low yielding traditional varieties (limited use of hybrids)
- Small farm sizes due to fragmentation from land tenure arrangements

Farm management:

- Poor farm management practices (Non adherence to good agricultural practices)
- Limited and irrational use of agro inputs such as fertilizers, fungicides, herbicides and insecticides
- Use of unapproved agro chemicals in cocoa production by some farmers
- Overly tall cocoa trees (10-15m) that make it difficult to manage

The environment:

- Erratic rainfall and rising temperatures as a result of climate change
- Competition for land and labour from unregulated surface mining activities (Galamsey) and establishment of non-cocoa crops (eg. rubber plantations)
- Expansion of cocoa areas by cutting down forests

▪ Cocoa production under little or no shade which results in unsustainable production (production declines with time)

Extension Service delivery:

- Low Extension Agent to farmer ratio
- Inadequately resourced Extension staff
- Low technological uptake by farmers
- Inappropriate extension packages
- Varying extension messages by partners

Others:

- Old age of farmers
- Limited access to credit
- Poor access to and unavailability of inputs
- Labour shortage
- Smuggling of cocoa beans and inputs into neighbouring countries

1.5 INTERVENTIONS

Due to the above challenges in the cocoa industry, COCOBOD and its Subsidiaries/Divisions have put in place certain interventions. Some of these interventions are:

SEEDLINGS PRODUCTION

The rationale for raising and distributing hybrid seedlings is to encourage the planting of improved planting materials to ensure the sustainability of cocoa production.Seedling production and distribution is done through the collaboration of Seed Production Division (SPD) and Cocoa Health and Extension Division (CHED).

COCOA HiTECH

The Cocoa HiTECH programme was introduced in 2003 to demonstrate to farmers the importance of fertilizer application toboost cocoa production.

COCOA REHABILITATION

It is estimated that about 40% of the cocoa tree stock in Ghana is unproductive. This includes over-aged and CSSVD infected farms.
To remedy the situation:

1. COCOBOD encourages farmers to:

- Replant old/moribund farms with hybrid cocoa seedlings
- Maintain productive cocoa farms through proper farm maintenance, removal of mistletoes and ap plication of fertilizer
- Cut-out (remove) and replant CSSVD infected farms with hybrid cocoa seedlings

EXTENSION SERVICE DELIVERY

Cocoa extension has gone through a lot of changes. The current extension system operates in the context of Public - Private Partnership in extension delivery and costs sharing. The principle is to operate with lean staff numbers who are professionally trained and highly qualified and motivated to provide cost effective and efficient cocoa extension services to business – oriented farmers.

▪Farmers are educated on Good Agricultural Practices through rallies, group meetings, farm visits, home visits and radio programmes. Farmers are also educated to appreciate cocoa farming as a business through the Farmer Business School (FBS) concept jointly developed with German Development Cooperation (GIZ).

▪Farmers are also educated on additional livelihood skills contributing to farmer livelihood diversification,particularly in cassava and gari production, plantain sucker multiplication, cocoyam, chili pepper production, snail rearing and mushroom production.

YOUTH IN COCOA

It is estimated that the average age of the Ghanaian cocoa farmer is about 55 years. To sustain the cocoa industry,COCOBOD is encouraging the formation of youth groups to enhance and facilitate their access to farm lands, extension education, inputs and credit.

FARMER AWARDS

COCOBOD awards hardworking cocoa, shea and coffee farmers at the District, Regional and National Levels during National Farmer's day celebrations held annually. Farmers are selected based on their output, contribution to their communities and their adoption of Good Agronomic Practices.

BACKGROUND AND TECNICAL INFORMATION ON COCOA PRODUCTION

2.0 TECHNICAL INFORMATION

2.1 COCOA BOTANY

Cocoa belongs to the genus Theobroma, sub family Sterculioidea and family Malvaceae. It has an elaborate root system, trunk, branches, leaves and flowers which develop into pods. **(fig.1.2)**

PARTS OF THE COCOA TREE

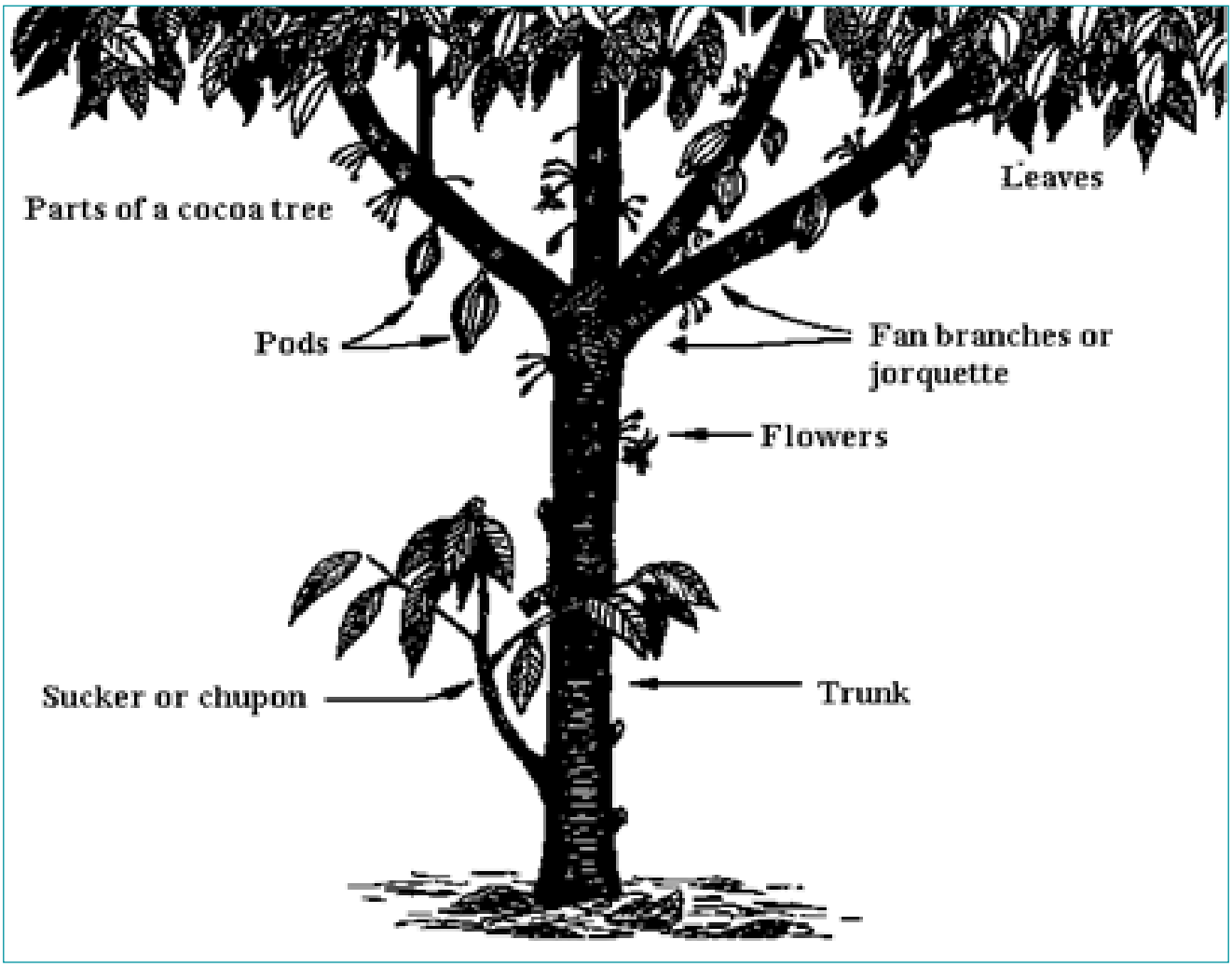


Fig.1.2 Parts of the Cocoa Tree

ROOTS

The root system of the mature cocoa tree consists of a tap root of 120 -200cm long with an extensive system of lateral feeder roots most of which lie in the top 20cm of the soil, but which may extend to 40-50 cm where the humic layer is deep. The lateral roots grow far beyond the limit of the tree's canopy forming a complex woven mat. At the tip of the main lateral roots there are bunches of fine rootlets which are especially abundant where plant residues are rotting. The tap root divides and has small rootlets at its extremity which indicates that the tap root absorbs water and nutrients. **(Fig.1.3)**

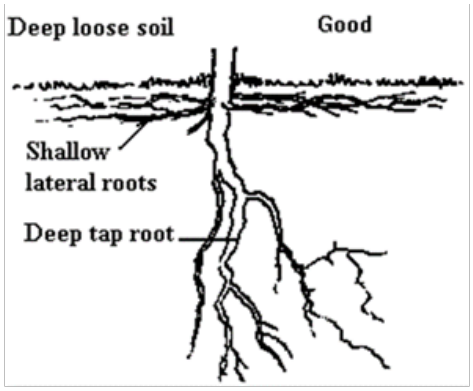


Fig 1.3 Cocoa root system

TRUNK

After germination and formation of the primary leaves the stem grows vertically for about 14 to 18 months. Further growth is then interrupted by the degeneration of the terminal bud. The first branches develop in the form of a whorl of five branches, growing horizontally. These fan branches form the framework of the tree and are called the jorquette. At this stage of growth, the trunk is about 1.5 m tall **(Fig 1.4).** One of the dormant axillary buds on the trunk below the branches of the jorquette develops and produces an orthotropic shoot termed the 'Chupon" which behaves like the main stem. The chupon stops growing after about another height of 1.5m form a second jorquette. When the latter is well developed, branches of the first jorquette gradually die off. This growth pattern continues in wild cocoa plants, but in plantations, it is stopped and modified by pruning. The cocoa tree is generally pruned to a single stem at the level of the second jorquette.

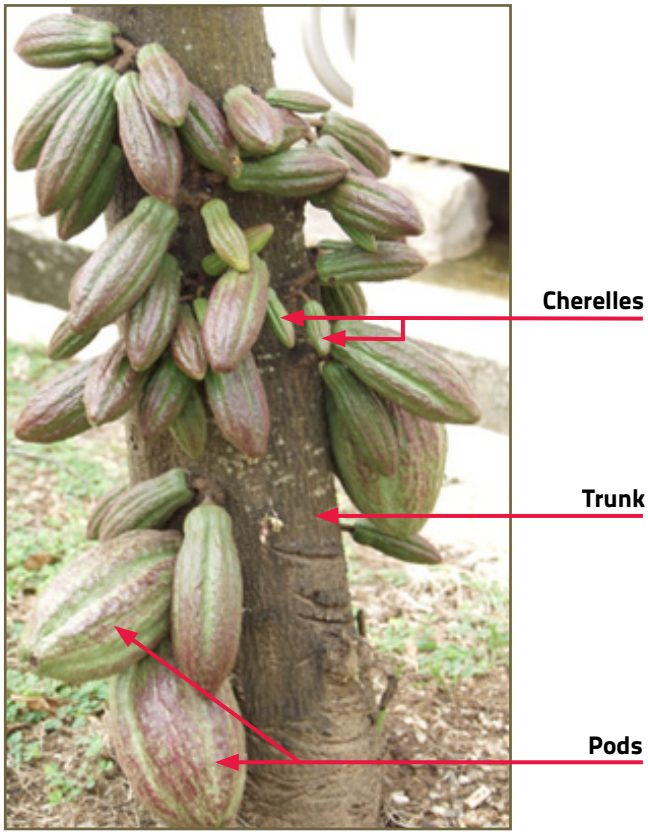


Fig 1.4 Cocoa root system

LEAVES

The leaves are usually produced in flushes in March–April and September-October.The young leaves are soft and have green midribs and veins. When matured, the leaves become dark green. The leaves have stomata on their under surface only. Their number per unit area is affected by the light intensity which also influences the size and thickness of leaves. Those that develop under shade are larger and greener than those that grow in full sun.

FLOWERS

The flowers are small pinkish white or greenish white and are borne on small flower stalks in clusters on the trunk and branches at the cushions. They are pollinated mainly by insects (midges). Pollination can also be done by hand by trained pollinators. **(Fig 1.5)**


Fig 1.5: Cocoa flowers

THE FRUIT

The fruit matures between 5 – 6 months after flowering. The young fruit is called cherelle.

The fruit comes in various colours, shapes and sizes, depending on the varieties and sometimes environmental factors. **(Figures 1.6 a -d /Table 1.1)**

CLASSIFICATION


Fig. 1.6a Forastero [Amelonado]


Fig. 1.6b Criollo


Fig. 1.6c Trinitario


Fig. 1.6d Hybrid

TABLE 1.1 COCOA TYPES, CHARACTERISTICS, ORIGIN AND OBSERVATION

GROUP	CHARACTERISTICS	ORIGIN	OBSERVATION
 **FORASTERO** [Eg. Amelonado]	▪Pod husk is hard ▪Small and elongated pods ▪Pod surface not warty and furrows inconspicuous. ▪Unripe fruit colour is green; ripe fruit colour is yellow. ▪Average number of beans/ pod 30 or more . Seeds are flat.	▪High Amazonia (Peru, Ecuador and Colombia) and the Amazon basin (Brazil)	▪Hardy and high yielding. ▪Used for selection of breeding varieties ▪Dominant planting material in cocoa production. ▪The West African Amelonado belongs to this group. ▪Possess 'harsh" flavour with bitter taste
 **CRIOLLO**	▪ Pod husk is soft ▪ Pod surface are warty and conspicuously furrowed. ▪ Normally large and elongated. Red/green when unripe and yellow/orange when ripe. ▪ Average number of beans/ pod 20-30. Seeds are plump.	▪ Mexico, ▪ Nicaragua, ▪ Guatemala, ▪ Colombia, ▪Venezuela and ▪Indonesia.	▪ Very vulnerable to diseases ▪ Possesses bland flavour and pleasant aroma
 **TRINITARIO**	▪ Pod husk mostly hard ▪ It is an intermediate between Forastero and Criollo ▪ Unripe fruit colour is red/ purple, Ripe fruit colour is orange ▪ Pod surface is intermediate ▪ Average number of beans/ pod 30 or more . Seeds are intermediate.	▪ Trinidad and Venezuela	▪ Highly susceptible to Black pod

GROUP	CHARACTERISTICS	ORIGIN	OBSERVATION
 HYBRID	▪ Has attributes of both parents that were crossed to produce the hybrid		▪ Establish easily ▪ Early bearing ▪ High yielding ▪Tolerant to black pod and cocoa swollen shoot virus diseases ▪Tolerant to mirids/ capsids (akate)

2.2 PLANTING MATERIALS

Cocoa can be planted using either seeds derived from pollinated pods (hybrid seeds) or through vegetative propagation (clonal material) methods.

HYBRID SEED PRODUCTION

Cocoa is planted using mixed hybrids (akokora bedi) of superior high yielding trees. The advantages of these hybrids are that they:

1. Establish easily
2. Early bearing (two years after transplanting)
3. High yielding
4. Have better tolerance to black pod and cocoa swollen shoot virus diseases
5. Have higher levels of tolerance to mirids/capsids (akate)

Hybrid pods should be obtained from SPD seed gardens. Pods from natural sets (not hand pollinated) at the seed gardens as well as those from trees on farmers' farms are pollinated naturally and cannot be used as planting materials. The seed gardens are located in the following towns:

Eastern Region
Apedwa, Bunso, Asamankese, Pankese/Akuase, Bieni, Oyoko, Akwadum and Tafo

Ashanti Region
Jamasi, Akomadan, Kwadaso, Poano, Fumso, Juaso
Central Region
Breman Asikuma, Baako and Assin Fosu

Western Region
Achechere, Saamang and Buako

Brong Ahafo Region
Sankore, Goaso, Wamfie and Bechem

Volta Region
Ampeyo, Akaa and Saviefe. **(Fig 1.8)**

VEGETATIVE PROPAGATION

Vegetative propagation is a method used to produce plants with the same genetic makeup as the parent plant.


Fig.1.7 Budded cocoa

One method of vegetative propagation is budding. **(Fig 1.7)**
This method can be used in producing planting materials for rehabilitating old/ moribund cocoa farms or establishing seed gardens.

Advantages of budding in cocoa:

1. Beneficial or desirable qualities in the parent plant are passed on directly to the young plants without any change.
2. It shortens fruiting time of the plant.
3. A desirable growth pattern is achieved to make work easier.

Disadvantages of vegetative propagation in cocoa:

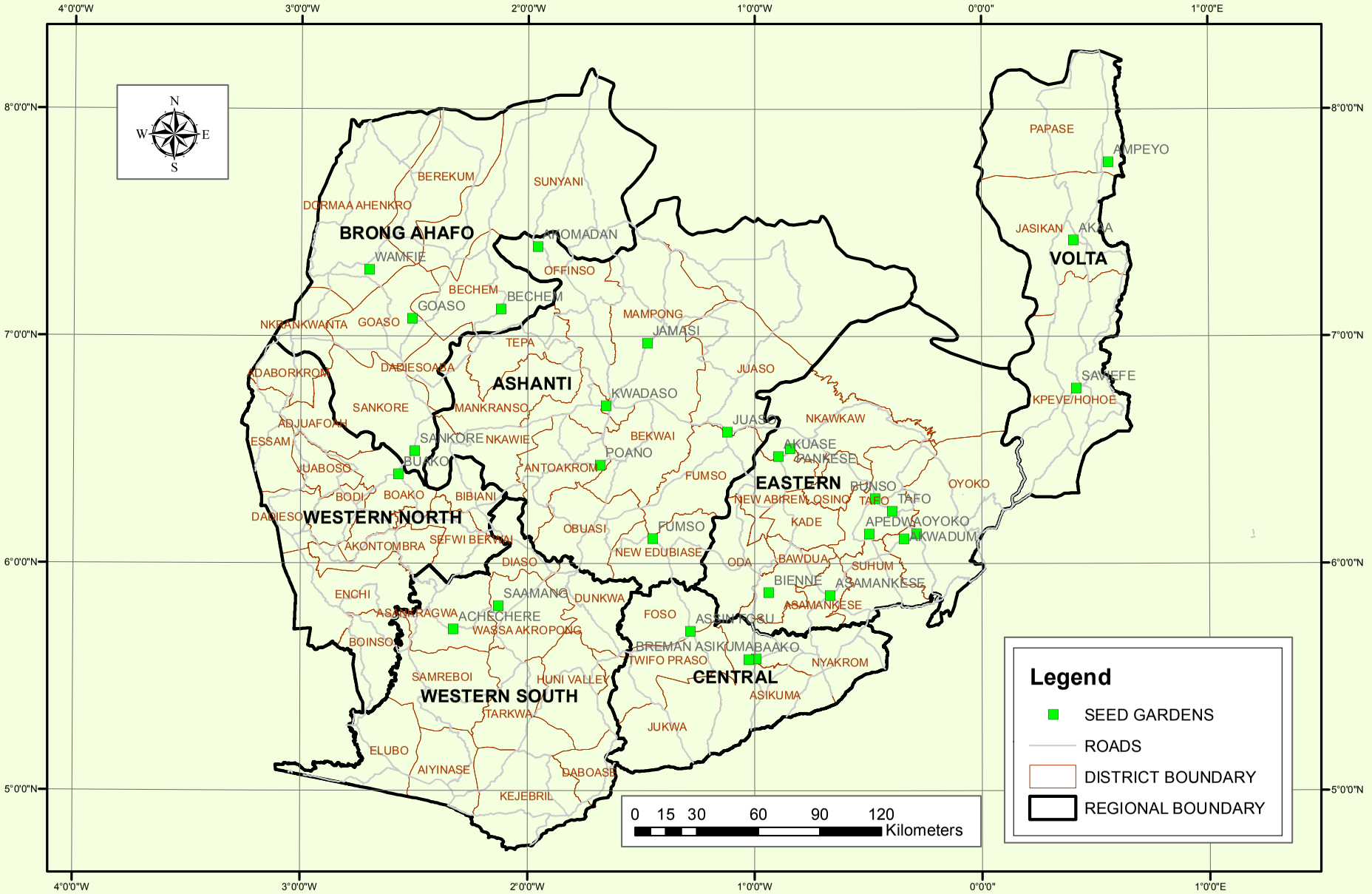
1. Skilled labour is required for its production.
2. It is labour intensive.
3. Variation which is very important in breeding is absent as compared to sexual reproduction.
4. Expensive tools and materials are required.

2.3 AGRO CLIMATIC REQUIREMENTS

RAINFALL

Cocoa can be successfully grown in areas having rainfall between 1100mm and 3000mm per annum. For optimum production, areas with rainfall between 1500mm-2000mm and a dry season of not more than three months with less

FIG.1.8 LOCATIONS OF COCOA SEED GARDENS IN GHANA



than 100mm rain per month are preferred. The rainfall regimes in Ashanti, Brong Ahafo, Central, Eastern, Western and Volta regions where cocoa is grown range from 1200mm to 1600 mm **(Fig.1.9).** Extremely wet and marshy areas as well as extremely dry areas are not suitable for cocoa production.

TEMPERATURE

Cocoa thrives in areas with maximum temperatures ranging between 30-32°C and minimum 18-21°C. The average annual temperature should be around 21°C.

RELATIVE HUMIDITY

Cocoa thrives in areas with relative humidity of 100% at night and about 70 -80 % during the day.



Fig. 1.9 Rainfall map of Ghana

3.0 GOOD AGRICULTURAL PRACTICES (GAPs)

3.1 NURSERY PRACTICES

The nursery is a site where cocoa seedlings are raised for transplanting to the field. Nursery operations should start between November and December.

SITE SELECTION

The site selected for the nursery should

- Be flat and preferably near a permanent source of water
- Not be too far from the proposed farm
- Have permeable soils to prevent water logging
- Be sited at least 10m away from an existing cocoa farm
- Not be near undesirable shade trees to prevent possible CSSVD infection.

LAND PREPARATION

Weed the area clean and remove any debris or obstacles from the site

SHADING

- Temporary shade using palm fronds or shade nets should be erected. This is to protect seedlings from direct sunlight.
- Provide shade of about 2 meters from the ground to allow for a convenient working height.
- Fence nurseries if there is the risk of disturbance from livestock or strangers

NURSING OF COCOA SEEDLINGS

There are two methods of raising cocoa seedlings.

- Polythene bag and
- Seed bed method.

NURSING OF COCOA SEEDLINGS IN POLYTHENE BAGS

1. Acquire polybags

a. Use smaller polybags (12.5 cm x 25 cm or 12.5 cm x 20 cm and 12.5 cm x 15 cm) if nursing for 3 months

b. Use larger polybags (18 cm wide and 25 cm high (7 in x 10 in) if nursing is for up to 6 months.

2. Create drainage holes in polybags. **(Fig. 2.1)**

3. Fill poly bags to brim with top soil (top soil is high in organic matter, well aerated and has good water retention). **(Fig.2.2)**



(a) Cocoa nursery with shade netting



(b) Palm frond to provide shade





Fig. 2.1 Preparation of drainage hole on polythene bags



Fig. 2.2 Filling of polythene bags with top soil



Fig.2.3 Polythene bags arranged in rows



Fig.2.4 Sowing of beans in polythene bags



Fig.2.5 Seedlings raised in polythene bags

- Arrange bags in rows of 10 bags wide and up to 100 bags long under the shade. **(Fig.2.3)**

- To facilitate maintenance operations (watering, weeding, disease and pest control activities), paths of about 45–60 cm should be left between the rows.

- The soil in the bags is watered before sowing the cocoa bean. Place beans with the pointed end upwards at a depth of abut 2cm; if in doubt as to which is the pointed end, place bean flat at the same depth. **(Fig.2.4)**

- Do not sow already germinated beans

- As the seedlings grow, sorting out should be done at regular intervals to avoid overcrowding and competition for light. **(Fig.2.5)**

NURSING COCOA SEEDLINGS ON NURSERY BEDS

To construct a nursery bed it is important to weed and remove all plant debris and work the soil thoroughly to root depth. This is easiest when the soil is slightly damp but not wet. Once the seed bed is ready, avoid any physical compaction such as walking on the bed.

- Dig, loosen and turn out the soil about half a metre wide. This will loosen the clump in the soil and also allow watering of the bed without stepping on it.
- Beds measuring 12.5cm high, 120cm wide and of any convenient length are made leaving a path of 45 to 60cm wide between them. **(Fig.2.6)**
- The top of the beds are levelled and furrows/grooves 20 cm apart are made along the entire length of each bed.
- Along each furrow/groove, fresh beans from pods obtained from SPD are sown 10 cm apart as described in the polythene bag method. **(Fig.2.7)**
- Seedlings raised on beds should not be kept for more than 4 months before transplanting.
- Provide shade over the seedlings similar to those sown in polybags. **(Fig.2.8)**



Fig. 2.6 Seed bed for raising cocoa



Fig. 2.5 Sowing of cocoa seeds on a seed bed seedlings



Fig. 2.8 Seed bed with palm frond shade



Fig.2.9 Watering of cocoa seedlings in the nursery

MAINTENANCE OF THE NURSERY

Watering

- After germination, the seedlings should be watered every other day in the evening or in the morning with watering cans fitted with roses **(Fig.2.9).** In the rainy season however, they should be watered as and when required. Avoid over watering to reduce damping-off disease.

Weeding

▪ The weeds on the bed or in the polythene bag are removed by hand.

FERTILIZER APPLICATION/MANURING

▪ Nutrient requirement by cocoa seedlings in the nursery stage are not high if good top soils are used as the potting medium.

▪ When the top soil used is deficient in nutrients, apply the recommended fertilizer (granular or foliar) to the cocoa seedlings one month after germination (see appendix...). Ensure that granules do not fall on leaves of seedlings since it will cause scorching. Seedlings should be watered thoroughly after application of granular fertilizer to dissolve the granules and ensure root contact and uptake.

PEST AND DISEASE CONTROL

▪ The seedlings are protected from diseases such as Phytophthora blight and damping-off and pests such as leaf eaters with recommended fungicides and insecticides respectively. Use pneumatic knapsack spraying machines in applying the fungicides/insecticides.

▪ Do not under any circumstance use knapsack sprayers meant for herbicide application for applying insecticides/fungicides and vice versa.

HARDENING

▪ A month prior to transplanting, the shade should be gradually reduced. A week to transplanting the shade should be completely removed.These are done to harden the seedlings. During the hardening period, watering of seedlings should be reduced and there should be no fertilizer application.

TRANSPORTATION OF SEEDLINGS FROM NURSERY TO FIELD

Seedlings are highly vulnerable to damage during transportation, therefore they should not be over stucked or over crowded during transportation.

RECORD KEEPING

Proper nursery records must be kept to identify the source of planting materials, number of polybags acquired and filled, number of seeds planted and number germinated which will assist you to determine germination percentages.

3.2 PREPLANTING OPERATIONS

SELECTION OF SITE

It is important to properly select an appropriate site before setting up the plantation. Select relatively flat or gently sloping land (avoid steep slopes). Rocky areas, sites with hard pans or marshy/extremely wet areas are not suitable. If in doubt as to whether the land is suitable or not, consult the cocoa extension officer in your area.

SOILS SUITABLE FOR COCOA

Not all soils are suitable for cocoa cultivation. Cocoa trees grow well only in good quality soils, thus a suitable soil for cocoa cultivation should have the following characteristics: **(Fig.2.1.1)**

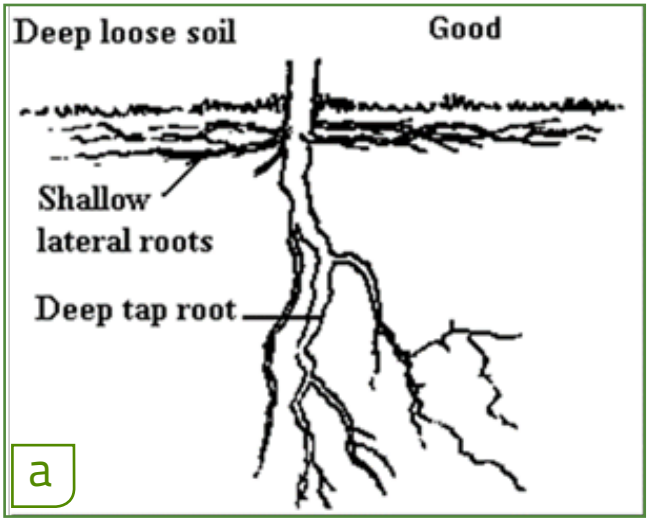
▪ A texture with good-water-retaining properties but must also have good drainage and aeration. The most preferred soils are loam or clayey loam.

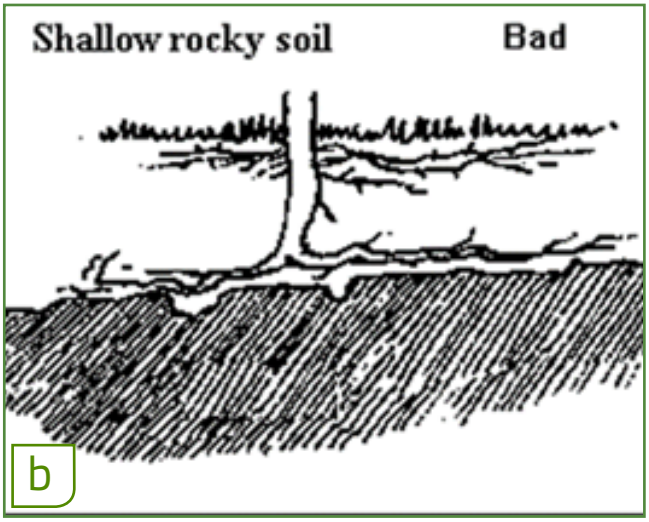
▪ Must be at least 1.5m deep, this is particularly important if there is insufficient or poorly distributed rainfall.

▪ The soil structure must be as homogenous as possible to allow roots to penetrate easily.

▪ The soil must be rich in nutrients with pH of 5–8. Soils with high organic matter content in the top soil (about 3.5% in the top 15cm) are most preferable.

SOILS SUITABLE/UNSUITABLE FOR COCOA ARE PRESENTED IN THE FOLLOWING DIAGRAMS





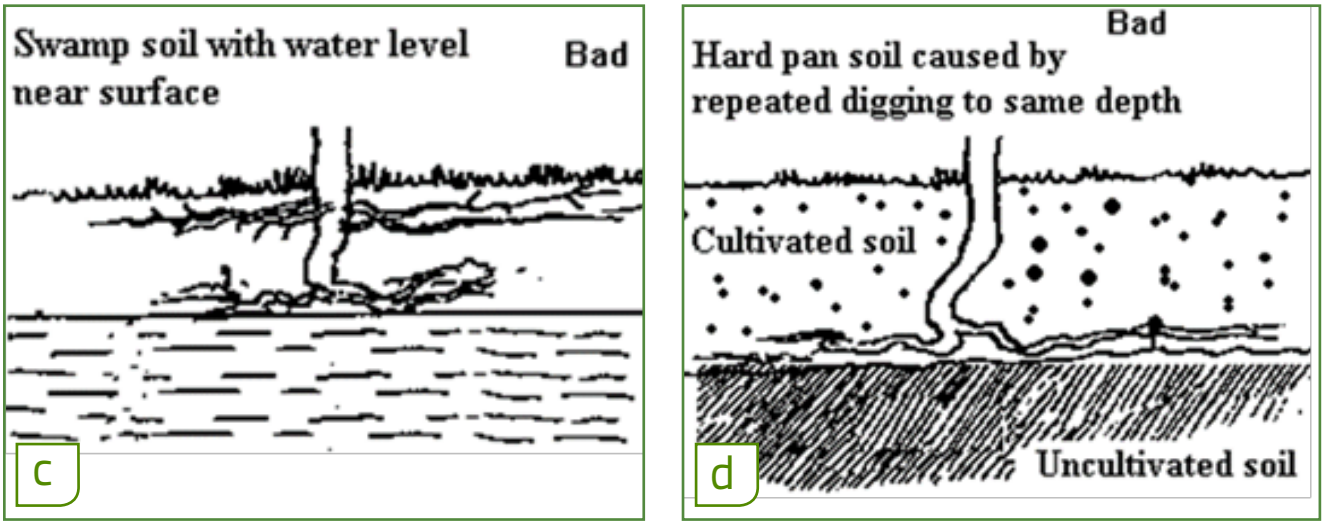


Fig.2.1.1 Soil suitable/unsuitable for growing cocoa (A = Good soil for cocoa B, C, D = Bad soils for cocoa)

CHARACTERISTICS OF A FERTILE AND PRODUCTIVE SOIL

Some characteristics of a fertile and productive soil are as follows; **(See map on Page 19)**

1. A fertile and productive soil shows a complex physical and biological interactions involving decomposition of rock minerals and organic matter to form inorganic nutrient ions in soil water.

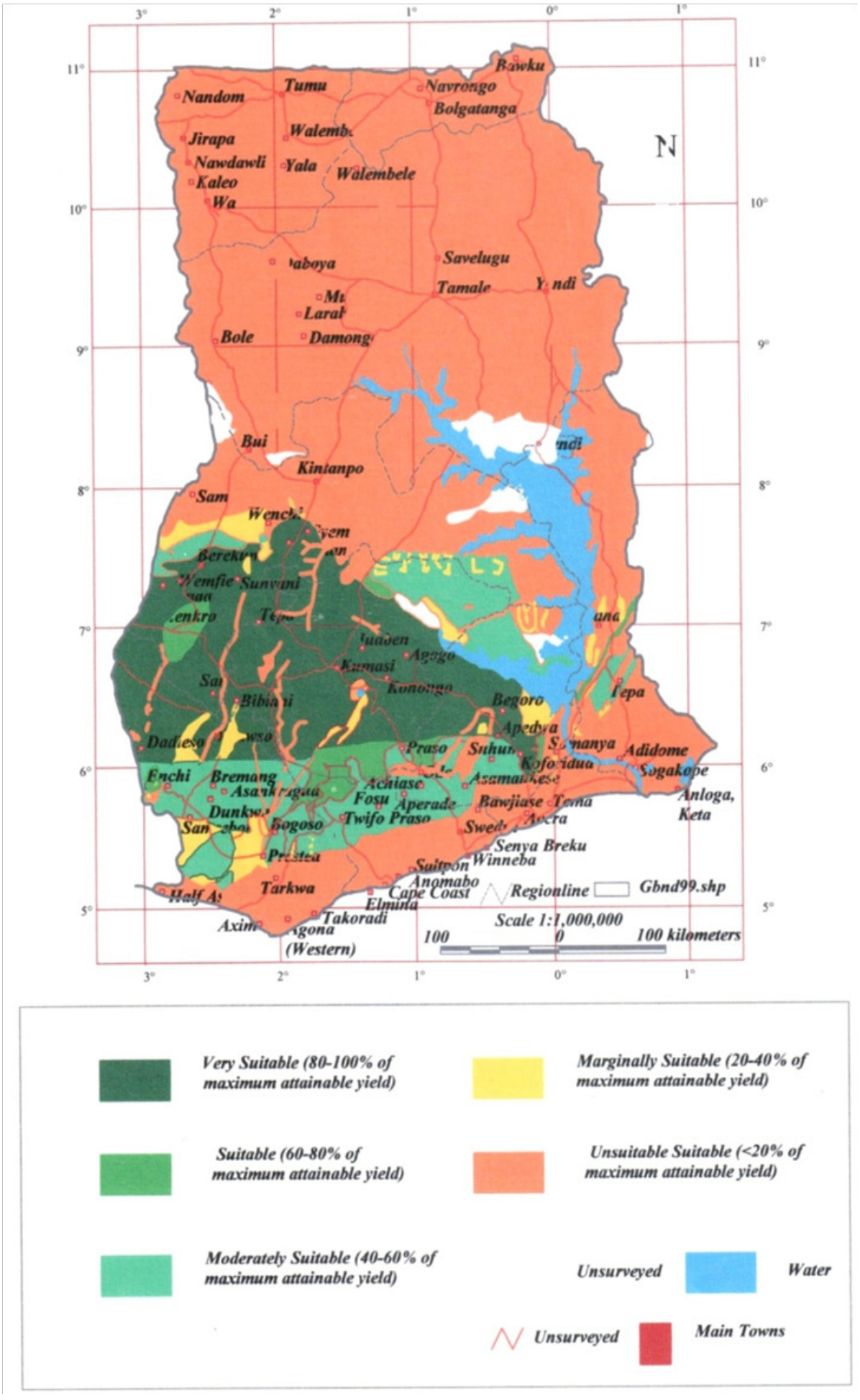
2. It has a good soil texture and this refers to the relative proportions of stones and cobbles, gravel, sand, silt and clay in the soil. This property affects and is related to several other soil properties such as aeration, water holding capacity, nutrient storage and water movement. Soil texture is therefore very important in terms of soil fertility.

3. It also has optimum pH, which is the measure of the acidity or alkalinity of the soil, for plant growth. The pH scale is from 0 to 14 with pH 7 as the neutral point. A pH below 7 is acidic and above 7 is alkaline. Soil pH has a great effect on the solubility or availability of plant mineral nutrients. In the range 6.0-7.5 major nutrients and trace elements are available. With increasing acidity, the major nutrients, particularly P becomes less available and others Fe, Mn, Cu and Zn become major available creating possible toxicity problems. Soil pH also influences plant growth by its effect on the activity of beneficial microorganisms. For instance bacteria that decompose soil organic matter are hindered in strongly acidic soils.

4. A fertile and productive soilhas high amount of soil organic matter.This is the soil fraction derived from materials of plant and animal origin. It includes residues in various stages of decomposition, soil organisms, and their synthesized by-products. Soil organic matter contains all essential plant nutrients and is therefore a storehouse of plant nutrients. The stored nutrients are released in a plant-available form upon decomposition. Organic matter is the soil adhesive that binds together the soil components into stable aggregates, provides energy for soil microorganisms improves water infiltration and holding capacity and reduces erosion potential. It is considered to be the most important indicator of soil quality, health and productivity Soil organic matter plays a critical role in soil processes such as cation exchange capacity.

5. It has a thriving and healthy soil organism community which is the driving force behind nutrient cycling in the soil, which is the decomposition of organic matter into simpler units and synthesis of new products that can be used by plants. Soil organisms also play a critical role in development of soil structure. Soil organisms are made up of macro-organisms (earthworm, nematodes, mites etc.) and microorganisms (bacteria, protozoa, fungi). One of the most important functions of microorganisms is the decomposition of organic matter and this is performed by a variety of soil bacteria and fungi. An important product of the decomposition is humus (humic acid) which has a great influence on cation exchange capacity and water retention.

6. It also has high cation exchange capacity (CEC), which is the ability of the soil to hold onto nutrients and prevent them from leaching beyond the roots. The more cation exchange capacity a soil has, the more likely the soil will have a higher fertility level. This is because the retained cations are easily exchangeable with other cations in the soil solution and are therefore readily available for plant uptake. Clay and organic matter are the main sources of CEC. The more clay and organic matter (humus) a soil contains, the higher its cation exchange capacity.



Land suitability map for cocoa cultivation in Ghana

LAND PREPARATION

The land should be cleared between December and February and large undesirable trees including those which harbour the cocoa swollen shoot virus felled leaving 15–18 desirable shade trees per hectare to provide permanent shade.

After clearing, it is advisable to leave the resulting debris to rot, though it can also be burnt. Burning however:

- Destroys a great deal of potential humus in the soil since it results in the release of large amounts of ash causing imbalance of nutrients in the soil.
- Exposes the soil to erosion, which can lead to losses of organic matter.

It is therefore recommended that farmers do selective burning or avoid burning.

LINING AND PEGGING

It is important to line and peg farms before cocoa is planted. Lining and pegging at the recommended spacing will optimize land use, facilitate husbandry practices, increase yield per unit area and increase income. In the process of lining and pegging, place a peg at a reference point and with a rope, tie the peg to make a horizontal line about 100 metres to the edge of the land (baseline). From the reference peg and on the horizontal base line, mark the recommended spacing (3.0 metres) for the positions of the cocoa seedlings and put a peg at each marked point. Repeat the process vertically until the whole farm is covered. **(Fig.2.1.2)**

SPACING

The recommended spacing for hybrid cocoa seedlings is 3.0m x 3.0m (10ft x 10ft) resulting in 1,111trees per hectare(435 seedlings per acre). Properly spaced cocoa trees are healthy looking, high yielding and allow farm operations such as weeding, spraying, harvesting, fertilizer application to be easily carried out. In closely planted farms, the trees grow tall and thin as a result of competition for light, water and soil nutrients.

SHADE ESTABLISHMENT

Cocoa grows well under the shade of other plants. Temporary or permanent shade plants should be established when cultivating cocoa in a multiple cropping system.

ESTABLISHMENT OF TEMPORARY SHADE

Food crops such as plantain and cocoyam should be planted at 3.0 m x 3.0 m and 1.0 m x 1.0 m respectively, to provide temporary shade for the young cocoa plants **(Fig.2.1.3 a, b and c)** The plantain should be spaced at 1.50 m away from the cocoa (i.e in between two cocoa seedlings) while the cocoyam should be planted 1.0 m away from the cocoa. The food crops should be planted in lines to facilitate farm operations such as weeding and spraying. Fruit trees such as pawpaw could be also planted at 3.0 m x 3.0 m to serve as temporary shade.In addition to this, quick growing trees like Glyricidia at a spacing of 6m x 6m can be used as temporary shade trees.

The benefits of such a practice may include

- food sustainability for the household,
- income generation to partially offset the cost of establishment,
- provision of temporary shade for the young cocoa,
- weed control
- Nutrients recycling
- Reduction in insect pest damage.



Fig.2.1.2 Lining and pegging of a cocoa farm



Fig.2.1.3a. Cidrella and plantain as temporary



Fig.2.1.3b. Plantain as temporary shade for young cocoa for young cocoa



Fig.2.1.3c. Plantain and cocoyam as temporary shade for young cocoa

ESTABLISHMENT OF PERMANENT SHADE

Where there are not enough desirable permanent shade trees on the farm at the time of clearing, trees such as *Terminalia ivoriensis* and *Albizia coriaria* can be planted with planting material supplied by the Forestry Commission. Ownership of such trees are now guaranteed by completing and submitting a tree ownership form **(Appendix 5).** It is recommended to plant 15 to 18 permanent shade trees per hectare.

TABLE 2.1 EXAMPLES OF DESIRABLE AND UNDESIRABLE SHADE TREES AND THEIR LOCAL NAMES

DESIRABLE SHADE TREES	UNDESIRABLE SHADE TREES
Terminalia ivoriensis (Emire)	*Ceiba petandra* (Onyina),
Terminalia superb (Ofram/Framo)	*Cola gigantea* (Watapuo),
Albizia coriaria (Awiemfuo samina)	*Chlamydocola chlamydantha* (Kra bise, Osonkrobia, Penamfera)
Entandrophragma angolense (Edinam, cedar)	*Adansonia digitata* (Odadee),
Funtumia elastica (Ofuntum)	*Blighia sapida* (Akyewobiri)
Alsonia boonei (Nyamedua),	*Canthium glabriflorum* (Gyapam, Nteteadupon),
Pycnanthus angolensis (Otie)	*Musanga cecropioides* (Odwuma)
Milicia excelsa (Odum)	*Carapa procera* (Kwakuo bise)
Entandropragma angolense (Sapele)	*Lecaniodiscus cupanoides* (Dwindwera)
Tieghemella heckelli (Baku/Makore)	*Myrianthus arboreus* (Nyankuma)
Khaya grandifoliola/ivoriensis/anthotheca (Mahogany)	
Entandrophragma utile (Utile)	

3.3 GOOD FIELD PLANTING PRACTICES

PLANTING

Time of planting

The best time for planting cocoa is May to July, which is the major rainy season.Transplanting should be done in the middle of the rainy season or when rainfall is expected to ensure optimum seedling survival. Transplanting is done when seedlings raised in polybags or on beds 3 to 6 months old.

HOLING AND TRANSPLANTING OF NURSED SEEDLINGS

In the case of seedlings raised in poly-bags:

- Water the seedlings heavily the day before transplanting
- Dig holes at 3m x 3.m spacing (10 ft x 10 ft) which are large and deep enough(depending on the size of the polybag used) to contain the poly bag
- Dig holes at the pegged points well in advance before planting.
- Remove bagscarefully in order not to lose too much soil from the roots of the seedlings.

▪ Place seedlingswith a ball of soil around in the hole.

▪ Cover the hole with the same soil dug from it. Firm the soil and make sure that the soil level is the same as under nursery conditions.

▪ Avoid heapingsoil around the stem of the seedling
Avoid over stacking during seedling transportation to minimise losses. Also, NEVER bury the polybags with the seedling during transplanting.
In the case of seedlings raised on beds.

▪ Remove seedlings with plenty of soil around the roots using a machete (cutlass) or hand trowel

▪ Place seedlings carefully in the dug holes.

▪ Cover the hole firmly with the same soil dug from it and make sure that the soil level is the same as under nursery conditions

For transported seedlings and bare-root seedlings, prune off any damaged tap roots before planting to prevent seedling stunting.

It is important to note that in transporting seedlings raised on beds, the roots should be covered with moist jute sack to prevent excessive water loss.

ADVANTAGES OF USING NURSED SEEDLINGS

▪ Better plant growth and hence better field establishment due to initial care given to seedlings in nursery.

▪ Higher survival rate (90-100%) after transplanting.

▪ Reduced losses due to diseases and pest.

▪ Provides opportunity for establishing farm with only healthy and uniform seedlings

▪ Losses due to weeding are minimized since seedlings could be easily identified during the operation.

▪ Tolerate adverse climatic conditions better than seedlings raised by bare root method.

DISADVANTAGES OF USING NURSED SEEDLINGS

▪ It requires special growing facilities, eg polybags/ nurseries.

▪ It is expensive to use since more labour is needed to handle seedlings at the nursery and during transplanting.

▪ It involves transportation cost/difficulties.

PLANTING AT STAKE (DIRECT SEEDING)

Fresh cocoa beans may also be planted directly in the field (planting at stake). A small hole with machete (cutlass) is dug and two beans are put in the hole which is thencovered with soil. When the seedlings reach the four leaf stage (6-8 weeks after planting), the weaker one is removed.This method is popular with farmers who lack the resources to buy inputs for raising seedlings in the nursery.

ADVANTAGES OF PLANTING AT STAKE

▪ Planting at stake is more economical as it requires no special plant growing facilities.

▪ Again since the seeds are originally sown in the place where they are eventually expected to be, it reduces transportation cost.

▪ Absence of transplanting shock.

▪ Seedlings can better tolerate adverse climatic conditions since they are developed in situ.

DISADVANTAGES OF PLANTING AT STAKE

▪ Planting at stake may result in poor growth of seedlings since they have to compete with weeds for nutrients and moisture.

▪ Seedlings in their very young stage are exposed to rodents and insect pests.

▪ There is little opportunity to select for uniform seedlings for field establishment.

▪ Greater care is needed during weeding to prevent mechanical damage, which could increase labour cost.

▪ More beans are needed to cover an area compared to the nursery method

3.4 MULCHING

Mulching should be done by spreading dry plant materials or plantain pseudostem around the base of the cocoa seedling towards the end of the rainy season (October). In termite infested areas, the mulch material should be treated with a solution of Termiticide (refer to appendix...)

Mulching is essential for young cocoa during the first and second years and especially in the dry areas. Mulching helps to:

- conserve soil moisture
- promote the activities of soil organisms
- smother weeds by cutting off source of light for their growth
- reduce the direct impact of rain drops on the soil
- slow down run-off and improve infiltration
- improve the nutrient status of the soil when the mulch decays
- regulate soil temperature

3.5 PRUNING

Pruning is the removal of unwanted growth or parts of the cocoa plant. It is an important agronomic practice that is needed to optimize productivity and facilitate field operations. Pruning is necessary since it:

- provides shape to the plant
- makes access through the farm and farm operations easy
- controls mistletoes and the spread of insects pests
- improves air circulation in the farm and as a result reduce the incidence and spread of fungal diseases such as black pod
- helps to reduce the cost on chemicals used for spraying against insect pests and diseases
- opens the canopy to allow more light into the farm
- provides the necessary environment for increase in yield

TYPES OF PRUNING

Several types of pruning are carried out in cocoa cultivation. These include formation, sanitary and structural pruning.
Formation pruning (Pruning of young cocoa)

FORMATION PRUNING (PRUNING OF YOUNG COCOA)

It is carried out in young cocoa to adjust the height of the first jorquette (branching) and create the desirable shape during establishment. It is done within the 3rd and 4th year of establishment. This pruning process involves;

- Cutting off low lying branches to maintain the first point of branching (jorquette) at the height of at least 1.5 m.
- Removing excess shoots when more than 2 arise from the jorquette and leaving the 2 shoots facing each other. Shoots are removed from the center to open up the cocoa canopy.

SANITARY PRUNING (PRUNING OF MATURE COCOA)

Sanitary pruning is carried out throughout the year in mature cocoa to remove diseased or unnecessary branches.
It involves removal of

- All disease infected branches and mummified pods
- Epiphytes and mistletoes on the branches of cocoa in the canopy in September to March when they can easily be detected due to the presence of flowers.

STRUCTURAL PRUNING (PRUNING OF MATURE COCOA)

Structural pruning is carried out in mature cocoa to shape the canopy to desired size and architecture. This should be done before the onset of the rainy season (April/May).
It involves removal of:

- Basal shoots (chupons) from the main stem at every round of weeding.
- Excess branches
- Interlocking branches

EQUIPMENTS FOR PRUNING:

A standard pruner or cutlass **(Fig.2.1.4 a, b, c and d)** with the aid of a ladder is used in the removal of mistletoes and unwanted branches on older trees. The branches of the cocoa tree are cut in a slant manner to allow water to drip off the cut surfaces and prevent fungal infection. Secateurs are used for pruning young cocoa.



Fig.2.1.4. Tools for pruning: **a.** Standard pruner **b.** cutlass **c.** motorised prunner and **d.** Secateurs

3.6 SHADE MANAGEMENT IN COCOA

It is important to establish a good shade level for all stages of cocoa to:

- Provide protection against pests like capsid
- Reduce the incidence of Black pod disease
- Reduce nutritional imbalance
- Reduce dieback in mature cocoa and
- Increase yield.

Shade levels of 30% sunlight is necessary when the cocoa trees are young (0 – 3 years) and 70% sunlight when the cocoa tree is mature (4 years and beyond).
In cases where the overhead shade is denser than the

recommended shade levels, thinning by gradual removal of temporary shade trees and a reduction in the number of mature forest trees should be carried out. On the other hand, more shade trees should be planted if the shade levels are below the recommendations.

Agro forestry

Some cocoa farmers in Ghana intercrop cocoa with some fruit and tree crops which serve as shade, source of food, lumber or extra income **(Fig.2.1.5 a, b, and c)**. These trees may include; avocado, coconut, mango, citrus, cola, and breadfruit. Although these crops are of economic benefit to the farmer, many of them are not suitable for intercropping with cocoa. For optimum performance in an intercrop system with cocoa, the right fruit/tree crop should be selected and planted at the appropriate spacing. For example in cocoa/coconut intercrop the coconut should be planted at spacing of at least 10.1m triangular and the cocoa at 3m x 3m. **(Fig.2.1.5a)**



Fig.2.1.5a. Cocoa-coconut intercropping system



Fig.2.1.5b. Cocoa-multiple crop intercropping system

3.7 WEED MANAGEMENT

Weed control in cocoa farms is necessary because weeds:

- compete with cocoa for nutrients, water and light
- encourage incidence of insect pests and rodents that attack the plants
- make the farm humid and increase the incidence of the black pod disease



Fig.2.1.5c. Cocoa with well-spaced permanent shade of *Terminalia sp.*

- make the collection of harvested pods difficult resulting in loss of pods
- Impede farm operations like spraying

Weed incidence is usually high where the cocoa canopy is not completely closed. Weeds can be controlled with a combination of methods.This may include manual (with machete/cutlass, slashers and hoe) or chemically (herbicides), cover crops and shade manipulation. The use of a combination of two or more of these methods is known as integrated weed management.

MANUAL WEED CONTROL

Manual weeding should be done 3-4 times in a year (March, May-June August and November), for young farms and about twice a year (April-May and July-August) in a mature farm. Brush the farm when the weeds reach a height of 30 to 45 cm. The weeds are brushed close to the ground and climbers removed. Manual weeding is much prefered from and environmental point of view.

CHEMICAL WEED CONTROL

Herbicides such as Glyphosate may be used to control weeds in both young and matured cocoa. The application rate, frequency of application, as well as the nozzle to be used for glyphosate application is shown in **Table 2.2.** Glyphosate at a dossage of 1.5 -2litres per hectre (225 - 300ml) per 15l pneumatic knapsack is recommended for weed control in cocoa.

The efficiency of herbicide application is very much improved when the cocoa is planted in lines. It is important to avoid contact between the cocoa seedling, food crops and the herbicide by directing the spray against the weeds. To avoid spray drift on cocoa seedlings and food crops, spraying should be done early in the morning or late in the afternoon. Do not spray Glyphosate when it is threatening to rain. For safety reasons, wear protective clothing **(Fig.2.1.6)** and avoid eating, drinking or smoking whilst spraying. Wash down immediately after spraying and avoid contaminating nearby streams and other water bodies. Properly dispose of herbicide containers by burying them and do not use them for storing water or food. Check leakages of knapsack sprayer before use. **(Fig.2.1.7)**

TABLE 2.2 USE OF *GLYPHOSATE* IN WEED CONTROL

INDICATORS	YOUNG COCOA	MATURE COCOA
Application rate/ha	1 litre of Glyphosate in 100 litres of water OR About1 milk tin Glyphosate in 15 litres knapsack sprayer full of water	1 litre of Glyphosate in 100 litres of water OR About1 milk tin Glyphosate in 15 litres knapsack sprayer full of water
Frequency of application	3 times in a year	2 times in a year
Nozzle to be used	The knapsack sprayer must be fitted with a low volume nozzle (e.g Lumark AN 1.0)	The knapsack sprayer must be fitted with a low volume nozzle (e.g Lumark AN 1.0)

How to calculate the quantity of chemical needed for spraying

The quantity of chemical needed to be put in both the pneumatic and motorized knapsack spraying machine can be computed by the following formula:

Q = C/W x R x 1000

Where **Q** is quantity of chemical needed in ml

C is capacity of knapsack sprayer

W is volume of water recommended per ha

R is recommended rate of chemical per ha



Fig.2.1.6 Chemical weed control in progress

Consider

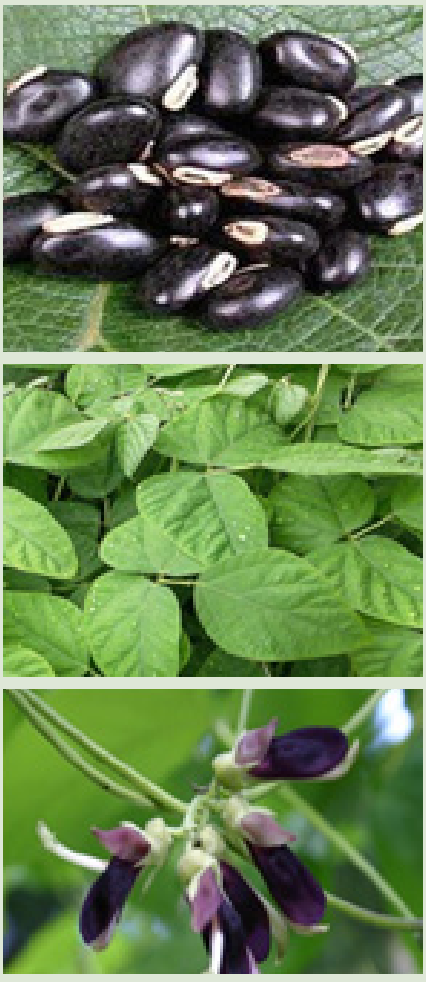




Fig.2.1.7 Pneumatic knapsack sprayer with samples of herbicides

USE OF COVER CROPS

Cover crops (leguminous and non-leguminous) such as *Mucuna puriens*, *Tropical kudzu (Pueraria phaseoloides)*, Stylosanthes sp. may normally be planted between the rows of young cocoa plants to manage weeds on the farm. This protects the soil and sometimes provides nutrients to the soil when nitrogen fixing crops are used. However, care should be taken to ensure that the cover crops do not entangle the young cocoa plants.



Mucuna (seed, leafs and flower)

3.8 SOIL EROSION MANAGEMENT

Soil erosion is one of the most serious and irreversible threats to soil fertility. It carries away the most fertile parts of the soil: the top soil and the finer clay fractions which are rich in humus and nutrients. Even low erosion rates which are almost invisible can over the years have a severe impact on soils. It is therefore of vital importance to protect the soil from erosion.

CAUSES OF SOIL EROSION

During the dry season, ground vegetation usually thins out and leaves the soil uncovered.

As a result, when it rains, large amount of topsoil can be washed away, affecting soil fertility. Not only sloping land is prone to soil erosion but also flat fields can be severely affected if not protected by any soil cover. Factors affecting soil erosion include:

- soil types (silt, sand loam)
- soil structure
- soil cover
- slope and
- severity of rainfall.

Fine tilth soils that have no vegetative cover, situated on a slope are more prone to erosion.A risk assessment should be made to find out which parts of the farm are most prone to erosion. Based on this assessment, a management plan to reduce soil erosion should be made.

Some of the practical steps for erosion prevention include:

1. Mulching (see chapter ...page...)
2. Use of cover crop (see chapter ... page..)
3. Use of shade trees
4. Use of 'stop wash lines"
5. Terracing
6. Diversion of surface run-off

1. USE OF SHADE TREES

In natural forests several layers of dense canopy break the speed of the rain drops falling on the ground. Large drops formed on leaves of the tree-tops are caught by the canopy of shrubs and ground vegetation. The water drops reach the soil at less speed and thus have a smaller splashing effect on soil particles. Hence, natural forests are less susceptible to erosion. This characteristic of natural forests can be recreated on cocoa farms to reduce erosion. It can be achieved through leaving or planting shade trees on farms during land preparation. Soil erosion control is especially important in areas near water sources and in steep areas. Even when you don't farm in those areas, you should still plant trees against soil erosion.

2. USE OF "STOP-WASH LINES"

To prevent erosion along slopes, blockades or barrages can be built across the slope to reduce the speed of water movement and also trap soil. A common type of such blockade is 'stop-wash lines".

3. TERRACING

A terrace is a leveled section of a sloping land that is used for cultivating crops. When digging the terraces, it is important that the fertile top soil is kept aside and later spread on top of the finished terrace. Cover crops or grass may be grown on the slopes between the terraces to prevent soil loss.

4. DIVERSION OF SURFACE RUN-OFF

Where precipitation is in excess of crop requirements, drains and ditches could be constructed to divert excess water.

3.9 PRODUCTIVITY ENHANCEMENT OPERATIONS

In addition to the use of improved planting materials and good farm management practices, soil fertility management, mistletoe infestation, control of pests and diseases should be addressed to optimise productivity on farms

SOIL FERTILITY MANAGEMENT

Soil fertility refers to the capacity of the soil to supply nutrients to the plant. A fertile soil is the one that contains an adequate supply of all the nutrients required for the optimum growth of plants. However, such a soil cannot be necessarily considered a productive one. To be productive, a soil must also provide a satisfactory environment for plant growth and the nutrients it contains must be available for use by the plants.

Intensive cultivation methods, deforestation and excessive use of synthetic pesticides, including herbicides, can lead to a reduction of soil fertility and to soil degradation. Soil fertility decreases with crop production, because with the harvest large amounts of nutrients are removed from the soil

The fertility of soils can be improved by the use of fertilizers which contain essential plant nutrient.

PLANT NUTRIENTS

Plant nutrients come in two main forms depending on their amounts required by plants. These are macro and micro nutrients. While macro nutrients are required in larger amounts, very little of micro nutrients are utilized by plants.

The macro nutrients are Nitrogen (N), Phosphorus (P) and Potassium (K)whiles the micro nutrients consist of Calcium (Ca), Sulfur (S), Magnesium (Mg), Iron (Fe), Zinc (Zn), Manganese (Mn), Boron (B), Molybdenum (Mo), Copper (Cu), Sodium (Na) and Silicon (Si).

To obtain maximum benefit from fertilizer application, the under-listed factors must be considered;

- high yielding recommended cocoa varieties should be used when establishing new farms
- weeds, insect pests and black pod disease must be controlled as recommended.

- swollen shoot infected trees, chupons and mistletoes must be removed.
- shade at recommended level should be maintained (refer to section on shade in cocoa farms)

FERTILIZERS

Fertilizers are substances that contain nutrients and are applied to the soil or plant leaves to provide nourishment for plants. Continuous fertilizer applications for 3-4 years can double yields of cocoa. However, cocoa yield increases in the first two years of application are usually minimal.

TYPES OF FERTILIZERS

There are two main types of fertilizers.These are (i) organic and (ii) inorganic fertilizers. Organic fertilizers are derived from plant and animal sources. Examples of such fertilizers are poultry manure, compost cocoa pod husk ash. Inorganic fertilizers are made from non-living substances such as gases, rocks, industrial chemicals etc. Inorganic fertilizers are made up of solid and liquid fertilizers. The solid fertilizers are applied to the soil while the liquid ones are usually applied to the leaves.

FERTILIZER REQUIREMENT AND ITS DETERMINATION

Crop fertilizer requirement depends on the stage of plant growth, soil type and its fertility. The crop nutrient requirement at any specific location (site-specific) can be determined by plant and soil analysis.

FERTILIZERS RECOMMENDED FOR COCOA

Three types of fertilizers are recommended by COCOBOD for cocoa **(Appendix 1)** as follows:

1. Conventional (inorganic) fertilizers

Conventional fertilizers are applied to the soil either by broadcasting under cocoa trees or as rings under cocoa trees once a year. The best time of application is the beginning of the main rains (April/May). Fertilizer application can be carried out on the same plot for four consecutive years with a one to two year break.

2. Foliar/Liquid fertilizers

Foliar/liquid fertilizers usually contain minor nutrients, such as magnesium, zinc andboron that are required in small quantities and sometimes some in addition to major plant nutrients (Nitrogen, Potassium and Phosphorous). Foliar/liquid fertilizers are usually applied when there is lack of soil moisture when solid fertilizers cannot be applied. It can also be applied when there is the need to obtain a quick response from fertilizers to correct nutrient deficiencies since uptake of nutrients through the leaves is much faster than through the roots.

3. Organic fertilizer –Organic fertilizers contain an appreciable amount of macro and micro nutrients that can be made available to plants after mineralisation. They also improve soil physical characteristics and soil moisture regulation and conservation. The use of organic fertilizers also reduce the risk of environmental pollution associated with conventional fertilizers.

FERTILIZER APPLICATION IN YOUNG COCOA (up to 18 months old)

Virgin or secondary forest soils have high fertility and will supportthe growth of cocoa. However, when new farms are established on previously cropped cocoa or food crop soils that has declined in fertility there is the need to apply fertilizers to booststhe initial growth of the cocoa. In the latter case the following fertilizer application is recommended:

GRANULAR FERTILIZER

Apply 70g or a match box full of ammonium sulphate on the soil surface in a 10 cm circular band about 20 - 40 cm from the base of the plant when the soil is moist as after a rainfall.

FOLIAR FERTILIZER

(i) Apply recommended liquid fertilizeras follows:

- Half fill the spraying machine with clean water
- Add recommended dosage of liquid fertilizer and add more water to fill the tank
- Shake the spraying machine to ensure complete mixture of the solution.
- Spray the solution unto the cocoa leaves until completely wet.

CONDITIONS FOR USE OF FOLIAR/LIQUID FERTILIZERS:

- Avoid spraying on cocoa plants under stress.
- Apply in the morning to avoid high wind and strong sunshine.
- Apply with motorised knapsack sprayer (mist blower) for tall cocoa plants and a pneumatic knapsack for medium-sized plants.

FERTILIZER APPLICATION IN MATURE COCOA

The fertility of soils cropped to cocoa declines with time because soil nutrients are constantly depleted through pod and beans removal from the farm. After about ten years of bearing the yield of cocoa trees tends to decline. This

decline has been attributed mainly to soil fertility decline in addition to other factors. In such case the fertility of such soils can be improved by the use of fertilizers.

NB:

- Some fertilisers (such as chicken manure or granular fertilisers) can damage plant leaves when there is direct contact between the fertiliser and the leaf.
- The overuse of chemical fertilisers can harm useful microorganisms in the soil.
- Applying them when there is no rain may cause burning effects on the leaves of plants.
- Using more than the recommended dosage is a waste of money and bad for the environment.
- Always store fertilisers in a dry and locked place.
- Never allow children to be involved in applying fertilisers.
- Always read labels on fertiliser packages before applying them; or consult a competent agent before application.
- Personal Protective Equipments (PPE)

COMPOSTING

Composting is an aerobic (in the presence of air) method of decomposing solid wastes. The process involves the breakdown of organic waste into humus.

Composting organisms require four equally important ingredients to work effectively. These are:

1.Carbon — for energy; the microbial oxidation of carbon produces the heat, if included at suggested levels. High carbon materials tend to be brown and dry.

2.Nitrogen — to grow and reproduce more organisms to oxidize the carbon. High nitrogen materials tend to be green (or colorful, such as fruits and vegetables) and wet.

3.Oxygen — for oxidizing the carbon, the decomposition process.

4. Water — in the right amounts to maintain activity without causing anaerobic conditions.

The most efficient composting occurs with an optimal carbon: nitrogen ratio of about 10:1 to 20:1.The resultant material is allowed to fully stabilize and mature through a curing process.

Benefits of Compost

(i) Improves the soil structure, porosity and density, thus creating a better plant root environment.

(ii) Increases moisture infiltration and permeability of heavy soils, thus reducing erosion and runoff.

(iii) Improves water-holding capacity, thus reducing water loss and leaching in sandy soils.

(iv) Although often seen as a good source of nitrogen, phosphorous and potassium, compost also contains micronutrients essential for plant growth. Since compost contains relatively stable sources of organic matter, these nutrients are supplied in a slow-release form

(v) Controls or suppresses certain soil-borne plant pathogens since it is known that increased population of certain microorganisms may suppress specific plant diseases such as Pythium and Fusarium as well as nematodes.

(vi) Supplies significant quantities of organic matter for soil microorganisms including bacteria, protozoa, actinomycetes and fungi. These organisms play an important role in organic matter decomposition which, in turn, leads to humus formation and nutrient availability and can also promote root activity as specific fungi work symbiotically with plant roots, assisting them in the extraction of nutrients from soils.

(vii) Improves cation exchange capacity (CEC) of soils and growing media, thus improving their ability to hold nutrients for plant use.

(viii) Supplies beneficial micro-organisms to soils and growing media.

(ix) Improves and stabilizes soil pH.

THINGS TO DO BEFORE AND DURING COMPOSTING

1. Organic materials containing carbon and nitrogen must be used and it is easier to obtain a good mixture if the pile is built up all at once. The organic materials may be arranged in layersas in traditional methods but they can also be mixed. Shredded organic materials heat up rapidly, decompose quickly, and produce uniform compost. The decomposition rate increases with the size of the composting materials.Organic materials that can be composted include cocoa pod husk, cocoa bean shell, coffee husk, animal manure, fireplace ashes, fruits and vegetables, grass clippings straw, leaves, sawdust, wood chips, yard trimmings. Organic materials that cannot be composted include charcoal ash, diseased or insect-ridden plants parts, fats (grease, lard, or oils), meat or fish bones and scraps, yard trimmings treated with chemical pesticides. These materials may contain substances harmful to plants. The diseases or insects might survive and be transferred back to other plants. Some of them may create odour problems and attract pests such as rodents and flies. Insecticides might kill beneficial composting organisms.

2. Organic materials need water to decompose and so if the pile becomes too dry, the decay process will slow down. If very wet materials are used in building the pile they must be mixed with dry materials. On the other hand if all the materials are very dry, soak them with water before using. Whenever the pile is turned, the moisture content must be checked and water added when necessary. Too much water is just as detrimental as the lack of water. In an overly wet pile, water replaces the air, creating an anaerobic environment, slowing decomposition.

3. Air circulation is an important element in a compost pile. Most of the organisms that decom-

pose organic matter need air to survive. Air should be able to pass through the pile. To achieve this, materials that are easily compacted such as ashes or sawdust must not be used without mixing them with a coarser material first. Tree branches or even ventilation tubes can be placed vertically into different parts of the pile, to be shaken occasionally, to maximize air circulation. A more labor-intensive way to re-oxygenate the pile is to turn the pile by hand, using a large garden or compost fork.

4. The temperature of the managed pile is important. It indicates the activity of the decomposition process. The easiest way to track the temperature inside the pile is by feeling it. It is okay if it is warm. If it is the same temperature as the outside air, the microbial activity has slowed down and more easily decomposable materials such as grass clippings, kitchen waste, or manure need to be added to the pile. Decomposition occurs most efficiently when the temperature inside the pile is between 40oC and 55oC. It is best not to turn the pile while it is between these temperatures, but rather when the temperature is below 40oC or above 55oC. This keeps the pile operating at its peak. Most disease pathogens die when exposed to 55oC for 10-15 minutes, though some weed seeds are killed only when they're heated to between 60oC and 65oC. If weed seeds are a problem, let the pile reach 65oC during the first heating period, then drop back down to the original temperature range. Maintaining temperatures above 55oC can kill the decomposing microbes.

Methods of composting

Composting can be carried in bins of various sizes made up of wood or metal, freestanding piles or in dug out pits in the ground.

Compost site selection

Any pile of organic matter will eventually rot, but a well-chosen site can speed up the process. Look for a level, well-drained, shadier spot so that the compost can be sheltered and doesn't dry out too quickly. Build the compost pile over soil or lawn rather than concrete or asphalt, to take advantage of the earthworms, beneficial microbes, and other decomposers, which will migrate up and down as the seasons change. Uncovered soil also allows for drainage.

Characteristics of matured compost

(1) It has brownish to black colour, sometimes with a white microbial patch.

(2) Its smell ranges from odorless, soil-earthy like or special compost smell.

(3) When a small amount of it is shaken in water a brownish to black colour is obtained.

(4) When water extract of compost is watered to cabbage seeds on blotting paper or toilet roll paper seed germination of above 90% is obtained.

Phytotoxicity of composts

The application of immature compost to soil will adversely affect the growth of crops. As such compost must mature before it can be used for crops. The toxins in the immature compost are inactivated as the decomposition process ceases and the compost becomes matured.

3.10 INTEGRATED CROP, PESTS AND DISEASES MANAGEMENT

INTRODUCTION

In the course of managing cocoa against pest and diseases, various strategies such as the use of improved varieties, cultural, biological and chemical control methods are applied. Chemicals however have adverse effect on the environment and may also harm the end users of the crops. In order to minimise the adverse effects of chemicals used in pests and diseases control, the Integrated Pest Management (IPM) concept was developed. The concept is now described as integrated crop management (ICM) because in addition to pest and diseases control, several environmental factors need to be manipulated in order to obtain a healthy crop. Thus by practising IPM or ICM, the growth of the crop can be enhanced.

PRINCIPLES AND PRACTICE

The general principles and practices involve the following:

1. Obtain and plant improved healthy planting materials

2. Select fertile soils and suitable planting sites

3. Adopt good nursery practices

4. Adopt appropriate planting distances and planting patterns

5. Plant crops at appropriate times

6. Adopt good soil management practices

7. Adopt suitable water management practices

8. Carry out regular weed management

9. Visit field regularly

10. Maintain high level of sanitation

11. Manage pests and disease efficiently

12. Enhance the build-up of populations of natural enemies or beneficials

13. Minimise the application of chemical pesticides

14. Adopt good harvesting techniques

15. Adopt good, clean storage systems

DECISION MAKING PROCESS OF IPM OR ICM

This process involves the following steps:

Observe – so that you know what is happening to your crop

Learn – to understand the organism or problem affecting your crop and the nature of the damage caused

Decide – on the best action to take to reduce the crop damage caused by pest, disease or environmental factors

Act – upon the management method chosen in order to overcome the problem

3.10.1 MANAGEMENT OF COCOA DISEASES

Based on their economic importance, diseases of cocoa in Ghana can be grouped into major and minor diseases:

- The major diseases are the cocoa swollen shoot virus disease (CSSVD) and the *Phytophthora* pod rot (black pod disease)
- The minor diseases include *Phytophthora* canker, pink disease, thread blight, mealy pods, root rot, cushion gall, *Lasiodiplodia* or charcoal pod rot, warty pods and damping off disease of nursery plants.

MAJOR DISEASES

COCOA SWOLLEN SHOOT VIRUS DISEASE (CSSVD)

Cocoa swollen shoot virus disease (CSSVD) lives in the plant and uses the plant's physical and chemical tools to spread itself.

- CSSV multiplies and moves from one cell to the other thereby causing disease in the cocoa plant.
- CSSV depend on living organisms to live, and so when its hosts die the virus also dies
- For CSSV to survive, it must be able to move from one host plant to the other. This movement of CSSV is aided by mealybug species (insects), which are capable of transmitting CSSV from one plant to the other (vector).

HOW CAN ONE TELL WHETHER A COCOA PLANT IS INFECTED OR NOT?

A cocoa plant infected with CSSV exhibits typical symptoms.

- The diseases starts with red-vein banding in young leaves **(Fig.2.1.8)**
- In mature leaves , different shades of chlorotic patterns develop. This include mosaic, fern pattern and different shades of yellowing or chlorosis. **(Fig.2.1.9)**
- On some occasions, the chlorophyll of the leaves becomes bleached along the secondary veins leading to the condition termed vein-clearing. **(Fig.2.2.1 a and b)**
- The entire leaf may be bleached leaving the veins, which can also lead to the symptom called green vein banding. **(Fig.2.2.2)**
- In the advanced phase in the development of the disease, swellings may develop in all parts of the plant i.e. stem, fans, chupons and roots swellings (Fig 13.5a,b,c).
- At the terminal stage of the disease, stems or shoot may start dying back usually starting from the tip – a condition referred to as tip or shoot dieback. **(Fig.2.2.3 a and b)** At the scenes of serious outbreaks, hundreds of dying trees can be seen with tip or shoot dieback. **(Fig.2.2.4 a and b)**



Fig.2.1.8 Red vein-banding in young leaves



Fig.2.1.9 Various shades of chlorosis in mature leaves (including fern pattern)



Fig2.2.1a,b. Vein clearing in a mature leaves



Fig 2.2.2.Green vein banding in mature leaves

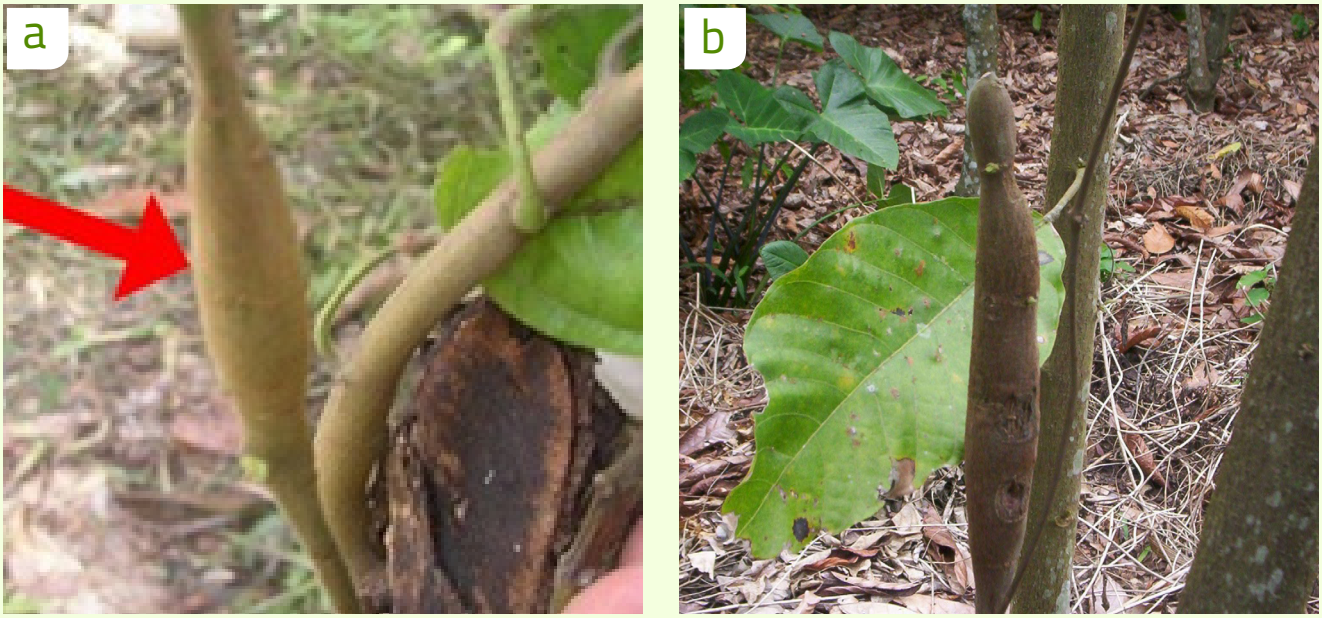


Fig.2.2.3a and b Swellings (eg. Fan, chupon and stem swellings)



b

Fig.2.2.4a and b Shoot dieback

i. ALTERNATIVE HOST PLANTS

- Apart from cocoa plants, CSSV can survive and multiply in other plants, which are termed alternative host plants.
- Several tree species such as *Ceiba pentandra* **(Fig.2.2.5)**, *Sterculia tragacantha* **(Fig.2.2.6),** *Adansonia digitata* **(Fig.2.2.7**), *Cola chlamydantha* **(Fig.2.2.8)** and *Cola gigantia* have been shown to be alternative host of CSSV.



Fig.2.2.5 *Ceiba pentandra*. Note the characteristic tongs on the stem





Fig.2.2.6 *Sterculia tragancantha*. Note the broad leaves



Fig.2.2.7: *Adansonia gigitata*



Fig.2.2.8 *Cola chlamydantha*

ii. WHERE CAN CSSVD BE FOUND IN GHANA?

- CSSVD was first discovered in the New Juaben area in the Eastern Region but it is now present in all the cocoa growing regions of Ghana
- The incidence or the distribution of the disease in the country is not uniform. In some areas or regions the incidence is high (Eastern and Western Regions) while in others it is low

Control of CSSVD

To control CSSVD, either the virus or the vector can be targeted. The current strategy for controlling CSSVD employs both approaches.

ERADICATION CAMPAIGN

Control depends on the size of infections. If the number of visibly infected trees (VIS) is up to ten, all the trees within a radius of 5 meters from the VIS are cut. If the number is between 11 to 100 trees within a radius of 10 metres are cut; and where the trees are over 100 VIS within 15 meters radius are removed.

If infections are detected early,spot treatment of removing the infected trees and their contacts are carried out before the disease can spread to other trees.

Use of barrier crops

This is to cut out large areas for replanting to be done with the provision of a barrier of immune crops around the replanted fields. This is based on the knowledge that the mealybug vectors transmit the virus in a semi-persistent manner. That is when the mealybugs acquire the virus upon feeding on an infected plant, it looses the virus after 48 hrs if it does not feed on an infected plant to boost up its viral content. So if a barrier of immune crops is planted around the replanted cocoa, then before a viruliferous (vi-

rus-containing) mealybug can move from an infected plant across the barrier into the replanted ones, it would have lost the virus and will therefore be harmless. Citrus and Oil palm are desirable barrier crops.

PHYTOPHTHORA POD ROT DISEASES

PHYTOPHTHORA DISEASES OF COCOA

i. *PHYTOPHTHORA* POD ROT (BLACK POD) DISEASE

- *Phytophthora* pod rot (black pod) disease is locally either called anonom, asukuo or kokoo prɔyɛ

- Black pod disease in Ghana is caused by two species of fungi, i.e. Phytophthora palmivora (less severe) and Phytophthora megakarya (more severe).

- Phytophthora palmivora is less aggressive and causes relatively lower crop loss. Phytophthora megakarya is more aggressive and if not treated or managed, can cause entire crop or yield loss in a season.



P. palmivora



P. megakarya

SYMPTOMS OF BLACK POD DISEASE

- The initial symptom observed is the appearance of a small brown spot (lesion) on the pod surface. The appearance of this brown spot takes about 2-3 days after the infection to manifest.

- This spot soon turns to a chocolate brown color in 2-3 days, then darkens and expands rapidly under favourable conditions.

- An infected pod can be covered entirely within 7-14 days depending on the species of Phytophthora.

- Within the first five days of infection, whitish spores (seeds) are produced on the pod.

- Pod rot symptoms due to P. megakarya are often characterized by multiple spots, which spread fast and coalesce (join together).

- Black pod can attack the pod at any stage of its development, i.e. from the very young pod (cherelle) to the fully matured pod.

CONDITIONS SUITABLE FOR THE DEVELOPMENT OF THE DISEASE

- *Phytophthora* species are water loving, and therefore, conditions that tend to create a humid and damp environment favours the development and spread of the disease.
- The fungus thrives in humid and damp environments, and thus, the disease is mainly prevalent in the wet (rainy) season.
- In dry conditions or seasons, the fungus survives in flower cushions, mummified (dry) pods, pod husksand in the soil.

SPREAD OF THE BLACK POD DISEASE IN THE COCOA FARM OR FIELD

- The spread in a cocoa farm can be from one pod to another or from one tree to the next.
- The spread On the farm is aided by several agents or means:

a. direct contact with existing infected pods i.e. when a healthy pod is in direct contact with an infected one.

b. rain splash – by rain drops splashing fungal spores onto healthy pods or drips of water from an infected pod falling directly onto healthy pods.

c. soil splash – when pods are in direct contact with infected soil or infected soil splashed onto pods or ants carrying infected soil or plant debris onto pods through building of nests.

d. insects and rodents can also spread the disease through their activities on a farm.

e. man –through contaminated hands and farm implements to transmit the spores from infected to healthy pods.

CONTROL OF BLACK POD DISEASE

CULTURAL CONTROL

- Judicious reduction of shade; leave 6-9 trees per acre (15-20 trees per hectare): this practice increases aeration and reduces canopy humidity, thus reducing sporulation and spread of the disease.
- Regular weeding; weed 2-4 times in a year, depending on whether the canopy has closed or not: this practice increases aeration thus reducing sporulation and spread of the disease.
- Judicious pruning and removal of chupons: this practice increases aeration and reduces humidity, thus reducing sporulation and spread of the disease.
- Plant at recommended spacing or thin out to the recommended spacing (3m x 3m): this practice increases aeration and reduces humidity, thus reducing sporulation and spread of the disease.

- Removal of infected pods during and in between harvests: this practice reduces the chances of the fungus sporulating and spreading on the farm.
- Removal of infected and mummified pods during or in between harvests on trees: the mummified pods serve not only as source of inoculum for subsequent infections but also prevent pods from forming at the cushions in the subsequent season.
- Regular and frequent harvesting (at least once a month). This practice saves partly infected mature pods, removes infected pods and reduces sources of sporangial inoculum and also reduces cushion cankers. At harvest it is essential that healthy pods are separated from diseased pods to obtain a well fermented cocoa.
- Removal or spraying of pod husk piles where they occur on farms. The piles serve as disease foci on farms.

CHEMICAL CONTROL

- Chemical control is achieved by spraying with recommended fungicides (Appendix 2). A fungicide is a chemical that is applied to control the growth and spread of a fungus. It may be protective or curative in action.
- Fungicides should only be used when they are really needed and they should be suitably approved and registered in Ghana.
- The protectant fungicides when sprayed onto the pods form a chemical barrier on the surface of the pod and guard against infection whereas the curative fungicides are able to penetrate into the pod and arrest the growth of the fungus within it.
- Fungicides must also be applied at the recommended rates for safe and effective disease control.
  - Overdose spray may not only injure the crop but it is wasteful. On the other hand, inadequate (underdose) spray of fungicide may not give good control, but also, in most cases worsen the disease situation.
- Spray approved fungicides at frequent intervals so that protection is provided for the duration of the infection period. This routine spraying is necessary because:
  - part of the fungicide coating on the pod is washed off by rain
  - the fungicide deposit on the surface of the pod becomes thin and gaps occur in the coating as the pod grows bigger and
  - new pods also develop in between sprays and they need to be protected.
- Spraying on farms should start when the cocoa trees are bearing pods or cherelles (okro stage of pods), and it has started raining continuously and b l a c k p o d s diseases are imminent.
- When it is time to start, choose the morning of a day when the weather is clear (rain is not threatening) to spray. If it rains within 3 hours after spraying you will have to spray again. Stop spraying in the season when the rains have stopped and/or there are very few pods to protect.
- The number of sachets used per unit area depends on the pod load and it may vary from farm to farm.

Current approved fungicides for cocoa (this list is subject to change with time) for black pod disease control, their dosage and interval of application is presented in Appendix.Table 13.1.

STEM CANKER OF COCOA

It is an important stem disease of cocoa caused by Phytophthora palmivora and Phytophthora megakarya. The local name of the disease is 'kokoo kokoram" or 'kokoo ananse".

WHAT DAMAGE DOES IT DO?

- The growing canker severely affects water and nutrient flow to the branches and the tree appears wilted.
- If the canker circles the trunk or branch, the tree dies back and the whole tree may lose its leaves.
- Stem cankers reduce tree vigour, destroy flower cushions, reduces yield and also provide a source of inoculum for black pod infections.

HOW DO I IDENTIFY IT? (SYMPTOMS)

- The first sign of canker is often the appearance of bark discoloration and exudation of reddish brown, resinous liquid **Fig.2.2.9a.**

- When the canker is exposed by removing the bark, the wood appears dull and discoloured from cream to reddish brown lesion. The wood lesions are irregular in shape but well defined in outline **Fig.2.2.9b.**

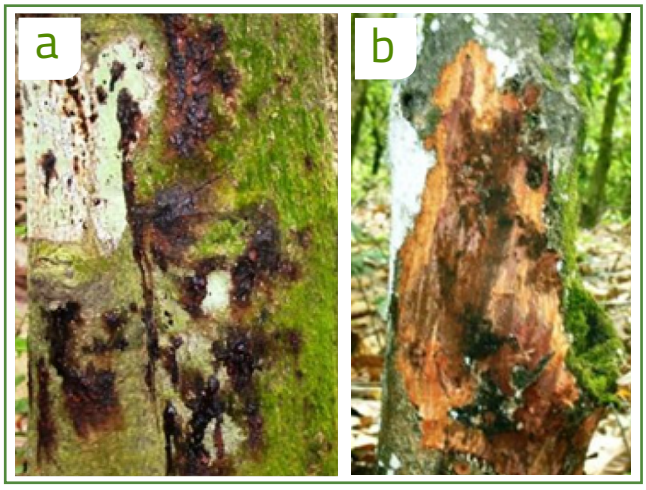


Fig 2.2.9.Symtoms of stem canker

HOW DO I MANAGE STEM CANKER? (CONTROL)

- To reduce canker disease, harvest pods frequently to prevent the fungus on pods from growing into the stem through the peduncle (pod stalk) to cause canker.
- If cankers have developed, scrape the surface to expose the lesions on the wood to dry out.
- Scraped lesions can be painted with a paste of any of the recommended fungicides for black pod disease control.

MINOR DISEASES

1. THREAD BLIGHTS OF COCOA

It is a fungal disease of cocoa that affects the branches and leaves. There are two types,black thread and white thread. Black thread blight is caused by *Marasmius byssicola* and white thread blight is caused by *Marasmius scandens*.

WHAT DAMAGE DOES IT DO?

- White and black thread kills leaves and this reduces yield.
- In severe situations, the dead foliage which remains suspended on the braches form a dense mass which obstructs new flushes.

HOW DO I IDENTIFY IT?

- Black thread blight forms thin black mycelia threads on branches and leaves in the canopy **(Fig.2.3).**
- White thread forms a network of white mycelia threads which spread over the leaves, petioles and branches **(Fig.2.3.1).**
- In both cases, the dead foliage remains suspended by strands of either white mycelia or thin black thread and together with healthy leaves, form dense mass which obstruct new flushes **(Fig.2.3.2).**



Fig 2.3 Black thread blight



Fig 2.3.1 White thread blight

Fig 2.3.2 Dead foliage caused by thread blight

HOW TO MANAGE THREAD BLIGHT?

- Prune and remove infected branches from the farm. In situations where infestation is persistent, spray with recommended fungicide

2. PINK DISEASE

- Pink disease caused by *Erythricium (Corticium) salmonicolor* affect branches, although the main stems could be attacked in the advanced stage of infection. **(Fig.2.3.3).**
- Pinkish encrustations (consisting of millions of spores (seeds) appear on the branch.
- Spores of the fungus may be spread by rain splash, wound or insects.
- Penetration of the fungus into the cortex disrupts the physiological processes of the tree leading to defoliation, branch dieback and consequently death of the branch and sometimes the whole tree.
- If the disease is not managed promptly, infected trees may die resulting in open patches on the farm.
- In Ghana, the symptoms are more evident during the dry months of November to March



Fig 2.3.3 Cocoa tree affected pink disease

CONTROL

- Pink disease is controlled by the removal and burning of all infected branches. Affected branches are removed about 30 cm below the apparent point of infection and burnt immediately. This is followed immediately by spraying the pockets on the farm with any of recommended fungicides at 3-weekly intervals with motorized spraying machines.

3. WARTY POD

Warty pod *(kokoo pcmpc),* starts as small protrusions (swellings) on green pods. The swellings turn dark brown as the pod matures and soft when the pod ripens. These dark brown lesions can easily be pressed in with the thumb.

4. CHARCOAL POD ROT

Lasiodiplodia (charcoal) pod rot *(kokoo bidie yare3)* is characterized by charcoal-like (black) sooty spores. When an infected pod is touched, a sooty black powdery substance is left on the palm. Charcoal pod rot often results when a pod is wounded and this wounding should be avoided during weeding and harvesting.

5. MEALY POD

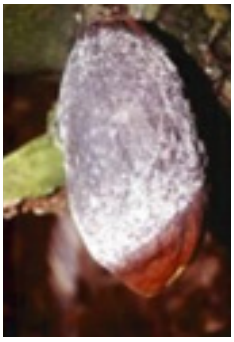
Mealy pod is seen as white powdery spores (seeds) on the cocoa pod. Unlike spores due to *Phytophthora* infection, these white powdery spores can easily be blown away by wind.

NB: Warty, charcoal and mealy pod diseases are of minor importance and do not require any control measures if good farm sanitation practices such as thinning, pruning, improving drainage and removal of infected trees or pods are followed. For charcoal pod also, avoid wounding of the pods.

SUMMARY OF COCOA POD DISEASES

PICTURE	SYMPTOM DESCRIPTION	CONTROL
 *P. palmivora* black pod (anonom, asukuo)	Starts as brown spot which become darker and expand to cover the entire pod within 14 days. Whitish spores (seeds) are produced on the brown few days after the appearance of the first symptom. Often, there are few or no whitish spores one cm from the advancing margin of the lesion.	Cultural practices but where incidence is still high, supplement cultural practices with 4-weekly spraying of COCOBOD approved fungicides
 *P. megakarya* black pod (anonom, asukuo)	Often starts as many brown spots which become darker and expand rapidly to cover the entire pod within 7-14 days. Relatively more whitish spores (seeds) are produced on the brown surface 3 days after the appearance of the brown spot. Spores cannot be blown around by wind	Cultural practices supplemented with 4-weekly spraying of COCOBOD approved fungicides
Warty pod *(kokoo pompo)*	Starts as small protrusions (swellings) on green pods. The swellings turn dark brown and soft when the pod ripens. These dark brown lesions can easily be pressed in with the thumb.	It is of minor importance and does not require any control measure

SUMMARY OF COCOA POD DISEASES

PICTURE	SYMPTOM DESCRIPTION	CONTROL
 Charcoal pod rot *(kokoo bidie yare3)*	Spores on infected pods are black and charcoal-like. When an infected pod is touched, a sooty black powdery substance is left on the palm. Charcoal pod rot often results when a pod is wounded.	It is of minor importance and it is caused by opportunistic fungi. Avoid wounding of pods during weeding and harvesting. No control measure is recommended.
 Mealy pod *(Kokoo powder)*	Seen as white powdery spores (seeds) on the pod. These powdery spores can easily be blown away by wind	It is of minor importance and does not require any control measure

3.10.2 MISTLETOES AND OTHER EPIPHYTES

Mistletoes are semi-parasitic plants (Figs 14.1 and 14.2). They attach to their host from which they obtain moisture and nutrients but manufacture their own food because they have green leaves. The genus Tapinanthus is the most common in Ghana, where they attack many dicotyledonous plants, especially ornamentals, forest and fruit trees. Mistletoes now cause considerable damage to cocoa farms and under heavy infestation can lead to complete destruction of the farmMistletoes can infest almost every dicotyledonous tree and most permanent shade trees on cocoa farms are first infested from which cocoa is later infested. *Tapinanthus bangwensis*, which is the predominant species in cocoa farms, takes about 9-12 months from the day of germination to mature and flower. In Ghana, T.bangwensis flowers twice in a year (i.e. March/April and July/August). Mistletoes produce seeds that are embedded in sticky pulps. This condition coupled with the brightly coloured flowers and fruits attract birds, which aid in their dispersal.

CONTROL

Several types of control strategies had been tried or tested. These include preventive, cultural, chemical and biological.

PREVENTIVE

Well maintained cocoa farms will prevent or minimise mistletoe attack. Having shade trees in the cocoa farm will also prevent or reduce attack.

CULTURAL

Removal or cutting-off infected branch as soon as it is notice will stop spread. It is important to identify infestation early enough since delay in detection will give mistletoe time to develop flowers and the sticky fruits, which are difficult to control.



Fig 14.1: (a) *Tapinanthus bangwensis*



Fig 14.2: *(b) Phragmantheraincana*

3.10.3 MANAGEMENT OF COCOA PESTS

INTRODUCTION

Cocoa is attacked by major and minor insect pests. The major ones are Cocoa mirids, Stink bugs and Cocoa Stem borers. The minor ones are Leaf defoliators/ *Skeletonisers,* Termites, Grasshoppers, Aphids, Pod borers, and psyllids. Others include Rodents such as African giant pouched rats and Mice.

COCOA MIRIDS (CAPSIDS) AKATE IN AKAN

IMAGE



Brown mirid
(Sahlbergellasingularis)



Black mirid
(Distantiellatheobroma)



Cocoa mosquito
(Helopeltisspp)



Pod damage by mirids



Feeding lesions on chupons caused by mirids



Brown mirid
(Sahlbergellasingularis)

	DAMAGE SYMPTOMS	MONITORING	PREVENTION	DIRECT CONTROL
	There are four main spices of Mirids on cocoa in Ghana. There are three important ones mainly the brown mirid the black mirid and the cocoa mosquito	They are found throughout the year especially during August to April. Inspect cocoa plants up to hand height monthly for the presence of mirids and feeding lesions on pods and shoots Inspect broken canopies for mirids and lesions on fresh chupons.	Plant tolerant hybrids (commonly called mixed) from COCOBOD authorized seed gardens. Remove chupons as they are succulent and attractive both as feeding and egg-laying sites for mirids. Remove alternative host plants such as young silk cotton trees and kola (Cola spp) Maintain continuous but well pruned canopy allows sunlight to reach the forest floor and promotes fresh chupons (new shoots) which attracts mirids. If the cocoa canopy is broken replace dead trees or plant plantain as it grows quickly and closes the canopy	As a last resort approved pesticides (miricides) may be applied using motorized mistblower (for mature cocoa) or pneumatic lever operated (for young cocoa) on monthly basis from August to December omitting November at peak season. Limited spraying can be carried out in January to July when mirid numbers and damage is high. In this case 2 applications at monthly intervals of infested areas or mirid pockets can be carried out. Pesticides listed below and others in **(Appendix 3)** are approved for use on cocoa as miricides: ▪ Actara 240 SC (Thiametoxam) at a rate of 17ml/11 litres or 85ml/ha ▪ Confidor OD (imidacloprid) at a rate of 30ml/11 litres or 150ml/ha ▪ AkateMaster (Bifenthrin) at a rate of 100ml/11 litres or 500 ml/ha
	Mirids cause damage to seedlings, cherelles and shoots by sucking the sap from their symptoms. Feeding puncture marks appear as water-soaked patches that turn black after 2-3 days. On young pods these are usually black, round lesions near the stalk facing the trunk and stems can cause split (cankers) and die back.	Damage on mature pods over three months old is not important but spray when average numbers reach 6 mirids per 10 trees		

COCOA STEM BORER *(KOOKOOA KOKONO)* IN AKAN *(EULOPHONOTUSMYRMELEON)*

IMAGE



Adult female stem borer on a stem of cocoa



Larva (Caterpilar) of cocoa stem borer



Exit hole created by the caterpillar of the borer on a matured cocoa tree



Stem borer exit holeplugged with a twig as control

	DAMAGE SYMPTOMS	MONITORING	PREVENTION	DIRECT CONTROL AND RESTRICTIONS
	In the past information on the cocoa stem borer (Eulophonotusmyrmeleon)did not portray it as an important pest (Cotterell,1928; Alibert, 1951;Entwistle, 1962, 1972). The borer now poses a serious threat to cocoa in Ghana (Padi and Adu-Acheampong, 1998; 2001) and in Togo (Gnakpenuo et al, 1996; Wegbe et al, 1997). Entwistle et al (1959) suggested that borer outbreaks resulted from intensive spraying of insecticides against mirids. The young larva bores into stems of both young and mature cocoa. Damage to the stem is as a result of the larva feeding inside the stem producing a excreted material looking like saw-dust(frass) at the base of cocoa stem and/ or gummy exudates from entry and exit holes made by the larva (caterpillar) in the stem.	They are found throughout the year especially during August to April. Inspect cocoa plants up to hand height monthly for the entry holes and the presence of excreta at the base of cocoa produced by the larva	Observe good cultural practices including intercropping with legumes at early field establishment. Remove alternative host plants of Anacadaiaceae family or old cocoa trees from moribund farms from surrounding fields since they may habour	Exit holes can be sealed with wooden plugs or cotton wool impregnated with COCOBOD approved insecticides. Pesticides listed below and others in **(Appendix3)** are approved for use on cocoa as stem borers: ▪ Actara 240 SC (Thiamethoxam) at a rateof 17ml/11 litres or 85ml/ha ▪ Confidor OD (imidacloprid) at a rate of 30ml/11 litresor 150ml/ha ▪ AkateMaster (Bifenthrin) at a rate of 100ml/11 litresor 500 ml/ ha

STINK OR SHIELD BUGS - ATEE IN AKAN (*BATHYCOELIA THALLASINA)*

IMAGE



Nymph stink bug



Adult stink bug

Feeding hole made by stink bug



Premature ripening of cocoa pod

	DAMAGE SYMPTOMS	MONITORING	PREVENTION	DIRECT CONTROL AND RESTRICTIONS
	▪ Both adult and nymph feed on the pod only. They suck the content of the beans. If the pod is young, it stops growing as soon as several beans have been damaged.	They are found throughout the year especially during August to April. Inspect cocoa plants up to hand height monthly for the presence adults and nymphs stink bugs on pods and shoots.	Remove alternative host plants such as young silk cotton trees, legumes andgrasses. Maintain continuous but well pruned canopy allows sunlight to reach the forest floor and promotes fresh chupon (new shoots) which may attract sucking insects. If the cocoa canopy is broken replace dead trees or plant plantain as it grows quickly and closes the canopy.	COCOBOD approved insecticides for the control of cocoa mirids can be used to manage *B. thalassina.* Pesticides listed below and others in **(Appendix 3)** are approved for use on cocoa as miricides: ▪ Actara 240 SC (Thiametoxam) at a rate of 17ml/11 litres or 85ml/ha ▪ Confidor OD (imidacloprid) at a rate of 30ml/11 litres or 150ml/ha ▪ AkateMaster (Bifenthrin) at a rate of 100ml/11 litres or 500 ml/ha
	Pods attacked by stink bugs turn yellow, then brown and finally black.	Look out for premature yellowing of cherelles and pods		

LEAF DEFOLIATORS/SKELETONIZERS
(CATERPILLARS OF LEPIDOPTERA SPP I.E *ANOMIS* AND *EARIAS* SPP)

IMAGE



Anomisspp



Eariasspp



Damage of flushes by the caterpillars

	DAMAGE SYMPTOMS	MONITORING	PREVENTION	DIRECT CONTROL AND RESTRICTIONS
	The larva eats leaves, green stems and the outside of unripe pods. It is common at the beginning of the rains (March – June). Feeding does not result in loss of beans and the pests are usually not controlled. However serious outbreaks of the pest must be managed.	On the unset of the rains look out for windowing of flushes and tender parts of cocoa including cherelles. Assess the spread and numbers of caterpillars and intervene if damage is potentially possible	Remove chupons regularly to reduce the attraction for egg laying of adult lepidopters.	COCOBOD approved insecticides for the control of cocoa mirids can be used to manage *B. thalassina.* Pesticides listed below and others in **(Appendix 3)** are approved for use on cocoa as miricides: ▪ Actara 240 SC (Thiametoxam) at a rateof 17ml/11 litres or 85ml/ha ▪ Confidor OD (imidacloprid) at a rate of 30ml/11 litresor 150ml/ha ▪ AkateMaster (Bifenthrin) at a rate of 100ml/11 litresor 500 ml/ha

OTHER MINOR INSECT PESTS OF COCOA

IMAGE
 Termites (White ants) ***Isoptera :Termitidae***
 (A) Variegated grasshopper ***(Zonocerus variegates)***
 (B) Aphids ***(Toxopteraaurantii)***
 (C) Pod Borer (***Characomastritigrapha)***
 *(D) Psyllids* ***(Tyoratessmanni)***

	DAMAGE SYMPTOMS	MONITORING	PREVENTION	DIRECT CONTROL AND RESTRICTIONS
	Termite is an important pest at the nursery and establishment stages of cocoa. Their damage is most common in the dry season.	Termites are usually underground pests whose presence can be detected by the presence of run ways (often covered) along healthy-looking stem.	Mulching in termite endemic areas must be avoided unless chemical control of termites is also intended. This is because moist conditions created by mulching invite termite pests to the seedling/ young cocoa tree. It is also advisable to keep general farm hygiene.	Cocobod approved insecticides for the control of cocoa mirids can be used to manage all other pests listed: Pesticides listed below and others in **(Appendix 3)** are approved for use on cocoa as miricides: ▪ Actara 240 SC (Thiametoxam) at a rateof 17ml/11 litres or 85ml/ha ▪ Confidor OD (imidacloprid) at a rate of 30ml/11 litresor 150ml/ha ▪ AkateMaster (Bifenthrin) at a rate of 100ml/11 litresor 500 ml/ha
	(A) Grasshoppersare also defoliators and common at the beginning of the rains (March – June). Feeding does not result in loss of beans and it is usually not controlled but serious outbreaks must be managed. **(B)** Aphids are insects which suck sap from leaves or stems of plants	All year round monitoring is encourage		
	(C) It is a moth whose larva is the destructive stage. It bores into pods and produces frass held together by silk at the entrance of the holes. Damage to matured pods do not affect the beans since it is only on the pod surface, but young and soft cherelles may wilt and die if attacked **(D)** Psyllids suck sap from leaves or stems of plants			

RODENT PESTS OF COCOA (RATS, SQUIRRELS AND MICE) (OKUSIE, OPURO AND AKURA IN AKAN)

IMAGE



African Pouch Giant Rat ***(Cricetomys gambianus)***



squirels



Mouse



Rodent damage to cocoa pod

	DAMAGE SYMPTOMS	MONITORING	PREVENTION	DIRECT CONTROL AND RESTRICTIONS
	Larger bodied species such as the African Pouch Giant Rat *(Cricetomys gambianus)* can take a whole pod and beans.	Damage may occur throughout the year but increases steeply when pods ripen. Persistent widespread damage is likely near to borders with crops that support rodents (oil palm, rice etc) Several species of squirrels (Paraxerus-poensis, Holomyscuss-tella, Praomystullbergi, Stochomyslongicau-datus) are the main culprits involved in pod damage	Cocoa grown under coconut or oil palm is highly susceptible to attack by rodents.	Culling (direct killing of existing Pests) through trapping and baiting with rodenticide Rodenticides listed below are appropriatefor use to manage rodents in the field and in storage structures. Brodifacoum, Bromodialone etc
	Small ones such as squirels and mice may feed only on the mucilage that surrounds the beans. The proportion of holed pods can be very high and they become increasingly susceptible to damage as they ripen. Average loses from rodents is estimated at 8.2% (Everard 1964).			
	Damage is compounded by ensuing fungal infection and affected pods are all lost.			

3.11 REHABILITATION

COCOA REHABILITATION

Rehabilitation of cocoa refers to the process of bringing back the productivity of old, moribund or unproductive cocoa farm which has been affected by the pest and disease attack, neglect, decline in soil fertility or lack of appropriate shade cover. Three models are available for rehabilitation of cocoa farms but the suitability of each will depend on the local situation. These models are:

- underplanting of cocoa
- complete replanting / re-establishment of cocoa
- rejuvenation/coppicing of the cocoa trees.

UNDER-PLANTING OF COCOA

Under-planting is carried out in areas where the cocoa swollen shoot virus disease is absent and when the cocoa tree stock is old or when the trees are suffering from pest attack. Improved cocoa seedlings are planted at the recommended spacing underneath the canopy of the older trees which serve as shade. In cases where death of the old trees has created significant gaps in the cocoa farm, it may be necessary to plant food crops or fast growing trees such as Gliricidia in the gaps and then cocoa seedlings planted to fill the gaps. As the planted cocoa matures the old trees are progressively thinned to reduce the shade provided. Weed, insect pest and disease management are carried out as and when needed. This model allows the farmer to maintain certain level of income from the old cocoa tree stock while the young cocoa seedlings matures to take over. The disadvantage associated with this system of rehabilitation is the risk of possible infection of the new trees with diseases and pests.

COMPLETE REPLANTING/REESTABLISHMENT OF COCOA

This is highly recommended in areas of cocoa swollen shoot disease infection. Under this model all old cocoa trees are cut down and the plot prepared for re-planting with improved varieties as in the case of establishment of a new farm. After cutting down the old trees, the land may be used immediately for re-establishment of cocoa provided the old cocoa stumps are killed with arboricide. This prevents the growth of cocoa chupons that could facilitate the transmission of the cocoa swollen shoot disease. When replanting is to be done, the land should be lined and pegged, and Giricidia and food crops planted to provide temporary shade for the new cocoa. A demerit of this model is that the farmer loses income from cocoa until the new ones start bearing.

REJUVENATION OF COCOA

As in the case of under-planting, this system is practised where the cocoa swollen shoot virus disease, is absent. It involves the use of any technique to bring an unproductive cocoa tree back to high productivity. It may involve the selective removal of chupons, coppicing of the old cocoa stem and grafting or budding of chupons with improved material (canopy substitution),removal of mistletoe and moss, pruning to ensure the rapid recovery of unproductive trees and control of pests and diseases.

Canopy substituted farms establish well with very low mortality and attain economic yields earlier than farms established with seedlings.

Canopy substitution also produce more uniform plant stand in terms of tree sizes, crown shapes and tree production. This reduces tree to tree variations and enhances reduction of unproductive trees thereby allowing for quick re-grafting of unsuccessful plants for rapid growth.

3.12 GOOD HARVESTING AND POST HARVEST MANAGEMENT PRACTICES

i. HARVESTING

Generally, there are two crop seasons of cocoa within a year, the main crop in October-March and the mid-crop in May-August. During the harvesting season, harvesting is done every 3-4 weeks when the pods are ripe and yellow in colour. It is done by cutting the stalk of the fruit with a knife as close as possible to the pod in order not to cause injury to the tree. Pods within reach are harvested with a cutlass whilst those on branches further away are harvested with sickle-shaped knives on long poles (Fig 16.1). Extreme care should be taken during harvesting to ensure that the cushions carrying the flowers and fruits are not damaged. During harvesting, diseased pods and those damaged by rodents, are also removed. The healthy pods are then carried to a central breaking point (Fig 16.2). At the end of harvesting, pod breaking operations begin.



Fig 16.1: Harvesting and picking of cocoa



Fig 16.2: Heaped cocoa pods at a central breaking point (fermentary)

ii. POD BREAKING

Pod breaking is done by cutting the pods open using blunt cutlasses or wooden clubs **(Fig 16.3).** However, wooden clubs are recommended as cutlasses may injure the beans inside the pod. The beans are scooped out of the broken pod by hand whilst the husk and placenta are discarded. All black and germinated beans as well as other foreign materials are also disposed off. Pod breaking should be done within 2-3 days after harvest. Germinated, black or diseased beans or pieces of husk and placenta fragments must be removed from the scooped beans. Because the flavour of the end product (Chocolate) is affected.



Fig 16.3: Breaking of cocoa pods



Fig 16.4: Broken pods showing fresh beans with sugary pulp

iii. FERMENTATION

The beans are embedded in a sweet, white mucilaginous pulp, which serves as a substrate for fermentation **(Fig .....).** Raw cocoa has an astringent and unpleasant flavour and must be processed after harvest into good-tasting and good-flavour chocolate. Fermentation is done the same day the pods are broken. The importance of cocoa fermentation is to develop chocolate precursors in the bean. The cocoa bean itself does not undergo fermentation but the pulp surrounding it. The pulp in an undamaged pod is microbially sterile. However, it gets contaminated during pod breaking with microorganisms from the surrounding environment including pod surfaces, knives and workers' hands.

Cocoa fermentation is a spontaneous process and occurs in two stages. The first stage is the fermentation of sugars in the pulp surrounding the beans to alcohol and then to acetic acid.

In the second stage, the acetic acid produced penetrates the bean to trigger biochemical reactions that are responsible for the formation of chocolate flavour precursors. Fermentation is normally done in six days and it is caused by microbial succession. Microorganisms involved in fermentation are yeasts, lactic acid bacteria and acetobacter.

Anaerobic phase (stage 1)

This occurs within the first two days when the pulp does not allow air circulation. Yeast and lactic acid bacteria fermentations occur in this phase. Yeast fermentation transforms pulp sugar into alcohol resulting in an increase in temperature. The increase in temperature favours the growth of lactic acid bacteria which produce lactic acid. The pulp then breaks down, drains away and air penetrates the beans.

Aerobic phase (stage 2)

This occurs from day three onwards and aeration allows strong growth of acetobacter which transform alcohol to acetic acid. Temperature then increases up to 50o C. Acetic acid penetrates into the bean causing the formation of chocolate flavour precursors. At the end of fermentation the temperature reduces causing the growth of putrefaction bacteria and prolonged fermentation will result in the development of hammy, off-flavour typical of over-fermented cocoa.

METHODS OF FERMENTATION

There are four methods of fermentation. They are the heap, basket, box and tray methods but the most commonly used are the heap, basket and box methods.

a. HEAP FERMENTATION

This method is the simplest and normally used on small farms. It is done by spreading out fresh plantain leaves in a circle on the ground and heaping fresh cocoa beans on them (Fig 16.5). This allows easy pulp drainage. The heap of beans is then covered with more leaves and held in place by small logs (Fig 16.6 a,b). The cover protects the fermenting beans against mould growth and also helps to maintain the heat generated within the heap. Size of the fermenting heap varies from 300 kg to 2 tonnes.



Fig 16.5: Fresh beans heaped on plantain leaves



Fig 16.6: Covering the heap



Fig 16.6: Covered heap

b. BASKET FERMENTATION

This method, like the heap method, is very simple and used on small-holder farms. There is no definite size for the baskets but it should contain about 10-150 kg wet beans. The baskets are first lined with fresh plantain leaves before placing the wet beans in them (Fig 16.7). They are then covered with more leaves which are held in place with small logs (Fig 16.8). The sweatings drain from the sides and the bottom of the baskets and air also passes through the sides and the bottom. The fermenting mass is turned by transferring the beans from one basket to the other.



Fig 16.7: Fresh beans heaped in basket



Fig 16.8: Covered beans in basket

c. BOX FERMENTATION

This is done in large, perforated boxes made of local hardwood. The holes at the bottom of the boxes allow the sweating from the pulp to drain out and air to enter. Therefore, the boxes are always raised above the ground level and placed over a drain. The boxes are normally arranged in tiers so that turning is done by moving beans from a higher box to a lower one Fig 16.9). The size of the box should be large enough to take 1000 kg wet beans (1.2 x 1.2 x 1.2 m). The beans are placed in the top box and covered with few layers of plantain leaves. This method reduces labour in turning beans.

To facilitate uniform fermentation in the above methods, beans are turned after 48 hours and second turning is done after another 48 hours. Fermentation is allowed to continue for another 48 hours or until the temperature begins to fall and the odour of ammonia develops, when the fermentation can be considered to have completed. Fermentation usually lasts between 5-7 days but the optimal time is 6 days.



Fig 16.9: Wooden box for fermentation

GET PICS

d. TRAY FERMENTATION

This is done by placing about 90 kg wet beans in wooden trays of 1.2 x 0.9 x 0.1 m size. The trays have battens or reapers fixed at the bottom. About 6-12 of such trays are stacked one over the other with an empty tray kept at the bottom to allow for aeration and drainage of sweating (Fig 16.10). Beans in the topmost tray are covered with banana leaves (Fig 16.11).After 24 hours of setting the stacked trays, they are covered with gunny sacks to conserve the heat that develops within the tray. There is no need for turning. Fermentation is completed in 3-5 days.



Fig 16.10: Fresh beans in wooden trays



Fig 16.11: Covered beans in trays

FACTORS AFFECTING FERMENTATION

These include the type of cocoa, ripeness of pods, pod storage before breaking, quantity of beans and pulp during fermentation, duration of fermentation, turning of fermenting mass, seasonal effects/climate and diseases that affect pods.

Over-ripening of pods can cause germination of beans. Harvesting immature, diseased and damaged pods produces poor quality beans for fermentation. The time between harvesting and pod breaking affects fermentation and ultimate bean quality. Storing the pods for more than six days causes the pulp surrounding the beans to dry up. Pulp and beans can contain more water during the wet seasons and too much pulp affects aeration of the fermenting mass and bean acidity. Turning aerates the fermenting mass to avoid uneven temperature and oxygen distribution.

iv. DRYING OF COCOA

At the end of fermentation, drying begins. It is done the same day fermentation ends. Drying is the reduction of moisture in fermented beans from about 55% to 7.5%. After fermentation, the beans are carried to the drying area and spread thinly on raised mats (Fig 16.12 a,b). These mats ensure uniform drying; and drying should not be done on the bare floor or asphalt roads. The beans must be stirred frequently to pick out germinated, flat and black beans, placenta and foreign materials, There are two methods of drying – sun drying and mechanical drying.

Sun drying is best for good quality beans and this is because during sun drying which is slow, acetic acid, a volatile compound, evaporates through the shells, Lactic acid, which is a non-volatile compound, is partly transported by water from the bean to the shell. There is also the oxidation (browning) of polyphenols resulting in the reduction of astringency and bitterness. More flavour forming reactions also occur during sun drying. Mechanical drying is generally not recommended because it is expensive; there is the danger of smoke contamination and high acid retention in beans. During drying the beans are covered to protect them from the rains and every evening to protect them from possible showers and dew. When it rains during the day, cover the beans to protect them from the rains. Uncover the beans early in the morning or after immediately after the rains. The beans are dry when they produce a 'cracking' sound after pressing them lightly in the fist. Do not stop drying until the beans are well dried. The minimum period of drying is 7 days. Fire should not be made under or close to the beans during drying as it will give the beans a bad taste or smell. The fresh bean to dry bean weight ratio is 3:1. Well fermented and well dried beans are brown in colour.



Fig 16.12: Drying of cocoa beans

3.13 COCOA QUALITY AND ITS ESTIMATION

Cocoa quality is determined by the following factors:

- flavour
- purity or wholesomeness
- consistency/uniformity
- yield of dry nib and functional potential

These have a direct bearing on manufacturing of the end product.

Quality characteristic of cocoa is influenced by the climatic conditions, composition of the soil, and the genetic make-up of planting materials used. Farmers, however are naturally constrained by the choice of soil and the environmental conditions on their farms. The choice of planting material is also dictated by diversity of cocoa varieties available to them. Nonetheless, once planting is done, there are a lot the farmer can do in terms of pre-harvest and post- harvest practices to ensure high quality of the beans. Additionally, all the other players along the value chain can perform significant roles to maintain or ensure the quality of the beans.

There is an international standard for the assessment of cocoa bean quality which stipulates that cocoa of merchantable quality must be;

- well fermented and thoroughly dry
- free from smoky beans and abnormal or foreign odours
- Free from evidence of adulteration
- reasonably free from living insects
- Uniform in size
- Free from broken beans, fragments, pieces of shell, and be virtually free from foreign matter.

PACKAGING AND STORAGE OF COCOA BEANS

PACKAGING

Cocoa beans should be packaged in clean bags, which are sufficiently strong and properly sewn or sealed. The bags should be made of non-toxic materials, preferably food grade vegetable oil treated jute bags. To ensure that good quality bags are used, Ghana Cocoa Board supplies the prescribed jute bags to Licensed Buying Companies (LBCs), who also supply same to farmers through their agents for primary packaging. After drying, the beans are bagged by the farmers and sold to the LBCs' agents. The cocoa stays briefly with agents before evacuation to a depot.

STORAGE FACILITY REQUIREMENTS

The agents' storage facilities which are normally small must meet standard requirements in the Cocoa Industry Regulations, 1968. The regulation stipulates that after removal from the farm, cocoa shall be stored in a building and the occupier thereof shall ensure that:

- Building is rainproof
- Its floors are dry and properly constructed of cement concrete, stone, brick or wood
- It is provided with sufficient doors and windows to allow adequate ventilation and
- The inside walls are painted or whitewashed and re-painted or re-whitewashed annually or at such other period as specified by Quality Control Company of Ghana Cocoa Board.

Cocoa from the LBCs' agents' facility is moved to LBCs' depot where bulking and sieving of stocks from the same society is done. After bulking, the produce is packed or stacked in terms of category with reference to bean sizes. The depots are bigger facilities that had been certified by QCC for having satisfied the requirements for storage of cocoa. The storage facilities (Warehouses) at the Take Over Centres (TOCs) are also bigger than those upcountry (depots and stores).

LBC SHED



Cocoa beans sold at LBC facility



Temporary storage at LBC facility

GOOD WAREHOUSING PRACTICES

Packing/stacking of cocoa is done on wooden pallets usually in lots with alleyways in between the stacks as well as stacks and the walls, except for special storage facilities like Kateon Natie (bulk cocoa shipping company in Takoradi) where the beans are heaped on specialised bare floor that will not allow dampness and contamination. Only well dried cocoa beans (moisture content of 7.5% or less) should be accepted into storage. Cocoa should never be kept on the bare floor or against the wall.

In addition to the provisions in the Cocoa Industry Regulations, 1968, the storage facility should be well illuminated to allow for thorough inspection of the produce hence, the use of transparent roofing sheets if need be.

Controlled ventilation helps to prevent build -up of humidity which eventually leads to dampness of cocoa

therein and also aids in fogging which requires an air-tight environment to be effective.

Cocoa storage facilities must not have cracks and crevices in the walls or on the floor that will harbour pests. Storage facilities should be at least 200metres radius away from storage barns, fuel dumps or fire places like kitchen or bakery in order to prevent cocoa from cross- infestation or absorbing smoke that will culminate into Polycyclic Aromatic Hydrocarbon (PAH) contaminations. Such facilities should also not be located in water logged areas or low lying areas that are prune to water seepage.

Receipt and evacuation of cocoa into and out of a storage facility must be on first-in-first-out (FIFO) basis. It is important to note that facilities for storing cocoa cannot be used to store any other products concurrently. Eating is also not allowed in such facilities.



Stack of Cocoa arranged with alley-ways in a warehouse



Hot fogging Cocoa beans in a warehouse to kill flying and crawling insects



Sampling of Cocoa beans in bags in a warehouse



Determination of relative humidity (RH) using Aquaboy



Bean count to determine average bean weight

QUALITY CONTROL

The Quality Control Company Limited (COCOBOD), following Federation of Cocoa Commence (FCC), international food safety laws and standards, and national regulations, carries out quality check on cocoa bean in Ghana. Quality Control Company has offices located in all the six (6) cocoa regions in Ghana. Ghana's cocoa quality check is in three tiers; (1) first tier at upcountry (LBCs' depot), (2) second tier on arrival at the TOCs and (3) third tier at the time of shipment (local evacuation or export overseas).

1. FIRST TIER QUALITY CHECK

For the first tier quality check, the produce is packed/ stacked in lots of 30 bags based on origin (societies) after bulking and sieving.

The moisture content of the beans in each bag in a lot is determined by the use of moisture meter as a preliminary check. The acceptable moisture content of dry cocoa bean must be 7.5% or less. Samples are then taken from all the bags that passed the preliminary moisture check in a lot for further moisture checks. A confirmatory moisture check is then carried out on a subsample from a lot after bulking and quartering using a more sensitive electrode of the moisture meter.

When a parcel (a lot) passes the moisture test, it is then subjected to bean size categorisation and uniformity index test. Where the number of beans per 100g weight of cocoa (bean count) is determined, the unusual beans within are also selected and expressed as percentage of the total number of beans. The acceptable uniformity index is 10% or less (no category of cocoa should have more than 10% of unusual beans in the parcel). Out of the bean count, the average bean weight can be determined.

After categorisation, cut test is conducted in order to assign a grade to the parcel of cocoa. For a consignment more than one bag, three hundred beans are randomly selected and cut through lengthwise. Half of each bean is arranged in such a way to critically examine the cut surfaces for defects.

The defects so detected are expressed as percentage of the number of beans cut. Grades are assigned as below: Table....

BELOW ARE VARIOUS CATEGORIES OF COCOA:

Number of beans per 100g	Category	
Up to 90	Super Main Crop	Main Crop
91 to 100	Main Crop	
101 to 105	Super Light Crop	Light Crop
106 to 110	Light Crop	
111 to 120	Small Beans	
121 to 150	Type 4	
151 to 180	Remnant	

Table

Grade 1 cocoa beans	Grade 2 cocoa beans
Mouldy beans, maximum 3% by count	Mouldy beans, maximum 4% by count
Slaty beans, maximum 3% by count	Slaty beans, maximum 8% by count
Insect-damaged, germinated or flat beans, total maximum 3% by count	Insect-damaged, germinated or flat beans, total maximum 6% by count.

Any parcel of cocoa with defects beyond that of grade two is marked substandard and not marketable.



For definations on defects of cocoa beans, refer to **(Appendix 4)**

TRACEABILITY

The grades determined are embossed on the jute bags containing the cocoa. In addition to the grades, a code for LBC that purchased cocoa from the farmer and the region from where it was purchased are also indicated on the bag. Drop marks (society code) and lot number are all embossed on the bag. A seal with a specific number and a grader's number pressed on it is affixed to a twine used in sewing the bag.

All these serve as means of traceability. Sealing a parcel of cocoa implies there is agreement between the inspector and the owner of the cocoa concerning the grade. A certificate of inspection of cocoa is then issued to cover the graded stock.

The graded and sealed stock is re-examined to validate the grade by a superior officer. This is done to check if the grade found tallies with what is indicated on the bags, otherwise, the parcel is de-sealed and reconditioned.

After the LBC had accumulated enough graded and sealed cocoa in the depot, an application for evacuation is sent to QCC. The stock is cross- checked by QCC to ensure that all the bags of cocoa to be evacuated are graded and sealed after which the vehicle to transport the cocoa will be inspected for its suitability for haulage.

SECOND TIER QUALITY CHECK

On arrival at a TOC, the second tier inspection ensues with QCC officials checking for wetness, dirtiness and other contaminations of bags, infestation and soundness of the vehicle that transported the stock. Cocoa Marketing Company Limited of COCOBOD (CMC) checks the number of bags purported to be on the truck and the weight of each bag. Each bag of cocoa on arrival at the TOC should weigh 64kg.

When the QCC and CMC are satisfied with regards to the parameters checked, samples of cocoa are taken from every bag on the vehicle that transported the cocoa (a vehicle is considered a lot) for inspection and grading. This process is similar to that of the first tier grading except that there would be no sealing. Acceptance (OK) is then given by QCC if all the parameters checked are within the acceptable limit, otherwise the parcel is rejected for reconditioning by the LBC if the defect can be reconditioned (internal mouldiness cannot be reconditioned). Cocoa Marketing Company then after issues Certificate of Take Over (CTO) for the cocoa to go into stack. At this point, the produce moves from the custody of the LBC to CMC who ensures that large stacks are built with enough alleyways to allow for ease of movement during the inspection and disinfestation while care is taken to manage space as well.

THE THIRD TIER QUALITY CHECK

The third tier inspection is carried out during shipment when the cocoa has been disinfested and found to be insect free. The entire process of inspection and grading is conducted and purity certificate given if the parcel passes. A stack in this case represents a 'lot", which is normally about 320 metric tonnes.

The Research Department of QCC regularly monitors the fat content in dry nib, free fatty acid level, pH, ochratoxin and pesticide residue levels of every consignment of exportable cocoa. In addition, the effectiveness of pest control on exportable cocoa is also assessed before and after export.

TRACEABLE FEATURES pics

TRANSPORTATION OF COCOA BEANS

Only trucks that are sound and fit to travel the distance required are allowed to transport cocoa beans. For secondary evacuation (from depots to TOCs), a truck-load is normally about 510 bags. The vehicle should not have previously carted poultry products to prevent cross infestation; especially mite infestation. If there is any doubt, the vehicle is disinfested before the stock is loaded onto it ensuring that the top assumes a dome-shape for easy dripping of raindrops. It is then covered with waterproof tarpaulin. The truck /vehicle should have spare tyres and waterproof tarpaulin. Cocoa on the truck should be covered with tarpaulin throughout the journey to prevent contaminations. A vehicle carting cocoa is not allowed to carry any other produce/ product.





Offloading of cocoa into warehouse

add pic

SHIPMENT

Evacuation of cocoa from the TOCs to a buyer either locally or overseas is loosely referred to as shipment. There are four main types of shipments. These are;

- break bulk shipment
- bag in container shipment
- bulk in container shipment
- Mega bulk shipment.

BREAK BULK SHIPMENT

This type of shipment is also called general cargo; here the cocoa in bags is loaded onto the ship as individual pieces (bags) not in intermodal containers or in bulk. The bags are transported to the dock area where they are placed on pallets having lifting slings attached, commonly referred to as a sling and/or sling load of cocoa beans. A typical sling of cocoa beans contains 30-35 bags.

The slings of cargo are arranged in groups adjacent to each other with the number of slings per group preferably equalling the capacity of the on-board crane, which the ship employs. The crane then lifts the cargo on to the ship.





Break bulk shipment

BAGS IN CONTAINER SHIPMENT

In this type of shipment, the floors and side walls of the container to be used is covered with corrugated Kraft paper, cardboard, or a double layer of single paper after the container has been inspected and declared fit for use. Bags of cocoa are then stuffed in and dry bags (desiccants) hanged inside the container to absorb condensation due to temperature fluctuations. The dry bags are arranged in two rows of eight in a fore and aft direction on top of the Kraft paper covering the bags and four facing the doorway on the floor.
The containers used may be either ventilated or not.



Bags in container shipment

BULK IN CONTAINER SHIPMENT:

This is the process where naked cocoa beans are poured into a container that has been lined with a lining prescribed by a buyer. Bags of cocoa beans are usually slit opened and the content poured on conveyor belt system that conveys the naked beans into the prepared container. It can also be done in a process where pail loader is used to scoop cocoa beans from heaps on to conveyor belt which eventually moves the beans into the container.



Container lined with the required material for bulk in container shipment



Cut and pour process of bulk shipment



Bulk in container shipment

MEGA BULK SHIPMENT

This process is similar to that of bulk in container shipment but here large quantities of beans are transported via conveyor into either a ship hole or a hatch, which had been inspected and certified for use.



Conveyor system for bulk shipment

STORAGE PESTS AND THEIR CONTROL

A wide range of pests infest cocoa in storage. Notably among them are insects, fungi, rodents and birds. The damage caused by these pests may lead to weight loss, loss in market value, loss in nutrients, contaminations or loss in goodwill.

Some of the insects that infest cocoa in storage include Warehouse moth (Ephestia cautella), Rice moth (Corcyra cephalonica),Red flour beetle(Tribolium castaneum), Cigarette beetle(Lasioderma serricorne), Coffee bean beetle(Araecerus fasciculatus), Corn sap beetle(Carpophilus dimidiatus) and Rusty grain beetle(Cryptolestes ferrugineus).

Federation of Cocoa Commerce (FCC) regulation stipulates that merchantable cocoa should be insect free and hence the presence of any insect diminishes the value of the cocoa.

The major stored cocoa fungi include; *Aspergillius spp, Penicillium spp, Rhizorpus spp, Mucor spp*. Internal mouldiness affect the quality and for that matter the grade of cocoa. Fungi (mould) attack on cocoa leads to increase in free fatty acid (FFA) level in some cases production of mycotoxins especially, ochratoxin A (OTA).

Rodents and bird cause damage to cocoa mainly by contaminating the beans with droppings, urine, hair and feathers.
Infestation of cocoa bean by pests usually results indisinfestation at ports of destination when pests like insects and mites are detected in a consignment of cocoa. The cost of such disinfestation, which is usually huge, is passed on to Ghana. In other cases, the consignment may be out rightly rejected if the infestation has led to a situation that cannot be remedied, for instance contaminations with rodent urine etc.

In order to mitigate the destructive effects of pests, disinfestation (pest control) strategies are put in place. Pest control in cocoa storage environment is solely carried out by QCC. At the beginning of every cocoa season, all storage facilities are cleaned, whitewashed and sprayed with COCOBOD approved insecticide (mostly pyrethrins and derivatives) before cocoa is allowed into them. Furthermore, cocoa in storage is fogged using COCOBOD approved oil based insecticide (pyrethrins and derivatives) to curtail insect populations. To ensure that a parcel of insect-free cocoa is shipped to a client, fumigation which is the use of insecticide in the gaseous form (phosphine gas) is embarked on. This operation eliminates all the life forms of insects as well as moulds.

Rodenticides and wire mesh are also used to control rodents and birds, respectively in the storage environment. It is important to state that all pesticides used in the cocoa storage environments are tested and the implications of their use critically evaluated by qualified personnel before approval is given. Thereafter, staff of QCC are trained on the proper use of the approved pesticides.



Lasioderma serricorne



Triboliunm castaneum



Ephestia cautalla



Cryptolestes ferrugineus



Fig 17.1: Loading of cocoa from warehouse



Fig 17.2: Physical assessment of cocoa beans



Fig 17.3: Chemical assessment (fat extraction)

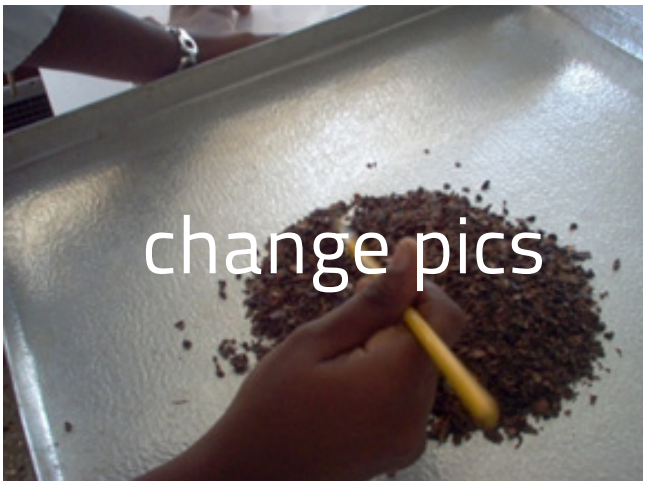


Fig 17.4: Entomological assessment of nibs

COCOA LABORATORY ANALYSIS INCLUDES THE FOLLOWING:

Physical assessment	**Entomological assessment**
Chemical assessment	**Free fatty acids (FFA)**
Moisture content	**Aflatoxin testing**
pH of cocoa beans	**Microbiological analysis**
Fat content	**Pesticide residue testing**

Cocoa quality can also be ensured by the farmer at the farm level through good post harvest practices. The farmer can assess the different types of defects in cocoa using the physical means.

PHYSICAL ASSESSMENT OF COCOA AT FARM LEVEL INCLUDES THE FOLLOWING:

MOULDY/MILDEWED BEANS – BADLY DRIED BEANS These are the worst defect of cocoa, which leads to the reduction in the value of cocoa. However, it is easily avoidable.	
Description	-The bean is mouldy on the inside and when cut or broken, a blanket of mould of variable colour (from black to white through brown and yellow) will be seen. -The bean is affected by moulds after the fermentation process. -The bean will still be considered mouldy even if a small part of it is affected. -This defect cannot be repaired
Causes	-Inadequate drying of cocoa beans -Storage of inadequately dried beans in a sack -Storage of dry cocoa beans in a poorly ventilated room results in the uptake of moisture by the beans.
Consequences	-If the beans are poorly dried or stored in a poorly ventilated room, the mould can spread quickly to infect the entire pile of cocoa beans. -One bag of mouldy cocoa beans can reduce the value of a whole truck load. -The presence of mouldy beans in chocolate production will result in a chocolate with a bad flavour.
How to avoid it and test it	-Infection by mould can be prevented during drying of the beans. -The beans must always be thoroughly dry before bagging. -To test for mouldy beans, the beans must be crushed in the hands and if the shells do not crack then they are not dried enough.
INSECT DAMAGED/MOTH-EATEN BEANS	
Description	-The beans are damaged by insects (moths/mites) and their larvae that feed on them. -The moth can still be in the bean or left the bean after feeding, it is still considered as insect damaged.
Causes	-Long storage periods of cocoa -Poorly dried cocoa beans.
Consequences	-When the cocoa stored for long periods, the insect multiply and spread quickly in the store room. -Untreated insect infested cocoa beans will also affect cocoa in other countries when exported
How to avoid it and test it	-Ensure that storage rooms are free of insects (moths/mites). -Fumigation of store rooms with recommended fumigants.

SLATE BEANS	
Description	-The bean shows a slate colour (dark gray) on the inside when cut.
Causes	-under fermentation or no fermentation at all. -Insufficient fermentation heap size. -Outside temperature too low (harmattan)
Consequences	-Slate beans gives chocolate a bad taste (bitter or musty). -They also reduce the market value of cocoa.
How to avoid it and test it	-Good fermentation practices ▪ Ferment under shade ▪ Heap size of at least 300 kg ▪ Ferment on banana leaves and cover with banana leaves ▪ Ferment for 6 day
BLACK BEANS AND BEANS WITH HIGH FREE FATTY ACID (FFA) CONTENT	
Description	-Black beans have low bean weight and high FFA content. -FFA cannot be seen with the naked eye but can be determined by chemical tests.
Causes	-Diseases such as black pod and brown rot *(pourriture brune).* -pods that have been left on trees for a long time before harvesting. -Improper storage or long storage of cocoa beans can also cause an increase in FFA.
Consequences	-Reduction in the market value of cocoa.
How to avoid it and test it	-Harvest pods regularly -remove diseased pods from healthy ones -Avoid long storage of cocoa
GERMINATED BEANS	
Description	-Germinated /sprouted beans have a small point at one end of the bean
Causes	-Over ripening or leaving pods on tree for a long time before harvesting -leaving an opened pod for a day or two can also cause germination of beans
Consequences	-Facilitates the entry of moulds through the ripped hull of the bean.
How to avoid it and test it	-Harvest regularly -Ferment beans immediately after pod breaking. -Do not mix sprouted beans other beans to prevent the spread of moulds
CHIPPED BEANS	
Description	-Beans with injury
Causes	-Breaking of pods with cutlass or sharp object
Consequences	-Facilitates the entry of moulds through the wounded area
How to avoid it and test it	-Breaking of pods with wooden clubs -Do not mix injured beans other beans to prevent the spread of moulds
PURPLE BEANS	
Causes	-Harvesting of unripe or green pods -Under fermentation
Consequences	-Bitter chocolate -Reduction in market value

How to avoid it and test it	-Harvesting of mature or ripe pods -Fermentation for 6 days
BROWN BEANS, BLACK SPOTS	
Causes	-Over fermentation
Consequences	-Taste of rot - Reduction in market value
How to avoid it and test it	-Fermentation for 6 days
SMOKY BEANS	
Causes	-Drying or storage of beans in contact with smoke
Consequences	-Taste of smoke
How to avoid it and test it	-Avoid bean contact with smoke from fire.
BEAN DEBRIS AND FOREIGN MATTER	
Description	-Small pieces of broken beans mixed with good beans -Foreign matter include - Small stones - Pieces of pod husk - Pieces of placenta - Pieces of metal
Causes	-unsorted cocoa or sorting not well done -place of drying not clean -farmer cheating the buyer by adding pieces of stones and metals the bag of cocoa to increase the weight
Consequences	- Reduction in the market value of cocoa. -Gives extra work to the exporter by sorting before marketing.
How to avoid it and test it	-Ensuring proper bean sorting -Keep areas of drying clean, use raised mats.
Causes	-unsorted cocoa or sorting not well done -place of drying not clean -farmer cheating the buyer by adding pieces of stones and metals the bag of cocoa to increase the weight
Consequences	- Reduction in the market value of cocoa. -Gives extra work to the exporter by sorting before marketing
LOW GRAINING AND FLAT BEANS	
Description	-Low graining is due to small bean size -Flat beans have cotyledons which are completely atrophied due to malnourishment from the tree.
Causes	-The size of the tree is related to the development of pods on the tree. -Lack of water and nutrients or disease infection affect the size of beans and number of pods on a tree.
Consequences	-Large beans have more cocoa butter and that manufacturers prefer them to small beans. - Reduction in the market value of cocoa.

How to avoid it and test it	- Good agronomic practices - Mulching - Correct spacing - Spraying against diseases.

3.14 COST AND BENEFITS OF COCOA PRODUCTION

The following factors of production have to be considered before venturing into cocoa farming: Land, labour, capital and entrepreneurship. Details are presented in the table below:
These usually include the following:

1) Land which is usually estimated as rent per annum.

2) Land preparation which involves clearing, stumping, ploughing etc.

3) Planting which may include planting materials, nursery development, cost of planting itself and transportation.

4) Weeding which is either manual or chemical.

5) Fertilizer application which also includes cost, transport and application cost.

6) Application of insecticides/fungicides which may include cost of chemical, cost of spraying (may include hiring of sprayer).

7) Harvesting which involves plucking, gathering of pods, breaking of pods, fermentation etc.

8) Transportation of produce to the point of sale.

N: B. Most labour operations may be in the form of contract or by-day charges and it may be necessary to estimate opportunity cost of family labour or any other inputs at the prevailing market rate in the area.

COMPONENTS OF COST

Some farm machinery and equipment are not consumed within a single production cycle. In other words only a fraction of the value is used in one cycle usually in a year. The value used must be estimated and added to the cost to obtain the total cost of production. This is normally done either using the depreciated value of the equipment used in the cycle or using the opportunity cost.

COST OF COCOA PRODUCTION

COST OF PRODUCING ONE HECTARE OF COCOA OVER A THREE (3) YEAR PERIOD

TABLE:XXX (A) COST OF INPUTS FOR ESTABLISHING ONE HECTARE OF COCOA FARM - 1ST YEAR

COST OF INPUTS	UNIT PRICE (GH¢)	QUANTITY	COST PER HECTARE (GH¢)
Pegs	0.50	1,100	550.00
Plantain Suckers	1.00	1,200	1200.00
Economic Shade Trees	1.00	18	18.00
Cocoa Seedlings	0.2	1,200	240.00
Sulphate of Ammonia (bags)	100.00	2.00	200.00
Insecticide (Litres)	40.00	2	80.00
Subtotal (A)			**2,288.00**

TABLE:XXX (B) COST OF ACTIVITIES FOR ESTABLISHING ONE HECTARE OF COCOA- 1ST YEAR

COSTS OF ESTABLISH-MENT	UNITS PER HECTARE (eg. no. of man- days, no. of bags, trans-porting distance)	UNIT VALUE (local currency) GH¢	COST PER HECTARE (local currency) GH¢	REMARKS
Land Preparation:				
Land Clearing	15	20.00	300.00	
Felling & Chopping big trees	1	600.00	600.00	Using chain saw machine
Clearing stumps	20	20.00	400.00	Man days
Lining and Pegging	8	20.00	160.00	Man days
Labour Cost:				
Cost of Transportation of plantain suckers (aver-age distance of 3km)	3	100.00	300.00	
Carting of cocoa seed-lings (Average distance of 3 km)	3	100.00	300.00	100 cedis per kilometer
Holing and Transplanting seedlings	10	20.00	200.00	
Fertilizer application	5	20.00	100.00	
Weeding (4 x per annum)	48	20.00	960.00	12 man days per weeding
Insecticide application	2	20.00	40.00	
SubTotal (B)			**3,360.00**	
TOTAL (A+B) (COST OF INPUTS & ACTIVITIES - 1ST YEAR)			**6,240.00**	

TABLE:XXX (C) COST OF ESTABLISHING ONE HECTARE OF COCOA FARM 2ND AND 3RD YEAR

COST OF ESTABLISHMENT	UNITS PER HECTARE (Eg. No. of Man- Days, No. of bags, litres)	UNIT VALUE (Local Currency) GH¢	COST PER HECTARE (Local Cur-rency) GH¢	REMARKS
Purchase and transporta-tion of cocoa seedlings	500	0.40	200.00	
Filling of vacancy (20% seedlings required / Ha)	2	25.00	50.00	Man days
Weeding (4 x per annum)	96	25.00	2400.00	12 man days per weeding
Cost of Insecticide (litres)	4	45.00	180.00	
Insecticide application	4	40.00	160.00	
Cost of Fertilizer (Ammo-nia Sulphate)	5	100.00	500.00	
Fertilizer application	10	25.00	250.00	
Total cost per hectare (C)			**3,740.00**	

***Grand total cost of establishiing 1 hectare cocoa farm for first three years (A+B+C) GH¢ 9,980.00**

Assumptions:

1. Prices given are purely for illustrative purposes

2. Farmer has access to land

3. Farmer will utilize paid labour for all activities

4. Figures of benefits of cocoa cultivation were taken from the FBS training manual by GIZ

3.15 USES OF COCOA AND ITS BY-PRODUCTS

- Chocolate
- Cocoa butter
- Cocoa powder

There are also many by products that can be derived from cocoa waste. Some of them are as follows:

- Animal feed production from cocoa pod husk
- Potash production for soap from cocoa pod husk
- Wine, alcoholic beverages such as the local gin (akpeteshie), gin and brandy from cocoa sweatings
- Jams and marmalades from cocoa sweatings
- Pectin for pharmaceuticals, cosmetic and food industries.

COCOA CONSUMPTION

Despite being the world's second largest producer of cocoa, the average Ghanaian consumes about 0.5 kilograms of cocoa products produced per year. There is therefore a profound dichotomy between the quantity of raw cocoa produced in Ghana and the quantity of cocoa products consumed in the country. To curb this menace and cultivate the habit of cocoa consumption among Ghanaians, COCOBOD has put the following measures in place:

- Giving of special concession to companies interested in local processing of cocoa
- Constitution of a National Committee for the Promotion of Cocoa Consumption
- Introduction of an annual Cocoa Festival to create awareness of the various cocoa products available and promote its utilization among Ghanaians. The festival is also aimed at providing a platform to sensitize Ghanaians on the health and nutritional benefits of cocoa and imbibe its consumption in them.
- Introduction of an award scheme for scientists who conduct research on the health benefits of cocoa as well as an award for journalists who write on cocoa consumption.
- Development of promotional brochures, posters and flyers on the health and nutritional benefits of cocoa
- Using other integrated marketing communication tools to promote cocoa consumption.

GOOD ENVIRONMENTAL PRACTICES (GEPs)

4.0

4.1 CLIMATE CHANGE, COCOA CULTIVATION AND CARBON TRADING

Climate change and climate variability pose a significant challenge on smallholder cocoa farming in Ghana. To address this issue require a new approach, called Climate Smart Agriculture (CSA), for re-orientating agricultural production to the realities of climate change. CSA combines different methods under a climate umbrella and assesses the risks and needs of a specific farm or farming community by addressing them to ensure resiliency and adaptation in the face of climate change.

'Climate change" is a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

It is becoming increasingly evident that the amount and distribution of rainfall in support of optimum plant growth and profitable crop production has been declining over the years. Also the intensity of sunshine and other climatic conditions have changed considerably. This is attributed to what is now referred to as Global warming or Climate Change. The scientific community has agreed that Climate Change is happening as a result of human activities.

CLIMATE CHANGE MECHANISM

Slashing and burning of vegetation for agricultural purposes, industries and vehicles, emit a lot of gases called greenhouse gases. Greenhouse gases, once emitted, go up in the air and cover earth like a blanket. When there are a lot of greenhouse gases in the air, the heat from the sun is contained under the blanket of gases. As the earth gets more heated, the rainfall pattern changes, and we start to experience unusual weather conditions all around the world resulting in the phenomenon often referred to as Global Warming or Climate Change.

CLIMATE HAZARDS

The main climate hazards that have been identified for the cocoa sector in Ghana include higher ambient temperatures, drought conditions, high or extreme rainfall events and flooding. Some major areas and sectors that are particularly important, and which could also be adversely affected by climate change are: water resources, agriculture and hence food insecurity, natural resource productivity and biodiversity, human health as a result of increased incidence of vectors, coastal zone vulnerability to sea-level rise with flooding, land management as a result of intensification of desertification, decline in national revenue particularly that from cocoa, decrease in energy (hydropower) production, reduction of tourist facilities particularly coastal infrastructure and national parks. The harsh effects of climate change is likely to impact more on vulnerable groups like women and the poor.

IMPLICATIONS ON COCOA OUTPUTS

Most cocoa farmers are already aware of these changes in their area and perceive climate change in terms of changes in rainfall pattern and temperature. Projected rainfall for 2020, 2050, and 2080 for the semi deciduous (SDFZ) and high rainforest zones (HRFZ) of Ghana, where most of the nation's cocoa is grown, indicates a decline in rainfall by 2%, 11%, 19% and 3%, 12% 20% respectively. The predicted drop in cocoa yield will be 14% and 28% for 2020 and 2050 respectively. By 2080, moisture is predicted to be inadequate for profitable cocoa production in Ghana if the current trend is maintained.

VEGETATION

There is evidence that the forest savanna interface is moving southwards and so with cocoa production. Initial results of the Consultative Group for International Agricultural Research (CGIAR's) global 'Çlimate Change, Agriculture and Food Security'(CCAFS) research project notes that by 2030 climate change will reduce the area available for cocoa production towards the northern transition to the Savanna zone. The current area for cocoa in Ashanti will remain suitable but will face uncertain climatic condition. Areas in the Western, Central and Eastern regions will likely become hotter and wetter, yet remain suitable for growing cocoa.

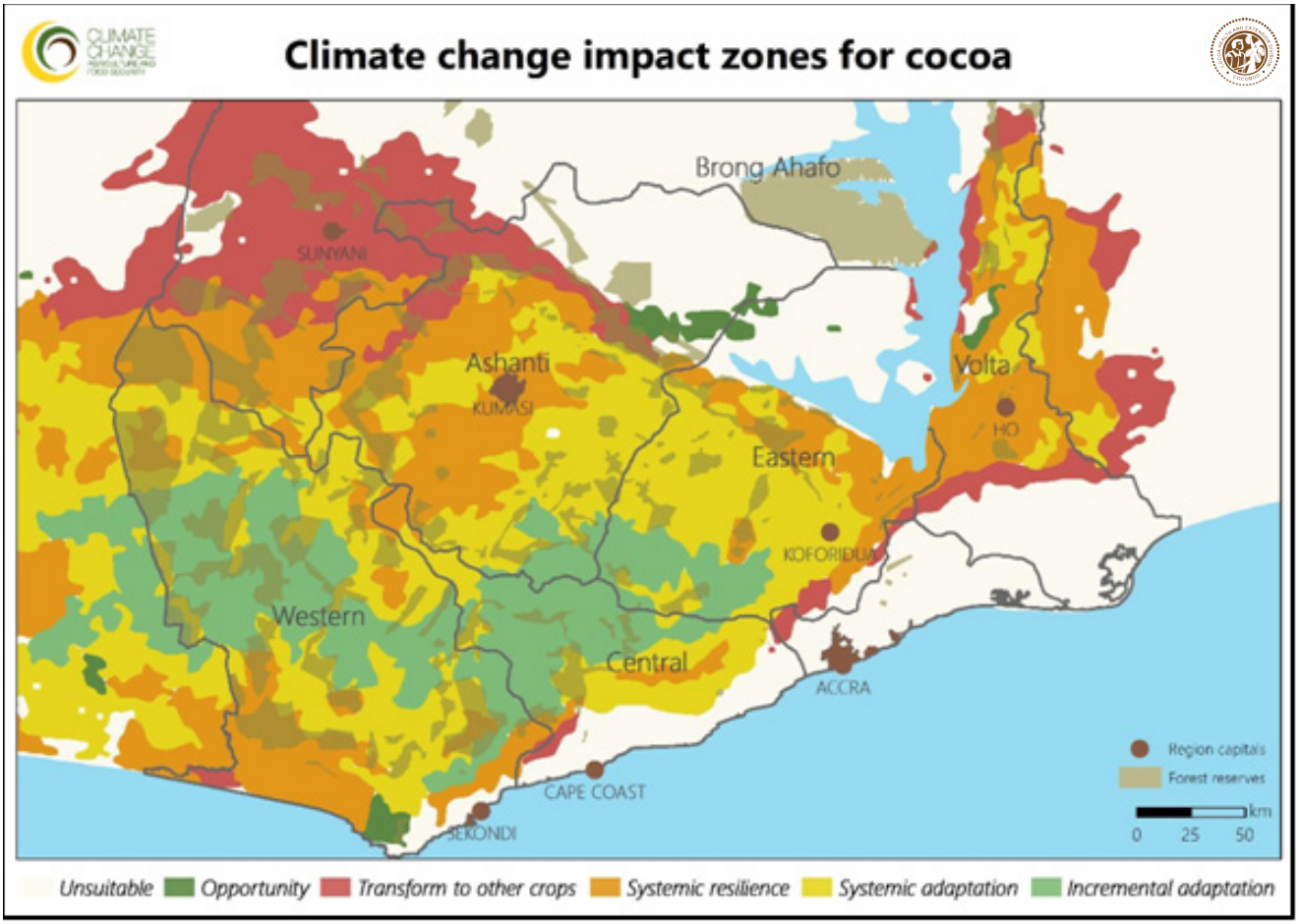


Fig. 1 Quality of change of agro-ecological zones (AEZ) for cocoa in Ghana 2050s; Locations in light green will not change the AEZ, yellowlocations will have to adjust to a different AEZ, orange high uncertainty, and red indicates transformation sites and dark green opportunity sites; shading indicates protected areas.

The impact of climate change for each region will require site-specific adaptation strategies to the degree of impacts. The northern cocoa belt regions will have to diversify into alternative cropping systems to adjust to either a changed climate or uncertain future. The southern part characteristics of the climate will remain the same but have to cope with higher temperatures. Southern Brong Ahafo, northern Ashanti and the north and south of Volta will become 'transformation zones that are expected to have to transition or transform into alternative agricultural systems. These areas were classified as no longer suitable for cocoa production by 2030.

STRATEGIC MEASURES

CSA strategies include many tried and tested measures for sustainable agriculture- building soil fertility, protecting watersheds, increasing access to knowledge, inputs and markets for more profitable and food secure farming livelihoods. For instance, CSA strategies that address drought conditions in a cocoa farming system will include suitable cover crops to enhance soil moisture retention and soil structure that aids water absorption, shade trees species that creates a microclimate that is supportive of life changes of cocoa and reduces competition for nutrients and water, or traditional drip irrigation systems that can aid the survival and growth in the establishment phase.

CARBON TRADING

Is a term that has emerged from climate negotiations, and is a market based mechanism for helping mitigate the increase of carbon dioxide in the atmosphere. Carbon trading markets are platforms that bring buyers and sellers of carbon credits together with standardized rules of trade.

Potential buyer of carbon credit is any entity, typically a business that emits carbon dioxide to the atmosphere and may have interest or may be required by law to balance its emissions through mechanisms of carbon sequestration. These businesses may include power generating facilities or many kinds of manufacturers. This emerging phenomenon could potentially lead to international carbon trade.

COCOA AND CARBON TRADING

Cocoa production in Ghana is said to follow a distinct cycle. The main characteristics of this cycle are:

i) Forest rent is the perfect growing environment represented by the forest ecosystem. The benefits include: soil fertility, protection from erosion, moisture or high humidity, protection from drying winds, stabilizing effect of precipitation within rainforest zone, protection from diseases and pests

ii) Migration; a process by which cocoa farmers habitually migrate in search of new 'forest rent'.

Clearing or thinning forests to plant cocoa will have a negative climatic effect. However, lands that are already degraded, planted in annual crop cycles, or are classified as savannah lands and are converted to cocoa cultivation will show a net gain in carbon and contribute to climate mitigation.

The greatest climatic effect of shaded cocoa systems is the effect of buffer zones in providing farmers a profitable cash crop option that maintains shade around protected forests. Thus:

a) farmers in the cocoa industry could through good agricultural practices reduce climate change and potentially trade in carbon.
b) practices that lead to deforestation and accelerate desertification should be discouraged whilst encouraging the planting of trees or afforestation.

From the above, it can be seen that farmers in the cocoa industry could through good agricultural practices reduce climate change and potentially trade in carbon. Practices that lead to deforestation and accelerate desertification should be discouraged whilst encouraging the planting of trees or afforestation.

4.2 WATER MANAGEMENT

- Water is a vital natural resource for the survival of men, animals and plants.
- With two thirds of the earth's surface covered by water and given the fact that 75% of our own body consists of water, it is clear that water is one of the prime elements responsible for life on earth.
- Water circulates through the land.
- All kinds of contamination of surface and underground water have to be avoided by adequate measures such as:

a) Keeping a certain distance between the fields/plantations and rivers, streams, lakes, etc.,
b) Preventing water contamination caused by the run-off of chemicals or sediments and
c) By avoiding any dumping of wastes (crop residues, empty containers, plastic bags, etc.) into the waters.
d) Manure, fertilisers and agrochemicals must be handled and stored in a way that prevents contamination because they pose a threat to human health and to biodiversity.

4.3 ECOSYSTEM PROTECTION

Cocoa production has contributed to deforestation and biodiversity loss in West Africa and other tropical countries. However, cocoa can also play a positive role for the environment and biodiversity conservation, if it is grown in a way that is similar to the cocoa's natural habitat, the rain forest. Shade-grown cocoa agroforestry systems are much more beneficial for the protection of biodiversity than full-sun plantation systems. (Agroforestry systems involve growing tree species in association with food crops and livestock on the same piece of land). Cocoa agroforests play an important role for the environment, like maintaining soil moisture, protecting soils from erosion, providing habitat for pollinators and other beneficial insects.

- The habitats of plants and animals need to be preserved because all living species have a role to play in our environment.
- Forests, for instance, provide habitats for many plants and animals that find shelter and food.
- Farming, cutting trees, development of roads and new settlements destroy habitats. In this way, plants and animals which previously used such places are displaced or destroyed, leading to loss of biodiversity.
- The importance of forests includes the following facts:

i) Forests enhance rainfall. This happens when trees capture water from the ground and release it into the atmosphere. This water comes back as rain water.

ii) Forests act like a sponge to retain large quantities of water. They gradually release the water so that it does not run off to cause floods and erosion. Most rivers have their source in forests. Often, the only streams that flow in the dry season are found in forests.

iii) Trees help to reduce erosion along streams and thus protect soil and maintain clean water. During unusual climate changes such as long dry periods and extreme rainfall, forests provide habitats for wildlife.

▪ Take measures to protect the ecosystem as follows:

i) Establish farms away from national parks, wildlife refuges, forestry reserves, buffer zones and other public or private conservation areas.

ii) Do not cut forest trees to establish new farms.

iii) Establish protected zones by growing trees and other vegetation on the banks of water bodies and between farms and protected areas.

iv) Keep a vegetation cover wherever possible to avoid bare soils and plant or promote natural growth of diverse trees on land not suitable for agriculture.

v) Use diverse and native tree species that will lead to multiple canopy levels.

vi) Do not collect threatened or endangered plant species.

vii) Do not burn to prepare new land for farming.

4.4 WILDLIFE PROTECTION

▪ In Ghana, the annual ban on hunting and collection of wild animals, otherwise known as 'Close Season" begins on 1st August and lasts till 1st December. This is the breeding season of most of the animals.

▪ During this period it is illegal for anybody to hunt, capture, or destroy any wild animal except the grass-cutter which can be done only under license issued by the Wildlife Division of the Forestry Commission.

▪ There are increased concerns about the effects that farming activities over the years have had on wildlife, with reports of declining numbers of farmland birds, insects, small mammals and rare plant species.

▪ The natural homes of plants and animals have been altered or destroyed due to farming activities such as land clearing, bush burning, application of agrochemicals, ploughing and harrowing as well as logging.

▪ Wildlife exists in a variety of habitats and some species, such as grass-cutters, can thrive in cultivated areas.

▪ Wild animals are our natural resources and require our collective efforts to conserve them. For most farmers wildlife is considered a pest that is directly competing with agricultural activities.

▪ However, wildlife does not have to compete with agriculture; on the contrary, it can benefit the farmers by maintaining a healthy balance in the ecosystem.

▪ It is important for cocoa farmers to produce high yielding quality cocoa.

▪ However, their production objectives should not endanger the survival of wildlife.

▪ Conserve wildlife through sustainable farming with the following activities:

i) Do not resort to bad practices such as bush burning, draining of ponds, or illegal hunting of wildlife animals

ii) Maintain a varied ecosystem as much as possible by retaining semi-natural habitats such as wetlands, forest trees and having a wide mix of crops within the cocoa plantation. This will maximise the insect and seed food sources for wildlife and increase the number of breeding sites.

iii) Keep fertilisers and pesticides away from natural vegetation and water. Pesticides are hazardous pollutants that affect wildlife at many levels. Many pesticides take a long time to degrade and build up in the soils or throughout the food chain.

iv) Predators such as hawks and owls can be harmed if they eat poisoned animals. Some groups of animals which live in water bodies are particularly vulnerable to these chemical pollutants and suffer greatly as a result of the high levels of pesticides in their habitat.

v) Harvesting should respect legislation (i.e. closed season and open season)

vi) Endangered species should not be hunted on any occasion

4.5 FARM WASTE MANAGEMENT

▪ Good waste management on farms is essential to ensure a healthy, safe and productive farming enterprise.

▪ Farmers are obliged to ensure that their waste do not impact negatively on the environment. 'Clean and green' agriculture is of increasing importance to cocoa farmers.

▪ Appropriate management of farm waste can benefit farms by preventing:

i) Contamination of the land and water on farms.

ii) Breeding sites for disease spreading organisms.
iii) Pests and predators.

▪ Avoid or reduce the production of waste by:

i) purchasing only what you need. When purchasing materials, such as agro-inputs, consider the costs of disposal. Where appropriate, buy materials in bulk so that you save on packaging material.

ii) Emptying chemical drums and using containers: all empty chemical containers should be rinsed three times immediately after use to prevent the chemical residue from solidifying in the containers. Then puncture the containers in the base to make them unusable and store them in a secure compound until their disposal is arranged.

iii) The leftover and rinsing liquid can be used to form a part of the spray mixture for the next application or sprayed on cocoa trees.

iv) Care should be taken to ensure that the water used for rinsing does not contaminate the environment - particularly the drinking water.

v) Never burn the containers, because the fumes are toxic.

vi) Also burying of containers is not allowed.

▪ Treat wastes where appropriate
Green wastes can be composted and reused as a fertiliser and soil conditioner. Composting green wastes will assist in destroying weed seeds.

4.6 PESTICIDES

Pesticides refer to any chemical used to kill, repel or control insects, weeds, rodents and other pests. Pesticides are usually classified on the basis of their target species, toxicity, hazard, chemical class or by use. For instance, insecticides, larvicides and fungicides kill insects, insect larvae and fungi and moulds respectively. Rodenticides kill rats, mice and other rodents. Miticides, molluscicides, avicides and nematicides also kill mites, snails, birds and nematodes respectively. Herbicides or weedicides kill weeds. The technical product of these pesticides is the chemical known as the active ingredient combined withother substances which are associated with it during their manufacturing processes. The active ingredient is usually mixed with ther other substances to facilitate its use. It is then known as a formulation. The other substances or ingredients mixed with the chemical in the formulation are the vehicle in the pesticide product. They may be solvents, stabilizers, preservatives and surfactants.

TOXICITY

The toxicity of a chemical is its ability to cause harmful effect in a living organism. The toxicity of a formulation usually varies with the concentration of the active ingredient in the formulation but it can also vary with the non-pesticidal constituents of a formulation or if the other substances associated with the active ingredient exceed their average levels. This normally occurs after long storage. The active ingredients (technical grade) of pesticides are classified (WHO rankings) as follows:

1. Extremely hazardous (class Ia)
2. Highly hazardous (class Ib)
3. Moderately hazardous (class II)
4. Slightly hazardous (class III)
5. Active ingredients unlikely to present acute hazard in normal use

HAZARD

Hazard is the inherent property to cause a potential-harmful effect. Risk is the likelihood that a harmful effect might result from exposure to a particular hazard. For toxicity to occur there must be exposure to a hazardous chemical. Pesticides selected for use on cocoa are expected to meet several safety, hazard and toxicity and residue criteria. Generally, pesticides on the classes **Ia** and **Ib** of the WHO classification are too hazardous for use on cocoa

MODES OF ABSORPTIONS OF AGROCHEMICALS ESPECIALLY PESTICIDES:

Absorption through the skin
Many pesticides form can be absorbed even through the intact skin without showing any marks.

How are they absorbed?

- When dust clings to the skin
- When liquid splashes on the skin
- When skin is immersed in liquid
- When spray mist/rebound spray lands on the skin and dries out.

Factors which will increase the absorption of pesticides through skin exposure:

- Formulation is concentrated
- The skin is warm or sweaty

The absorption of pesticides through wounds, cracked skin and rashes on exposed skin is greater than that through the same area of intact skin.

Absorption through the lungs
Pesticides get into the lungs if gas or vapour is inhaled. Once taken into the lungs, it may be rapidly absorbed.

In what form can pesticides enter the lung?

- Very light dust
- Vapour
- Aerosol
- Fog
- Gases

Pesticides taken through the mouth are absorbed in the gut
This may happen if you eat, drink or smoke at work (during mixing of pesticides and spraying) or without first washing hands after spraying.

4.7 USE OF AGROCHEMICALS

Farmers often apply agrochemicals without understanding the causes of the problems and without knowing how to prevent them in the first place.

- Agrochemicals are often used without selecting the most appropriate and safest product that is registered with the authorities.

- Spraying machines often do not have the recommended nozzle size or are not properly maintained, causing risks of poisoning for the farmer and the environment.

- Farmers must understand that application of agrochemicals must be based on rational use and that they are the last resort in a combination of various techniques to reduce the likeliness that pests and diseases grow out of control.

HOW TO ENSURE SAFE USE OF PESTICIDES

- Take adequate measures such as:

i) Keeping agrochemicals out of reach of children. Only use or store agrochemicals which are permitted by the EPA and COCOBOD/CRIG.

ii) Protecting yourself by wearing protective clothing when applying agrochemicals.

iii) Avoid using chemicals that are banned or not approved in the country for cocoa.

iv) Applying agrochemicals that are suitable for the pest, disease or weed, according to label recommendations.

v) Using the prescribed dosage, timing and intervals of application of agrochemicals as indicated on their labels and train workers accordingly.

Vi) Read label instructions carefully.

vii) Do not buy damaged pesticides.

viii) Do not store pesticides in the bedroom or near food items or farm produce.

ix) Storing agrochemicals in places which are well ventilated and light enough to ensure that product labels can be easily read. When transporting agrochemicals, they must be properly sealed to prevent spillage.

x) Areas for preparing agrochemicals must be equipped for spills.

xi) Plan spraying in such a way as to have no or very little spray solution left.

xii) After applying agrochemicals, place warning signs at the farm to indicate time of application and recommended days until harvest and train workers accordingly.

xiii) Keeping invoices or any other documentary evidence of all agrochemicals used in a safe place and make them available at the time of inspection.

xiv) Calibrate at least once a year and maintain application equipment in order to minimise waste and excessive applications of chemicals.

xv) Empty containers must be triple rinsed, punctured and safely stored. All equipment that has been in contact with hazardous materials must be cleaned and stored.

xvi) Keep records to prove that reliance on chemicals is being reduced gradually.
- Do not use expired insecticides.

- Never stir insecticides mixture with your hands.

- Never suck up liquid insecticides with a tube.

▪Do not blow out clogged spraying machine nozzles or sieve with the mouth but clean them with soap and clear water, using a sponge or brush.

▪Never eat, drink or smoke when spraying.

▪Do not use recommended cocoa insecticides on other crops.

▪Do not work in strong wind or spray against the wind direction. This means that before starting to spray, you must find the wind direction and spray along it.

▪Do not spray agrochemicals when childred are around. Children should leave the form before spraying.

The first step therefore, in the safe use of pesticides is the reading of the label. The label which should be in English or local language should have the following essential parts:

▪The trade name and the approved name of the pesticide.

▪The active ingredients and the hazards it presents (the classification of the formulation

Keep unused pesticides in a locked cupboard but not in the same cupboard as drugs or medicine.

The adverse effects of pesticide use

In the environment pesticides can contaminate soil and animal food on the ground, water and air. This can result in the loss of domestic animals and birds, fish and beneficial insect. Every effort must be made to apply pesticides so that the environment is not harmed.

5.0 GOOD SOCIAL PRACTICES (GSPs)

5.1 FARMER ORGANIZATIONS

There are success stories of farmer associations that have improved the lot of their members. For instance the Kuapa Kokoo Farmers Union in Ghana has built the reputation of furthering the interests of her members by providing credit and extension support. Besides Kuapa Kokoo there are other farmer associations in the cocoa sector.

TYPES OF FARMERS ASSOCIATIONS IN THE GHANA COCOA INDUSTRY

Over the years, five types of farmers' associations have evolved in the Ghana cocoa industry.These include farmers' co-operative marketing organizations, cocoa farmer marketing societies, farmers marketing companies, farmers' production associations and farmers' assistance societies. The objectives of these associations are not much different from each other. In general these associations are interested in the production and marketing of their produce and the acquisition of farm inputs to improve cocoa output and hence to increase their incomes. They mainly target farm inputs including chemicals and equipment for pests and diseases control, and other yield increasing input technologies such as fertilizers at low cost. Other objectives include enhanced ability to mobilize savings and attract capital for farm investments, access to labour at low prices for farm maintenance, improved inputs delivery system, and to serve as a forum for the dissemination of cocoa production technologies.

1. Farmers' co-operative marketing organizations

These are registered co-operative societies that operate according to co-operative principles. In Ghana these organizations consist of primary co-operatives societies at the village or cocoa buying centre levels comprising mainly of cocoa farmers whose main objective is to produce and market their cocoa. The umbrella organization under which the primary co-operatives operate is the Ghana Co-operative Marketing Association Limited which is registered by the Department of Co-operatives.

2. Cocoa farmer marketing societies

These consist of non-registered semi-cooperative primary societies which evolved around the cocoa buying centres in the wake of the dissolution of the United Gold Coast Farmers Convention (UGFCC). The structure is based on formal co-operatives. They are managed by seven-member executive committees consisting of a Chairman, Secretary, Treasurer, and 4 other members. The executive members are elected by voting and are removed or replaced if society members are not satisfied with their performance.Members contribute one kilogramme of cocoa beans on each bag of cocoa brought to the society buying centre as a means of building up capital for the purchase of inputs in bulk for their use on credit basis. This is referred to as the 'kilo kilo' deductions by the farmers. Funds not used for input purchases are used to grant credit to the farmers for other welfare purposes, such as payment of wards' school fees. The 'kilo kilo' deduction funds are also meant to be used as collateral for input credit from other sources. Some of these associations have been successfully used as channels of input credit to cocoa farmers. However, much needs to be done to improve on their performance. Among some of the problems associated with these associations is the lack of accountability on the part of the executive committee of some of the societies. This has led to mistrust and some farmers have stopped contributing to the 'kilo kilo' fund. There are also complaints that the few literates in the societies take advantage of their illiterate counterparts through autocratic control thereby undermining the original objective of democratic control.

3. Farmers marketing input companies

There is currently only one such company in the industry, as a subsidiary of the Ghana Cocoa, Coffee, and Shea nut Farmers Association. The main objective is to improve inputs distribution to cocoa, coffee, and shea nut farmers. The company has set up a number of depots in the cocoa growing areas from where farmers buy their input needs. The initial problems being encountered are in the form of low capital endowments, low managerial skills, lack of sufficient infrastructure in the form of warehouses and haulage trucks.

4. Cocoa farmers' production association

These are relatively new associations which are emerging in the cocoa growing areas. They consist of informal self-help farmer groupings with memberships of up to 300 farmers in some areas and concentrated around

cocoa farming villages and small townships. The main objective of these farmer associations is to assist one another to obtain and apply the latest technological inputs to boost their cocoa production for bulk purchasing and distribution of farm inputs.

5. Farmers' assistance societies

These are also recent forms of farmer associations that are springing up around the cocoa buying centres. The modus operandi of these societies include the mobilization of funds and labour in the cocoa farming communities for carrying out farm maintenance operations, such as weeding, spraying against capsids and black pod and mistletoe control. They also provide inputs on credit payable during the main harvesting season. The main problem with this type of associations is their low capital base for the acquisition of chemicals to improve upon their pests and diseases control practices.

CHALLENGES FACING THE FARMER ASSOCIATIONS

The main limitations of these associations have been lack of capital, low level of managerial skills, and lack of infrastructure in the form of warehouses for input storage and distribution. Their main need is a stronger capital base. Due to discouraging experiences of many farmers as a consequence of the manner in which principles of co-operation were disregarded in the past, many farmers are sceptical and appear unwilling to get involved in formal co-operative activities. It is on record, however, that if farmers are given the freehand to run their own co-operative societies, they can make positive strides in capital mobilization which is essential for the development of an efficient input delivery system to support pest and disease control. The key strategy is therefore farmer education and empowerment to apply co-operative principles in their organizations.

- In order to fight against widespread diseases and pests in cocoa, farmers frequently use pesticides, such as insecticides, fungicides and herbicides in their farms.

- These products can be a serious health hazard for the farmer and his family, either through direct contact when spraying or by contaminating food or water when stored improperly.

- It is important for farmers to store agrochemicals in a safe place and to wear protective clothing when handling and applying agrochemicals

- Training must provide to members and workers who handle pesticides and other hazardous chemicals on the risks of handling these materials and on how to handle them properly.

1. Training must address:

a. How to store safely, especially so that the materials cannot be reached by children.

b. How to understand the product label and other safety instructions made available by the manufacturer. Containers should be labelled indicating contents, warnings, and intended uses (preferably in the original container when possible)

c. how to handle accidents and spills when preparing and applying.

d. how to handle and safely dispose of empty containers, including triple rinsing and

e. puncturing containers o intervals of time when people are not allowed to enter a sprayed area or field without any personal protection equipment.

- Raise awareness amongst all members and workers of the hazards and risks related to pesticides and other hazardous chemicals, even if they are not directly handling these materials.

- Pesticides and other hazardous chemicals must not be applied within 10 metres from ongoing human activity (housing, canteens, offices, warehouses or the like).

- A buffer zone of at least 10 metres must be kept unless there is a barrier that effectively reduces pesticide drift.

- The employer must make work processes, workplaces, machinery and equipment on the production site safe.

- Children under the age of 18 years, pregnant or nursing women, mentally handicapped people, people with chronic, hepatic or renal diseases and people with respiratory diseases must not carry out any potentially hazardous work.

- The employer must ensure alternative work for employees in the case that a change of work is necessary to comply with this requirement.

- The employer must have accessible first aid boxes and equipment and a sufficient number of people trained in first aid in the workplace at all times.

- The employer must provide clean drinking water and clean toilets with hand washing facilities close by for workers, and clean showers for workers who handle pesticides.

▪These facilities must be separate for women and men and the number of facilities must be in proportion to the number of workers.

▪The employer must ensure that workers nominate a representative who knows about health and safety issues and who will raise workers' concerns on health and safety issues with the organization's management.

▪The employer must provide training to workers who carry out hazardous work on the risks from this work to their health, and to the environment, and on what to do in case of an accident.

▪The employer must display all information, safety instructions, re-entry intervals and hygiene recommendations clearly and visibly in the workplace in the local language(s) and with pictograms.

▪The employer must provide and pay for personal protective equipment for all workers who perform hazardous work.

▪It should be made sure that the personal protective equipment (gloves to protect your hands, hat to protect the top of your head, overalls (or comfortable clothes) to protect your body, arms and legs, Boots to protect your feet, goggles to protect your eyes, respirator or mask to protect your mouth and nose, facial mask to protect your eyes, mouth and nose is used and that replacement equipment is ordered and distributed when the existing equipment wears out.

5.3 LIVELIHOOD DIVERSIFICATION

Cocoa farmers depend heavily on income from the sale of cocoa beans to meet their needs. However, it is important that they also embark on other income generating activities to supplement that from cocoa and also minimise risks. Some of the potential income generating activities are as follows:

- Bee keeping
- Grasscutter Production
- Mushroom cultivation
- Chilli pepper production
- Snail rearing
- Maize production
- Cassava/gari production
- Cocoyam

Farmers who are interested in these activities may contact their community extension agents to facilitate training in any of the above topics.

5.4 CHILD LABOUR

CHILD

The different ethnic cultures may define a child differently but legally, a child is a person below 18 years.
Child labour is:

Work that exploits a child by preventing it from access to education and harming its health and/or development **OR**

Work performed by a child which deprives the child of the basic rights, and is abusive, hazardous, exploitative and harmful to the health, safety, morals and development of the child **OR**

Work that denies a child of education or does not allow the child to benefit fully from school, by way of attempting to combine school with heavy work or work for long hours (ILO C138, 182: Children's Act 1998, Act 560).

According to the ILO (International Labour Organisation of the United Nations), child labour refers to work that is mentally, physically, socially or morally harmful to children and interferes with their education by preventing them from going to school or by requiring them to combine school attendance with excessively long and heavy work (ILO Convention 182).

The minimum age for a child to be legally allowed to work is determined by laws in each country and can be set at 14, 15 or 16 years. In Ghana, the minimum age for employment is 15.

Light work or permissible work is any work that is not likely to harm the health and development of the child and does not interfere with their school attendance or their participation in vocational orientation and training programmes.

Not all work carried out by children can be considered **"child labour". Children can do small tasks (at home and on the farm) which are appropriate for their age and level of development during non-school hours. In rural areas children can be found helping their parents with light work in the field or carrying out small tasks in the house. This is not child labour as defined by ILO. As part of their upbringing, children participate in work appropriate to their level of development, and which allows them to acquire practical skills and learn to become responsible citizens. Light or acceptable work forms part of the socialization process and is beneficial to the child's development, inter-generational transfer of skills and future of cocoa production. Such work may include helping parents to care for the home, assisting in family business, earning pocket money outside of school hours and during holidays, and helping parents on the farm during weekends and school holidays.**

PERMISSIBLE WORK IN COCOA PRODUCTION AND RECOMMENDATIONS
(Various age categories below 18 years)

AGE GROUP	ACTIVITY/TASK	RECOMMENDATION
13-14	May accompany parents to the farm during weekends or holidays but do not undertake any specific task	
	Assisting in taking care of babies and toddlers on the farm	
	Helping in cooking and serving food	
	Running farm errands	
	Picking harvested pods from under cocoa trees in the company of adults	
	Uprooting weeds around young cocoa plants	
	Filling nursery bags with black soil/loam	Adequate training
	Fetching water for spraying and leaving the farm before spraying commences	Under adult supervision
	Gathering cocoa pods	
	Scooping and removing beans	
	Carting minor loads	
	Watering seedlings at the nursery	
15-17	Assisting in planting cocoa (require adequate training)	Under adult supervision
	Weeding /brushing undergrowth with age-appropraiate cutlass (sua-ado or small cutlass)	
	Plucking pods within hand-reach	
	Breaking cocoa pods with breaking mallet or hitting on the ground	
	Carting load:	
	a. seedling for planting	Weight carried should not exceed 30% of body weight for more than 2miles (3km)
	b. water for spraying	
	c. cocoa pods for heaping	
	d. fermented beans to drying mat	
	e. dry beans for sale	

ABUSE OF CHILD RIGHTS

Every child has a right to education, a decent livelihood, development and protection, but this is not always the reality in cocoa growing areas (Children's Act 1998, Act 560). As various reports[1] pointed out, many children in West African cocoa areas are engaged in the worst forms of child labour, for example in hazardous work that is dangerous to their health, safety and development. These children carry heavy loads, work long hours in the sun, and some of them are even trapped in forced labour on cocoa farms.

These children typically lack any opportunity for education, leaving them with no way out of poverty. Education for a child is an important step towards securing opportunities and a decent livelihood as an adult.

Many consumers around the world put pressure on the big chocolate manufacturers to take tangible and concrete steps to put an end to worst forms of child labour in the cocoa sector.

If the worst forms of child labour continue, producers may find it difficult to market their cocoa as consumers are increasingly aware that they do not want to consume products made from child labour.

Moreover, child labour constitutes a violation of children's basic rights enshrined in national laws and international conventions.

There exists an international cocoa initiative against the worst forms of child labour.

[1] *E.g. Payson Center for international Development and Technology Transfer of Tulane University, 2007:First annual report: Oversight of public and private initiatives to eliminate the worst forms of child labor in the cocoa sector of Cote d'Ivoire and Ghana; ILO 2005: Combating child labour in cocoa growing*

WORST FORMS OF CHILD LABOUR

Child labour may appear in many different forms. One category of child labour is referred to as 'the worst forms of child labour' and is defined as work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of a child. The ILO Convention No. 182 defines the following **four classes of work as the worst forms of child labour (WFCL):**

1. All forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom and forced or compulsory labour, including forced or compulsory recruitment of children for use in armed conflict.

2. The use, procuring or offering of a child for prostitution, for the production of pornography or for pornographic performances.

3. He use, procuring or offering of a child for illicit activities, in particular for the production and trafficking of drugs as defined in the relevant international treaties.

4. Work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children (hazardous work).[2]

Eliminating these worst forms of child labour should receive the most urgent attention, according to the 171 countries that have ratified ILO Convention 182.Article 3 of ILO Convention No. 182 calls for immediate prohibition of the worst forms of child labour by enacting laws, regulations and standards.

Convention 182 therefore states, among others, that hazardous work should not be done by persons younger than 18 years, but calls for special attention to girls.

Categories 1, 2 and 3 are unconditional WFCL which are illegal activities defined and prohibited internationally for both children and adults work. These demand immediate arrest.

Category 4 refers to Hazardous Work and is one of the WFCL. It is work that poses danger to the health, safety or morals of a person. It could also be a legitimate work, but in dangerous or unhealthy conditions that could result in a child being killed or injured, maimed or made ill as a result of poor safety and health standards and working conditions. In cocoa production, work that is hazardous for the health and safety of children includes:

a. Pesticides application. Children should not be allowed to apply pesticides on cocoa farms. They may fetch water for spraying but MUST not be present during the spraying.

b. Removal of mistletoes. Children using ladder to climb cocoa trees to cut mistletoes is hazardous work and not acceptable

c. Carrying heavy loads. Children should NOT carry weights which are MORE THAN 30% of their body weight. For appropriate loads, the walking distance should not be more than 3km.

d. Use of inappropriate tools. Machetes (cutlasses) and other tools must be of the size and make that children can use.

[2]Sources:

ILO Conventions No. 105 on Abolition of Forced Labour (1957), No. 138 on minimum age for labor (1973); No. 182 on the worst forms of child labor (1999);

STCP, 2002: Child Labor in the Cocoa Sector of West Africa
STCP, 2005: Learning about Sustainable Cocoa Production: A Guide for Participatory Farmer Training,

CRIG, 2010: Cocoa Manual, a source book for sustainable cocoa production

Republic of Ghana,Ministry of Manpower, Youth and Employment, 2008: Hazardous Child Labour Activity Framework for the Cocoa Sector in Ghana (HAF)

CHILD LABOUR IN GHANA

Most countries have signed international agreements with the ILO that state that children aged 12-15 are permitted to carry out 'light work" which is not likely to harm their health or development or attendance at school. In Ghana, the following national laws and programmes exist to protect children against abuse and exploitation:

▪The Children's Act, 1998 (Act 560) protects the rights of all children in Ghana and regulates various aspects of their development.

▪The Labour Act, 2005 (Act 651) makes provisions for the protection of young persons, i.e. persons aged between 18 and 21, from engaging in hazardous work.

▪The Human Trafficking Act, 2005 (Act 694) protects children and adults against trafficking within and outside Ghana.

▪The Domestic Violence Act, 2007 (Act 732) protects

HAZARDOUS COCOA WORK LIST (PROHIBITED FOR BELOW 18 YEARS)- GENERAL ISSUES

PROHIBITED ACTIONS	HEALTH AND OTHER IMPLICATION OF EXPOSURE
Working on the farm for more than 3 hours per day or more than 18 hours per week (for children on weekends, holidays and/or for those who have completed school).	Predisposition to errors leading to accidents and injuries, increased exhaustion affect education and health (even hired adults work for maximum of 4-6 hours)
For children in school, working more than 2 hours/ day on a school day.	
Working without adequate basic protective clothing for their feet and body (e.g. long sleeves, trousers and 'Afro Moses')	Injury from thorns, tree stumps, snake and other reptile bites, insect bites, contact with toxic irritant plants.
A child working alone on the farm in isolation (i.e. beyond visible or audible range of nearest adult)	Prone to abduction, defilement, indecent assault and rape; no help in case of injury or accident.
Going to or returning from the farm alone or working on farm between 6.00pm and 6.00am	Poor visibility leading to slips and falls, snake bites and injuries.
A child withdrawn from school during cocoa season to do farm work.	Child losing out on education, leads to school dropouts and failures
Working full time on farm and not attending formal/ non-formal school (applicable to children under 15 years)	Increases tendency to participate in hazardous work, deprivation of the benefits of education.

children from being abused in the domestic setting. This may include protecting children from worst forms of child labour that may take place within the household.

▪The National Programme for the Elimination of Worst Forms of Child Labour in Cocoa (NPECLC) provides a national framework for eliminating WFCL.

▪The Hazardous Child Labour Activity Framework for the Cocoa Sector in Ghana (HAF).

FACTORS FOR DETERMINING CHILD LABOUR

1. Age: three groupings for admission to various categories of work [Section 89 of the Children's Act, 1998 (Act 560)]

▪ Children who are 13 years and above can do light work (work which is not harmful to the child's health or development and does not affect the child's school attendance or capacity to benefit from school work):

▪ Children who are 15 years and above can be employed in normal work:

▪ Children who are 18 years and above can do hazardous work

2. Type of work (whether or not it exposes the child to hazards)

3. Working condition and environment (whether or not the environment is healthy)

4. Working tools (whether or not the machines or equipment are dangerous)

5. Working hours-Children should not work:

▪ At night (8pm to 6am)[Sect 88 of Act 560]
▪ For long hours i.e. more than 2 hours during school days or 3 hours during non-school days.

WHAT ARE THE CAUSES OF CHILD LABOUR?

The causes of child labour are manifold but grouped under five main groups:

ECONOMIC FACTORS:

Low agricultural productivity, insufficient financial management skills (e.g. lack of savings), lack of access to financial services and lack of business skills (how to run the farm as a business) are some of the contributing factors to low farming incomes.

Low incomes may force some farmers to reduce costs of labour by using their own children or employing other children as they are paid little or nothing for their work. Children work in cocoa production mainly because their parents and adult relatives do not earn enough to support the family and to employ adult labour for the cocoa farm.

INADEQUACIES IN EDUCATION SYSTEM:

Lack of access to relevant quality education. There are inadequate schools, not enough teachers, school fees and other costs, etc.

SOCIO-CULTURAL FACTORS:

Structural inequalities, gender-based discrimination as well as lack of education on the part of the parents may constrain them from seeing the necessity to send their children to school. Sometimes parents are not aware of the dangers of involving children in certain activities. The children of sharecroppers, migrants and seasonal workers are particularly at risk to have to work on farms, as their families usually are poor and need their children's help to improve incomes.

NATURAL DISASTERS:

Conflict, the HIV/AIDS epidemic, environmental disasters may predispose children to child labour.

WEAK INSTITUTIONAL CAPACITIES:

Poor law enforcement may exacerbate child labour conditions

WHY SHOULD COCOA FARMERS PREVENT CHILD LABOUR?

▪The consequences of child labour are that it creates a cycle of poverty, puts children at unacceptable risks, and negatively affects their future since it may prevent them from getting education resulting in high illiteracy, and/or a healthy physical and psychological development. This means that these children will later find it difficult to improve their living conditions because they lack the necessary education.

▪It should be understood that children are exposed to higher risks of accidents than adults during work because of their lack of work experience and knowledge of hazards, and how to prevent them. As the bodies of children are still growing, carrying heavy loads and using heavy tools can lead to serious or even permanent injuries and malfunctioning of organs.

▪Children are also much more vulnerable to the exposure of pesticides than adults. Chronic long-term health effects from exposure to pesticides may only appear much later and affect the health and livelihood of the child and its family.

WHAT CAN FARMERS AND COCOA COMMUNITIES DO TO PREVENT WORST FORMS OF CHILD LABOUR?

▪First of all, farmers have to understand that children who are engaged in child labour (as defined above) are prevented from developing their bodies and minds healthily in a way that they become successful, responsible members of the community.

▪Nourishing the children healthily and allowing them to go to school regularly is probably the best and most important thing parents and guardians can do. Children may be engaged in cocoa farming but not in the execution of hazardous activities, or in work that negatively affects their education.

▪Farmers can also do a lot to improve their living conditions so that they don't need to resort to child labour.

▪Education (formal and informal and both for parents and children) is the key to overcome child labour and to improve the family's livelihood. Wherever possible, farmers (both men and women) should take part in educational programmes offered by the government or NGO's.

▪Forming or joining farmer groups and organisations helps to discuss this issue and to learn from each other.

▪The development of Internal Management Systems (IMS) could provide proactive alerts to farmers of child labour and ways to address it, in particular communities where this form of labour remains common. Communities can organise themselves to monitor the existence of the worst forms of child labour and take action if necessary.

▪The individual farmer can reduce the dependence on cheap labour by improving the productivity of his farm and hence income through keenly following advice on good agricultural practices as described in this curriculum.

▪Farmers should learn to understand their farms as a business in order to better plan expenditures and incomes, and to improve their savings ratios, which is necessary for investing further in their cocoa farms or in alternative income generating activities.

MEASURES FOR ELIMINATING CHILD LABOUR

▪Raise awareness among producers to dialogue with them on worst forms of child labour (WFCL), child labour and the importance of education.

▪Where there are indicators of exploitation/trafficking of children, the farmer group/organisation reports these cases to the relevant authorities.

▪Children who are carrying out work on the farm must always be accompanied and supervised by one of their parents, a legal guardian, or an authorized adult.

▪The farmer group/organisation employing young workers aged between 15 and 17 (Ghana) must keep

records including date of birth, names of parents or legal guardian, place of origin and permanent residence.

In addition to the above measures the hazardous child labour framework has provided a number of recommendations which will serve as a guide to parents and guardians with respect to children's involvement in cocoa activities.

GENERAL RECOMMENDATIONS FOR CHILD PARTICIPATION IN COCOA PRODUCTION

No.	Recommendations
1.	All children of school going age should be in school and should not go to the farm during school hours or go to a distant farm before or after school or be withdrawn to do farm work in peak seasons. Children from the age 12 can do light (age recommended as permissible) work but not for more than 2 hours and preferably after school.
2.	All children who accompany their parents to the farm should be provided with basic protective clothing at least to protect their feet and body.
3.	Ideally, provide bite-proof protective boots with non-skid soles to prevent snake bites, slips and falls e.g. children's wellington boots. In the absence of this 'Afro Moses', canvas or any boot is recommended. Going to farm barefoot is hazardous and bathroom slippers are not acceptable.
4.	Body protection in the form of trousers, long sleeves and long dresses is recommended.
5.	Sun hat is recommended on hot and sunny days
6.	Incorporate at least 10 minute breaks hourly for children in the different acceptable age categories; they should not work for more than 3 hours a day
7.	Adults must sufficiently train a child for any farm work (even the basic ones) before assigning duties.
8.	Ensure adequate intake of drinking water hourly to prevent heat stress.
9.	Load carried should not exceed 30% of body weight if farm is far (>2 miles or 3km). If the farm is farther, reduce carrying weight or have rest stops.
10.	Lifting /handling/ carrying loads over short distance (500m) should not exceed 50% of body weight.
11.	In assigning permissible load to a child, adequate adjustment is required if the terrain is unfriendly. This is particularly the case in hilly and slippery terrains when it rains. It is also applies when crossing a river with heavy loads.
12.	Stop children below 18 years from working with pesticides, even if Personal Protective Equipment is provided.
13.	Children should stay at distances where they do not smell pesticides. Fetching water for sprayers during spraying when sprayers run out of water is inacceptable.
14.	Sick children should not be made to work under any circumstance.
15.	Attaining 18 years is no license to engage in all cocoa activities. Persons 18-24 years should be well protected, and engagement in any hazardous farm work should be graded until maturity, experience and training permits.

Adapted from Amoo (2008)



Fig 21.1: Children accompanying parents to the farm (This is acceptable)





Fig 21.2: Children carrying loads in cocoa communities in Ghana (Credit: MMYE, 2008)





Fig 21.3: Range of baskets and machetes (cut-lasses) used by various age groups in cocoa communities in Ghana (Credit: MMYE, 2008)



Fig 21.4: Community sensitization on child labour in a cocoa community (Credit: MMYE, 2008)

TRACEABILITY AND COCOA CERTIFICATION

6.0

6.1 TRACEABILITY

To monitor and provide feedback on quality issues, it is necessary to be able to know where cocoa beans were produced. Ideally, it should be possible to trace a lot of beans from the end user back to the farmer or farmer group who produced it. However, the smallholder nature of the crop and the mixing and blending export systems make traceability a difficult task.

Consumer expectation means that cocoa and cocoa products have to be of the highest quality. Governments, consumer organisations, health experts, and the media are taking an increased interest in food safety and in residue and contaminant issues which might cause damage to health. Therefore, in a sustainable cocoa economy, cocoa quality with respect to food safety is of paramount importance, exceeding even physical and flavour quality needs. The cocoa supply chain has several features which make the implementation of quality and food safety standards difficult.

6.2 CERTIFICATION OF SUSTAINABLE COCOA

CERTIFICATION AND TRACEABILITY

Certification is a procedure by which an independent inspection body gives a certificate that a farm, farmer group, processing facility, trader, importer or exporter has been assessed and is adhering to specific standards (e. g. such as Fairtrade International (FLO), UTZ Certified, or Rainforest Alliance (RA). The certification is intended to ensure that the cocoa sold under the seal of the standard organisation does actually originate from a farm or operation that produces according to the relevant standards. Certified producers and traders of cocoa must show documentary traceability, i.e. contracts, bills of lading, delivery notes, invoices, etc. that show where a product was sourced and to where it was sold. The independent inspection body checks the documentation to make sure equivalent amounts of sustainable cocoa were bought and sold, thus tracking the quantity of sustainable cocoa through the supply chain.

Certification is the process of confirmation and recognition given to an individual, organization, process, service, or product or farm that it meets certain established criteria, often through external (third party) assessment of compliance to a standard and often voluntary. In simple terms, Certification is a procedure that helps farmers to follow good farming practices. These farmers receive a certificate from a certification organization.

WHY CERTIFICATION?

People who buy products made from cocoa do not want cocoa that was produced by bad practices, such as destroying the forest, using worst forms of child labour or not treating workers well. In effect people who buy cocoa and chocolate want cocoa that has been produced under the following conditions:

i. Good agricultural practices (examples are: pruning, weeding, sanitation, safe use of chemicals, fertilisation.)

ii. Good environmental practices (examples are: water and forest protection, safe waste disposal.)

iii. Good social practices (examples are: sending children to school, fair treatment of workers, keeping records.)

Farmers who want their produced certified are required to adopt good agricultural practices and best environmental practices, promote the health and safety of farm workers and ensure quality of produce. In effect people (social), planet (environment) and profits (productivity) must be sustainably managed well. Certified cocoa earns farmers extra income in addition to what Ghana Cocoa Board pays.

BENEFITS OF CERTIFICATION TO FARMERS

Farmers who undertake certification stand the chance to get higher yields and better quality of their beans, leading to higher incomes.

With better records, the group can manage themselves better and will discipline themselves to follow the good advice of the cocoa extension agents.

Farmers are assured of better living and working conditions. Health and safety of the farmers are ensured and labour rights are respected.

By respecting the social and environmental criteria/requirements, the families and communities in the cocoa farming areas will enjoy a higher quality of life, with greater female participation, better educated children, protected biodiversity and more sustainable access to natural resources.

Farmers will get higher yields and better quality of their beans, leading to higher incomes.

Farmers are able to learn from each other, better manage their farms and solicit support for their groups.
As a group, the farmers may be able to negotiate better prices for farm inputs or gain better access to credit.

Benefits of certification to consumers
Consumers have better and clear information about food origin (traceability).

Consumers trust in produce quality is assured and there are reduced risks to their health and safety.

6.3 STEPS TO CERTIFICATION

There are 4 main steps to certification
Extension agents must help farmers

1. Organized farmer group

Explain to farmers what certification entails and the benefits thereof. Each farmer can decide, if he or she wants to join the group or not. The group members discuss, if they want to get certified or not.

2. Develop an Internal Control System (ICS)

Farmers develop their own ICS. An ICS is a system within the farmers' group that helps individual members to manage their farms and comply with the certification requirements. The group can only function, if all of its members follow the rules of the group. The ICS makes certification easier and less expensive. Some standards organizations (Rainforest Alliance and UTZ Certified) require a full ICS, Fairtrade only requires some elements of it.

ICS ensures farmers have records of their farms and activities. These include:

- a register of all group members and a map of all the farms
- a profile of each farmer and her/his farm (including history and data on land use)
- Information about production: both past and estimates for the next harvest
- A copy of each farmer's commitment to work towards the certificate
- Information about the training received by the farmer
- Information about which inputs have been applied to the farm
- Reports of any farm inspections
- A list of chemicals / fertilisers recommended by the extension agent
- Records of any group decisions relating to the certification activities
- A diagram explaining who is responsible for certification activities
- Information about the traceability system
- Information about how any 'premium' is used to benefit the farmers

3. Organize inspections

The group organizes inspection. There are two inspections:
a. An internal inspection which is done by the ICS inspector, who can be a member of the group
b. An external inspection that is done by an independent inspection company.

4. Apply for certification

If the group wants to get certified, then they must apply for certification to one or several of the standards (Rainforest Alliance, UTZ Certified, Fairtrade, Global GAP). Each standard has its own criteria or requirements.

The different certificates reflect the different concerns of the people buying the cocoa, for example:

(1) social issues (e.g. the worst forms of child labour);

(2) environmental issues (e.g. protecting natural resources like water);

(3) sustainable farming methods (e.g. integrated pest management and good soil conservation practices to maintain soil fertility for tomorrow's cocoa farmers);

(4) fairer/minimum prices for the farmer; or

(5) a mixture of all of these concerns (1) – (4)

An individual farmer can get certified but more expensive. Group certification is less costly. A group of farmers can also work towards achieving two or more certificates at the same time. This would increase their chances of selling the cocoa at a premium, as they would gain access to a larger share of the market for certified cocoa.

WHICH TYPES OF CERTIFICATION EXIST AND HOW CAN I FIND OUT MORE?

UTZ Certified
www.utzcertified.org

The **UTZ Certified** vision is to support cocoa farmers to become professionals implementing good practices which lead to better businesses, whilst also addressing social and environmental issues.

Therefore the **UTZ Certified** certificate focuses on rewarding cocoa farmer groups that practice sustainable farming methods (as outlined in previous chapters of this manual), and includes criteria relating to social and environmental issues too.

Premiums received for UTZ Certified cocoa are spent in a way that clearly benefits all certified producers, in cash and/or in kind.

For more information contact:
WAFF represents **UTZ Certified** in Ghana:
admin@waffco.org or 021 232376

Rainforest Alliance
www.rainforest-alliance.org

The Rainforest Alliance works to conserve biodiversity and ensure sustainable livelihoods by transforming land-use practices, business practices and consumer behavior. Farmer groups that participate in its programs meet rigorous standards that conserve biodiversity and ensure sustainable livelihoods.

Farms that meet its comprehensive standards for sustainability earn the **Rainforest Alliance Certified™** seal. These standards conserve biodiversity; ensure that soils, waterways and wildlife habitats are protected; and ensure that the rights and welfare of workers, their families and communities are protected.

The **Rainforest Alliance** certificate therefore encourages cocoa farming practices that are sustainable over the long term by maintaining a healthy environment, decent working conditions and protecting local communities.

IMO Social & FairTrade Certification

www.fairforlife.net

IMO Social & FairTrade Certification guarantees that human rights are guaranteed at any stage of production, that workers enjoy good and fair working conditions and that smallholder farmers receive a fair share. Fairtrade improves the livelihood of thousands of smallholder farmers and workers by providing the means for social community projects and empowerment of people.

For more information contact:
Aaron Ampofo, aaronipapa2@yahoo.com or 0244...

Fair Trade
www.fairtrade.net

Fair Trade is an organized social movement and market-based approach that aims to help producers in developing countries and promote sustainability. The movement advocates the payment of a higher price to producers as well as social and environmental standards in areas related to the production of a wide variety of goods.

Fair Trade certified cocoa must be grown and harvested in accordance with the international **Fairtrade** standards set by FLO International. The supply chain must also have been monitored by FLO-CERT, to ensure the integrity of labelled products.

- The minimum price paid for **Fair Trade** certified cocoa is guaranteed, so if prices for conventional cocoa drop below this level, farmers receive a better price for their cocoa.
- The **Fairtrade** premium is used by farmer groups for social and economic investments within their communities.
- Pre-harvest lines of credit are given to the farmer groups, if requested, of up to 60% of the purchase price

For more information contact:
Edward Akapire, Liaison Officer, FLO International
e.akapire@fairtrade.netor 0208493339 / 0243523300

Organic certificates

Organic certification addresses a growing worldwide demand for organic food. The criteria vary for each organic certificate, and generally involve a set of production standards for growing, storage, processing, packaging and shipping that include:

- avoidance of most synthetic chemical inputs (e.g. fertilizer, pesticides, antibiotics, food additives, etc), genetically modified organisms, and the use of sewage sludge;
- use of farmland that has been free from chemicals for a number of years (often three or more);
- maintaining strict physical separation of organic products from non-certified products.

For more information contact:
Ghana Organic Agricultural Network,

adimadosam@yahoo.com or 0244 580 720; coordinated by Agro Eco-Louis Bolk Institute Ghana@louisbolk.org or Agro Eco Ghana@agroeco.net. -0302786097; or Dr. Defenzi Schandorf - 0206369244

6.4 RECORD KEEPING AND TYPES OF FARM RECORDS

It is impossible for the human mind in spite of tremendous power to remember or recall everything all the time. Record keeping is therefore essential for any form of organization. Farm record can serve as a powerful tool in farm organization. By keeping records and recording important information, the farmers can analyze the information to identify possible problems and take corrective actions.Some of the main use that farm record can be put to include the following:

▪Planning purposes – guide for future decision making.

▪Calculating cost and benefits – ascertaining the financial positions of the farm. This can then be used a basis for determining the credit worthiness of the business and for purposes of taxation.

▪Budgeting purposes – future targets and projections.

▪National statistics and national planning – lack of any reliable farm level data has been one of the greatest constraints to agricultural production and hence economic development of most developing countries. Lack of accurate data from the farm sector can contribute partly to poor performance of economic predictions in many third world countries, and this is because the farm sector is usually the largest sector of their economies, contributing a substantial portion of the national product and employing the largest percentage of their labour force.

▪Environmental regulations: Increasingly, farm owners are being asked to keep records about chemical use, livestock waste applications and irrigation water use on their farms. This is particularly becoming increasingly important for certification in cocoa.

SELECTING A RECORD-KEEPING SYSTEM

Selecting a record-keeping system should depend on the expected use of the records. There is no best record keeping system for all situations, however, a farm records system should:

1. Provide accurate and necessary information
2. Fit into the farm organization or framework
3. Be available in a form to aid decision making

Generally, records should be easy to keep and should give the necessary information when required.Depending on farm size and affordability, record keeping could be carried out by clerks employed by the farmer or by the farmer's educated children or by the farmer himself if educated.Very simple forms of record keeping like using pieces of sticks, marbles and pebbles have been used over the ages by African farmers to count crop yields and number of animals.However, with increasing monetization of the economy and share of farm produce ending up in the market, more modern means of record keeping, involving the use of paper, need to be encouraged in addition to the simple traditional record keeping. This could be done even with small note books.

1. Records of farm assets and liabilities, income and financial records coming under the general heading – farm accounting.
2. Production records, including crops and live stock where applicable.
3. Labour records
4. Supplementary records

FARM ACCOUNTING

The basic concepts of farm accounting include:

a. Cost concept, where the farmer records the amount he actually pays for the good or service or how much he is paid for his produce. The opportunity cost of produce consumed by the farmer, gifts and labour used by the farmer in production are all important components of this concept in the African context and must be considered.

b. Dual aspect concept where assets of the farm must always be equal to equities. Equities consist of liabilities which are what the farm owes to its creditors and owners equities which are what the farm owes to its owner. The owners' equity or net worth is that share which belongs to the farmer or the owner.

c. Consistency concept where methods and concepts used in keeping records are consistent.

Records of assets and liabilities involve identification, quantifying and valuations of all inputs and outputs from the farm.Depreciation of machinery and equipment and other long term assets of the farm must be taken into account.Financial Records are normally used to derive balanced sheet and income statement. All transactions of the farm may be kept in an improvised book or an accounts book called the journal. The journal records all receipts and expenses of the farm during a period and is sometimes called the daily diary. It records all transactions chronologically or on a day to day basis. An example is shown below for a small farm in **Table 20.5.1**

TABLE20.5.1: JOURNAL OF ANCHIRINAH FARMS

Month: August, 1997

No.	ITEM	DATE	AMOUNT	REMARKS
1.	Purchased spraying Machine from Agricare	4/8/97	¢150,000	Expenses
2.	100 crates of eggs sold to Mr. Haruna	11/8/97	¢500,000	Revenue
3.	Poultry feed bought Kumasi central market	25/8/97	¢250,000	Expenses

In addition to the journal, another record can be kept on all produce used by the farmer's family. This is particularly important in the African context since a greater portion of the farm produce is consumed by family. In the same vain all inputs supplied by the farmer's family for production purpose must also be recorded. An illustration is shown in **Table 20.5.2.**

TABLE 20.5.2: FARM PRODUCE USED BY FAMILY AND HOME SUPPLIED FARM INPUTS FOR ANCHIRINAH FARMS:

Month: April, 2009

DATE	ITEM	VALUE	REMARKS
8/3/2009	5 bowls of millet	Gh¢3	consumed by home
9/3/2009	1 crate of eggs	Gh¢5	consumed by home
13/3/2009	2 goats for Logori Festival	Gh¢60	Consumed by extended family
16/3/2009	Maize seed supplied	Gh¢3.5	Used for maize farm

Total home supplied input for month = Part of cost of production of the farm

Also a separate account may be kept for debtors and creditors along side the exact amount of cash or inputs owned to the farmer and/or his creditors. For very large farms, ledgers may be kept. A ledger is a principal book for farm accounts into which transactions from the journal may be transferred. At the end of the year or the farming season, income statements and balance sheet can be prepared to give the farmer a better idea of his/her income and general progress in farming.

A balance sheetis a statement shows the financial position of the farm at any point in time, e.g. balance sheet of Anchirinah farms as at 31st December, 2009. The uses of the balance sheet to farmer include the following:

1. It shows the need for reorganization or liquidation of the farm especially for commercial and large scale farms.

2. It shows the lender or the Agricultural Development Bank the extent of risk involved in extending credit.

3. It may establish the kind and amount of credit that is needed.

4. It may also be used for taxation purposes

Balance sheet computation also involves assembling both assets and liabilities.

PRODUCTION RECORDS

Though income and finance records are essential for

the planning and control of the farm, special types of records are needed for production of crops and livestock on the farm. They are called Production Records and are made up of crop and livestock records if the size of livestock farm is large.Crop records normally contain details of crops grown such as varieties, the date of planting and harvest, the amount of seeds and other inputs used in the production process and yields. Livestock records should be kept and ideally separated from different types of records. They may be kept for each livestock enterprise and may involve special records for feed intake, antibiotics among others. Record of diseases may also be kept. An example of general live stock records is shown in **Table 20.5.3**

LABOUR RECORDS

These may be separately kept from all other records and should include payments made in cash or in kind. A wage book may also be kept specifically for all hired labour used on the farm. Record of non-hired labour which includes those of family and communal labour must also be kept.Refer to Table 20.5.4 for an example of a seasonal labour record chart for hired farm labour. Past labour records can act as guide in determining labour requirements of particular crop and live stock enterprises for future planning purposes.

TABLE 20.5.3: A GENERAL SIMPLE LIVESTOCK RECORD BOOK FOR A SMALL LIVESTOCK FARM

Month: April, 2004

CLASS OF ANIMALS	NO AT THE BEGINNING	BOUGHT OR RECEIVED AS GIFT	BORN	TOTAL	DIED	SALES OR SLAUGHTERED	PRESENT NO.
	(a)	(b)	(c)	(d)=a+b+c	(e)	(f)	d-(e+f)
Goat	20	2	1	23	3	5	15
Sheep							
Poultry							
Pigs							
Rabbits							
Other							

TABLE 20.5.4: LABOUR CHART FOR HIRED FARM WORKERS ON A FAR

Date	Worker's Name	Duration of work (hrs)	Nature of work	Payment in kind (food/ drinks, etc)	Payment in cash	Total payment
15/3/09	Akua Fokuo	7	Weeding	4	12	16
16/3/09	Kwame Doogo	8	Harvesting	5	18	23
'	'	'	'	'	'	'
'	'	'	'	'	'	'
'	'	'	'	'	'	'
'	'	'	'	'	'	'
'	'	'	'	'	'	'

SUPPLEMENT RECORDS

These are records kept because of their special role in farming and may include soil maps, farm map, specifics from field maps, rainfall data, records for land and legal documentsand any special records of any part of the farm. Tape recorded oral history and written history of land acquisition and procurement by previous and past clan lineages and elders of land may be kept so as to aid future possible land litigation or other legal problems. With emerging issues like certification some of these records may become increasingly important.

FARM RECORDS ANALYSIS AND INTERPRETATION

It will be of no use and in fact a complete waste of time and resources by merely keeping records if they are not analysed to identify problems and seek their solutions. These will help prevent waste and improve efficiency by aiding general management decisions to control and evaluate current or projected farm plans and to help in planning of possible expansion of the farm.Analysis of farm records may be done by computing several measures. Standards of comparison with these computed measures may be the budgeted objectives, standards set by the farmers themself or certain technically achievable optimums from research and/or extension. Some of the measures that farms record can be used to compute include the following:

a) Net farm Income which is the difference between the total farm revenues and total expenses. Net returns per various factors of production like labour, land and capital can also be computed. These net returns ratios can then be used to compare a particular farm with other farms or with the average or a model farm to determine whether the farm is doing reasonably well compared with the other farms in the area.

b) Efficiency of crop production is analysis of records on crops to compute measures such as a crop yield per hectare, returns per hectare and net returns per hectare. Other measures include the crop yield index defined as:

Crop Yield Index (CYI) = [(Actual Crop Yield)/Normal or average crop yield] x 100

If CYI is grater than 100%, then actual crop yield is higher than average or normal crop yield. The reverse is also true.

c) Labour efficiency measuresinclude total labour costs per hectare of crop, net returns per manday employment on the farm, amount of work accomplished by each hired labour and input index.

Labour input index may be defined as the amount of work accomplished by a particular worker divided by the amount of work completed by standard or average worker within a given period of time. Such an index may help in some cases to determine whether a worker is intentionally slack on the job or some thing is preventing him from doing average work.

The importance of farm record keeping in any farm enterprise cannot be over emphasized. These records are essential not only at the farm level but for national planning as well. The current focus of development thinking is that, if development is to take place in the third world and become self-sustaining then it has to start in the rural areas in general and in the agricultural sector in particular which is the main source of livelihood of the rural majority. No proper or meaningful planning can be done based on wrong and unreliable assumptions or data as these will certainly lead to wrong conclusions and projections. What happens in the agricultural sector therefore have serious implications for the other sectors of the economy. Adequate and reliable farm level data will help in efficient production, and allocation of resources through an efficient marketing system.

EMERGING ISSUES IN THE COCOA INDUSTRY

7.0

7.1 PESTICIDE RESIDUES

Pesticide residue is the amount of the active ingredients that remain on or in the produce after a given pesticide has been used to protect the produce. The level of such residue left in or on the produce depends on the pesticide concerned and the method of application. Pesticide residues dominate the food safety issues on cocoa in Ghana. Production of high quality cocoa requires the judicious use of protective pesticide applications to ensure the quality and yield of the crop. Cocoa attracts a lot of pests and disease agents, so the crop must be protected with proprietary products approved by COCOBOD. Risks associated with use of chemicals must be managed so that they do not harm the users, damage the environment or poison consumers.

Pesticides need to be applied in a safe and sustainable way that does not threaten the health of the operators using them, present risks to the environment, or result in illegal residues. The allowable level of pesticide residue in any produce with special reference to cocoa depends on the class of the pesticide in question. Hence different levels of different pesticides are permitted in cocoa. The safety aspects including real and potential risks to growers and consumers have led to the need for regulatory measures in the form of determination of Maximum Residue Levels (MRLs). All cocoa export to the EU, Japan and elsewhere can be subjected to analysis to detect the presence and quantity of chemical residues. In the EU and USA, samples of cocoa beans are first de-husked before residue analysis takes place, whereas whole beans are analyzed in Japan (which is more likely to result in residue violations).

In Ghana, Cocoa Research Institute of Ghana and the Research Department of QCC evaluate pre-harvest and postharvest pesticides, respectively for use against targeted pests after which residues and tainting are determined. A product is recommended to COCOBOD for use on cocoa when the level of residue is lower than or is in conformity to existing MRLs set by Codex, EU, USA (EPA) and Japan.

The Research Department of QCC further carries out monitoring of the levels of residue of the active ingredients of pesticide being used on cocoa and offers advice on how to properly tackle violations.

7.2 OTHER CHEMICAL AND BIOLOGICAL RISKS FOR COCOA

Recent advances in food safety management have highlighted potential food safety risks associated with contamination of cocoa with cadmium, ochratoxin 'A" and polycyclic-aromatic hydrocarbons (PAH). The EU has already established maximum residue levels (MRL) for PAH's in cocoa and cocoa-products. It seems likely that MRL's will be introduced for cadmium and ochratoxin 'A".

Heavy metals - Aside pesticides, the main potential food safety risks are possible contamination with cadmium, zinc and lead. A cocoa tree can take up soluble nickel and cadmium salts and concentrate the metals in the cocoa beans. Therefore, the risk here would be due to either planting of trees in soils rich in cadmium or nickel salts or more likely, as a result of applying sub-standard inorganic fertilisers (often containing cadmium salts) or sewage sludge obtained from areas subject to industrial pollution such as 'galamsey' sites. In 2007 a defective batch of fertilizer caused high levels of cadmium in pineapples. In the Ghanaian context the most likely source of heavy metal contamination would come from use of cheaper non-approved inorganic fertilizers. The most likely contaminant from cheap fertilizer is cadmium; COCOBOD therefore, insists on analysis of fertilizer before approval and supply to cocoa farmers. Lead is a metal that has caused poisoning, and young children are particularly susceptible. Cocoa trees are unable to take up soluble lead salts directly from soil, but wet cocoa beans will absorb soluble lead salts if they come into contact with contaminated material.

The most likely routes for contamination would be drying of wet beans in contact with contaminated soil or via exposure to contaminated dust. Some soils are naturally rich in lead salts but lead can also enter the environment from industrial sources and also from petroleum products in countries that still sell leaded petrol. Fortunately, however, Ghana has phased out leaded petrol, so this is not an issue

Cadmium: Cadmium can cause kidney failure and has been statistically associated with an increased risk of cancer. Cadmium is the heavy metal that is of most concern. The Codex Committee on Contaminants in Foods (CCCF) concluded in 2013 that total cadmium dietary exposure for high consumers of cocoa and cocoa products was unlikely to be of concern, but legislators in the EU are becoming more aware of the metal as a contaminant. The European Food Safety Authority Scientific Panel on Contaminants in the Food Chain has recommended that the provisional tolerable weekly intake (PTWI) should be 2.5 µg/kg body weight. This is to ensure a high level of protection of all consumers, including exposed and vulnerable subgroups of the population. They found that chocolate products contributed 4.3% of dietary exposure.

Contamination of cocoa beans with cadmium may be due to use of phosphate fertilizers containing unacceptable levels of cadmium contamination. This is a potential issue for Ghana as there is no regulatory system in place for testing heavy metal content of phosphate fertilizers. Limited scientific evidence indicates that levels in beans are not at significant levels in Ghana, but some of the cheaper fertilizers contained levels, which would raise concerns. The cadmium MRL's do not apply to whole beans as parts of the whole bean (outer shell) are not used as food.

Ochratoxin 'A" (OTA) is a toxic metabolic by-product of the growth of a mould, Aspergillus ochraceus on the outer shell of the cocoa bean. Moist cocoa beans contain sufficient moisture for the fungus to grow on the seed coat, but proper drying reduces moisture content to 5-7.5% preventing the fungus from growing. However, the beans are highly hygroscopic and can rehydrate if inappropriately handled post drying or simply not dried properly in the first place. If the moisture content reaches 8% or higher this represents a water activity (available water) of between 0.75 and 0.85 in the outer shell of the bean, which will consequently allow growth of A. ochraceus and OTA formation. The fungal spores are likely to be present on most cocoa farms in Ghana, and reservoirs of infection will be provided through the presence of decaying waste materials such as discarded pod husks and rotting pods either on the trees or left on the ground under the trees. Transfer of fungal spores to the beans is most likely to occur if the pods are damaged during harvesting but could also occur during drying if contaminated materials are left close to the drying mat. EU regulation EC/1881/2006 mentions the possibility of OTA in fermented cocoa beans and cocoa powder but does not establish any maximum residue limit due to the low-level of risk to human health represented by these products. This position was challenged in 2009, but the European Food Safety Authority (EFSA) concluded in 2010 that there was no scientific evidence to support changes to specifications for OTA stated in EC/1881/2006 (EFSA 2010).
Polycyclic-Aromatic Hydrocarbons (PAH) – PAH's are a large group (~660 compounds) of toxic and carcinogenic substances that are formed through the incomplete combustion of coal, oil or other fuels such as wood. The most relevant compounds are a smaller group of 16 compounds that are non-volatile, highly persistent and fat soluble. The most toxic compounds are benzo(a) pyrene, benzo(a)anthracene, benzo(b)fluoranthene and chrysene (often grouped together as PAH4).

The most likely contamination routes for PAH's onto food is via processes such as smoking, heating or drying if the combustion residues come into contact with the food. In drying, contamination will occur if a direct heating system is used. Indirect heating systems are safer but problems can occur if combustion gases leak into the air stream or if the exhaust gases are poorly ventilated.

Other contamination routes include exposure to motor-fuel combustion products if cocoa-beans are dried along the edge of a road, and contamination during storage if beans are kept close to leaking containers of fuel oils. PAH's usually contaminate the outer shell of the bean but being highly fat soluble and stable, they will accumulate in the cocoa mass and carry through into final products such as chocolate if the beans are damaged. There is some evidence of limited direct migration of PAH's into the cocoa nibs.

APPENDICES

APPENDIX 1 - FERTILIZERS APPROVED FOR USE ON COCOA

GRANULAR FERTILISER (INORGANIC)	NUTRIENT CONTENT	RATE PER ACRE (50kg/BAG)
Asaasewura	NPK 0-22-18+9CaO+75+MgO	3 Bags
Cocofeed	NPK 0-30-20	3 Bags
Cocoa Master	NPK-1-21-19+9CaO+65+6MgO+18	3 Bags
Dua Pa	NPK 3-25-18-7CaO+45+6MgO+0.3(B+Zn)	3 Bags
Ferta Agra Cacao Super	NPK 3-21-20+10CaO+55+5MgO+0.5(B+Zn)	3 Bags
So Aba Pa	NPK 4-22-18+4CaO+45+5MgO+0.5B+0.2Zn	3 Bags
Adom Cocoa Fertiliser	NPK2-23-18+8CaO+6SO3+6MGO+0.5ZN+0.5B	3 Bags
Adehye Cocoa Fertliser	NPK2-23-18+8CaO+6SO3+6MGO+0.5ZN+0.5B	3 Bags
GRANULAR FERTILIZER(ORGANIC)	**NUTRIENT CONTENT**	**RATE PER ACRE (50kg/BAG)**
Elite Organic Fertilizer	NPK 3:4:4+9Ca+1Mg+0.04B+0.08Zn+11 Organic matter	8 Bags
Natural Organic Cocoa Fertlizer	3%N, 2%P, 2%K + 50% Organic matter	8 Bags
LIQUID FERTILIZER	**NUTRIENT CONTENT**	**DOSAGE (ml PER 11 LITRE TANK)**
Sidalco	NPK 6:0:20 + Trace elements (Mg, Fe, Mn, Cu,Zn)	30ml (300ml per acre) must be applied 6 times in a year
Lithovit	Urea+Carbonates of Ca and Mg+Trace elements	
Lifet A +	NPK 10:10:10 + Trace elements (Mg, Fe, Mn, Cu, Zn)	

APPENDIX 2 - FUNGICIDES APPROVED FOR USE ON COCOA

FUNGICIDES

Product	Active ingredient(s), Formulation type*	Dosage (gm or ml) per spraying tank of 15l	No. of sachets/ spraying tank	Maximum interval between sprays (weeks)
Kocide 2000 DF	53.8 % Copper (II) hydroxide, (35 % copper), DF	100 gm	1	3-4
Funguran-OH	77 % Copper (II) hydroxide (50% copper) WP	100 gm	1	3-4
Champion	77% Copper (II) hydroxide, (50% Copper) WP	100 gm	1	3-4
Fungikill 50WP	15% metalaxyl + 35% Copper (II) hydroxide, WP	75 gm	1	3-4
Ridomil Gold 66 WP	6% mefenoxam +60% Cupper (I) oxide, WP	50 gm	1	3-4
Copper Nordox 75WG	86% Cupper (I) oxide, WP (75% Copper)	75 gm	1	3-4
Metalm 72WP	12 % metalaxyl + 60 % copper (1) oxide, WP	50	1	3-4
Sidalco Defender	Dicopper chloride trihydroxide, SC	100 ml	100 ml	3-4
Agro Commet 72WP		50 gm	3-4	
Fantic	Benalaxyl M + copper (I) oxide	75 ml	75 ml	3-4
Forum R	60 g/kg Dimethomorph + 400 g/kg Copper hydroxide	100 g	100 g	3-4
Vamos 500SC	500 g/L Fluazinam	50 ml	50 ml	3-4
Banjo Forte 400 SC	200g/L Dimethomorph + 200g/L Fluazinam	75 ml	75 ml	3-4
Royal Cop 50WP	50% Copper (II) hydroxide	100 g	100 g	3-4
Delco 75WP	75 % Cupper (I) oxide	75 g	75 g	3-4

APPENDIX 3 - INSECTICIDES APPROVED FOR USE ON COCOA

INSECTICIDE (TRADE NAME)	ACTIVE INGREDIENT(S)	APPLICATION RATE
Confidor OD	Imidacloprid	30 ml per 11 litres of water (150 ml per ha)
Actara 240 SC	Thiamethoxam	17 ml per 11 litres of water (85ml per ha)
Akate Master	Bifenthrin	100 ml per 11 litres of water (500 ml per ha
Miricon EC 900	Deltamethrin +Pyrethrum	66 ml per 11 litres of water (330ml per ha)
LUFU™	Thiamethoxam + Deltamethrin	54 ml per 11 litres of water (270 ml per ha)
Nomax 150 SC	Alpha-cypermethrin + Teflubenzu-ron	52 ml per 11 litres of water (260 ml per ha)
Buffalo Super 4EW™	Acetaprimid	98 ml per 11 litres of water (490 ml per ha)
Thodan Super™	Lambda cyhalothrin +Acetamiprid	110 ml per 11 litres of water (550 ml per ha)
Acati Power	Thiamethoxam	20 ml per 11 litres of water (100 ml per ha)
Insecticide A1 (formerly Capsiprid)	Imidacloprid	20 ml per 11 litre of water (100 ml per ha)
Pridapod	Imidacloprid	20 ml per 11 litres of water (100 ml per ha)
Callifan Super	Bifenthrin + Acetamiprid	20 ml per 11 litres of water (100 ml per ha)
Viper Super 80 (formerly Aryna)	Indoxacarb + Acetamiprid	105 ml per 11 litres of water (520 ml per ha)
Pyrethrum 5 EW	Pyrethrum	80 ml per 11 litres of water (400 ml per ha)
Volian Flexi	Thiamethoxam + Chlorantraniliprole	20 ml per 11 litres of water (100 ml per ha)
Galil 300	Imidacloprid + Bifenthrin	13 ml per 11 litres of water (65 ml per ha)
D Lion Akate Global 4000	Thiamethoxam	20 ml per 11 litres of water (65 ml per ha)
Regent 200 SC	Fipronil	17 ml per 11 litres of water (85 ml per ha)
Acetastar	Bifenthrin + Acetamiprid	120 ml per 11 litres of water (600 ml per ha)
XDE	Sulfoxaflor	120 ml per 11 litres of water (600 ml per ha)
Trebon 30 EC	Etofenprox	60 ml per 11 litres of water (300 ml per ha)
Akate Star 3 EC	Bifenthrin	20 ml per 11 litres of water (100 ml per ha)
AF Confidence	Capsaicin	200 ml per 11 litres of water (1000 ml per ha)

APPENDIX 4 - DEFINITIONS FOR DEFECTS OF COCOA BEANS

1 ADULTERATION
Alteration of the composition of a parcel of cocoa beans by any means whatsoever
so that the resulting mixture or combination does not conform to the contractual
description.

2 BEAN CLUSTER
Two or more beans joined together which cannot be separated by finger and thumb.
3 BEAN COUNT
The total number of whole beans per 100 g derived from a test sample.

4 BROKEN BEAN
Cocoa bean of which a fragment is missing, the remaining part being more than
half of a whole bean.

5 COCOA BEAN
Raw cocoa bean, which is the whole seed of the cocoa tree (Theobroma Cacao L.)

6. CONTAMINATION
The presence of a smoky, hammy or other smell not typical to cocoa, or a substance
not natural to cocoa, which is revealed during the Cut Test or physical inspection.

7. CUT TEST
The procedure by which the cotyledons of cocoa beans are exposed for the purpose
of determining the incidence of defects- slaty, violet or purple and/or the presence of contamination.

8. DEFECTIVE BEAN
An internally mouldy or insect-damaged bean or slaty bean.

9. FAIR FERMENTED
Cocoa beans that are not more than 10% slaty and 10% defective by count.

10. FLAT BEAN
A cocoa bean which is too thin to be cut to give a complete surface of the
cotyledons.

11. FOREIGN MATTER
Any substance other than cocoa beans and residue.

12. FRAGMENT
A piece of cocoa bean equal to or less than half a bean.

13. GERMINATED BEAN
A cocoa bean the shell of which has been pierced, split or broken by the growth of
the seed-germ.

14. GOOD FERMENTED
Cocoa beans that are not more than 5% slaty and 5% defective by count.

15. INSECT DAMAGED/INFESTED BEAN
A cocoa bean the internal parts of which are found to contain insects or mites at any
stage of development, or to show signs of damage caused thereby, which are visible to the
naked eye.

16. MOULDY BEAN
A cocoa bean on the internal parts of which mould 1 is visible to the naked eye.

17. RESIDUE
Any cocoa element other than whole cocoa beans and flat beans which, does not pass
through the sieve (eg. broken beans, fragments and pieces of shell).

18. SIEVE
A screen with round holes the diameter of which shall be 5.0mm min./max.

19. SIEVINGS
The material which will pass through the Sieve.

20. SLATY BEAN
A cocoa bean which shows a slaty colour on at least half of the surface of the cotyledons exposed by the cut test.

21 Mould is not to be confused with WHITE SPOT which is a concentration of theobromine or cocoa fat.

22 VIOLET OR PURPLE BEAN
A cocoa bean which shows a violet or purple colour on at least half of the surface of the cotyledons exposed by the cut test.

APPENDIX 5 - SHADE TREE REGISTRATION FORM

Forestry Commission

Farmer Pin:

REGISTRATION OF PLANTED TREES

Type of establishment: ☐ *Woodlot* ☐ *Commercial plantation*
☐ *Planted trees on farm* ☐ *Others (Specify: eg. Nurtured?)*

Farmer Detail

Name on National ID

First Name: _____ **Surname:** _____

Picture

Gender: ☐**Male** ☐**Female** **Date of Birth/Age:** _____

Address: (Postal / Residential): _____

Phone Number: _____ **Email Address** (if any) _____

Next of Kin (Alternative Contact): _____ **Date of Birth/Age:** _____

Gender: ☐**Male** ☐**Female** **Address**

Farm Location/ site

Region: _____ **Forest District:** _____

District Assembly: _____ **Location/ Community:** _____

Land / Farm Information (attachment)

Farm Size (HA)/ Plantation Area: _____ **Development of Maps (optional)**

Coordinates of the Plantation plot/ Farm (GPS coordinates):

Date	Point ID	Latitude	Longitude	Way Point	Remarks

Tree Information (attachment)

No.	Species Planted	No. of Trees *(Stocking)*	Planting Distance *(Spacing)*	Year of Establishment	Comments *Eg. Planting Completed*
1.					
2.					
3.					

Farmer Signature/Thumbprint:	Witness Signature/Thumbprint:	DM Signature/Thumbprint:
Date:	Name: Date: Phone #:	Name: Date: Phone #:

NOTE:

- *This form does not constitute an indenture.*
- *Before planting the trees I had sought the approval of the land owner(s).*

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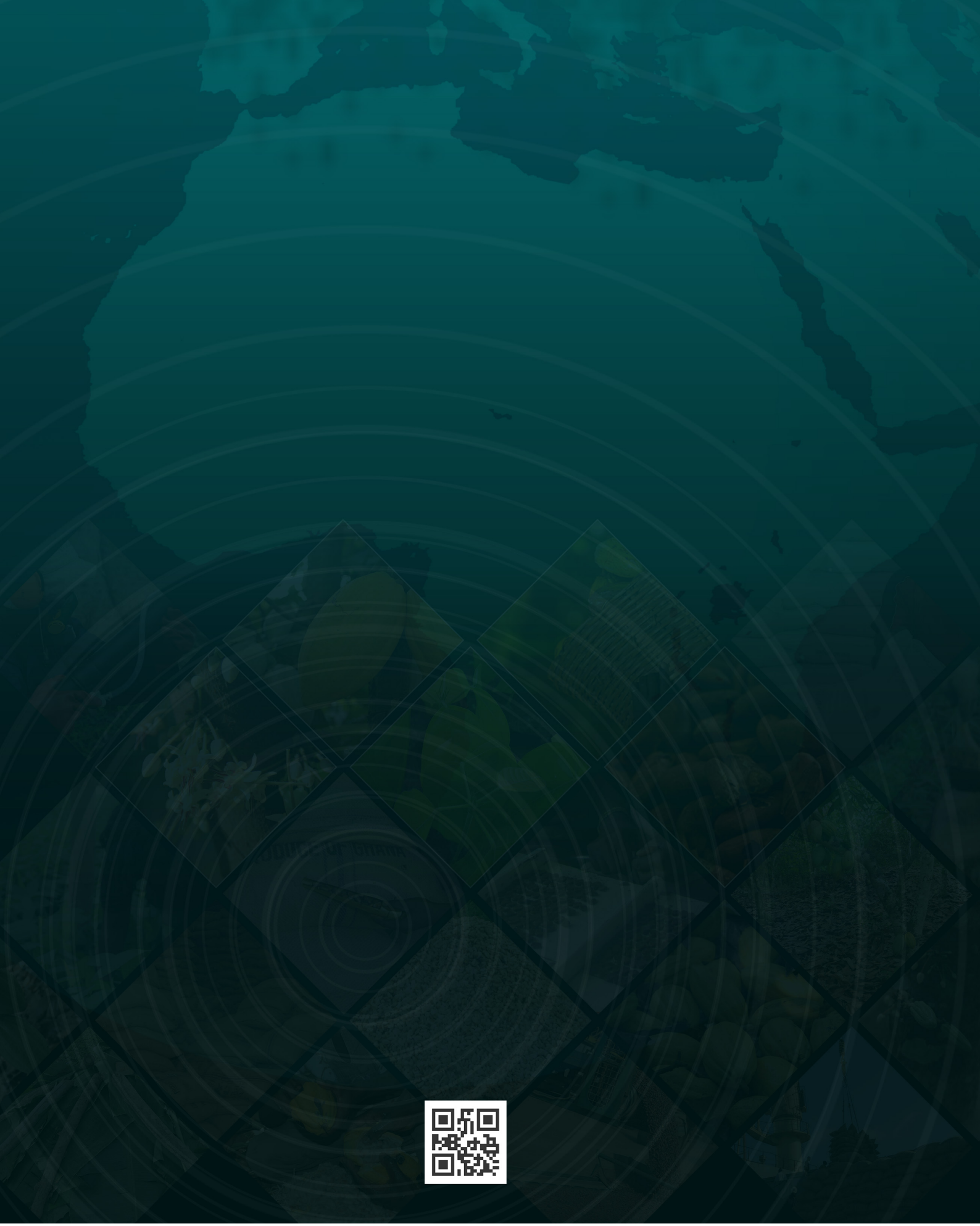
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Ghana Cocoa Board (COCOBOD) / Cocoa Health and Extention Division [CHED] / USAID
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