

COURSE CODE:	HRT 502
COURSE TITLE:	PLANTATION CROPS PRODUCTION (POMOLOGY)
NUMBER OF UNITS:	2 Units
COURSE DURATION:	3 Hours

COURSE DETAILS:

Course Coordinator:	Prof. I. O. O. Aiyelaagbe B. Sc., M.Sc. Ph.D.
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COURSE CONTENT:

What is a plantation? Economic importance of plantation crops. Climatic and soil requirements. Fruit tree propagation, selection and preparation of nursery site of cacao, kola, cashew, oil palm, citrus, coffee, rubber etc. Plantation / orchard establishment: Site selection, layout, land preparation and planning. Crop improvement / management practices. Chemical weed and pest control. Harvesting: Seed control, preservation, storage, packaging, processing and marketing.

Practical: Identification of different types of plantation crops. Identification of fresh fruits, seeds / nuts and primarily processed seeds / nuts of these crops. Production and management of their seedlings in the nursery. Identification of vigorous, less-vigorous, diseased and insect infested seedlings in the nursery. Criteria for selecting transplantable seedlings of these tree crops.

COURSE REQUIREMENTS:

The course is compulsory for all students in COLPLANT and COLAMRUD. All students must make 75% class attendance in order to be eligible to sit for the examination.

READING LIST:

- Opeke, L. K.** Tropical Tree Crops. Spectrum Books Ibadan, Nigeria. 2005.
- Nakasone, H.Y. and Paull, R.E.** Tropical fruits CAB International, U.K. 1998.
- Ohler, J. G.** Cashew. Communication 71. Department of Agricultural Research. Koninklijk Instituut Voor De Tropen. Amsterdam. 1979.
- Van Eijnatten, C. L. M.** KOLA: ITS BOTANY AND CULTIVATION. Communication 59. Department of Agricultural Research. Koninklijk. Instituut Voor De Tropen. Amsterdam. 1969.
- N. K. Jain, M. A. Siddiqi, J. H. Weisburger.** Protective effects of tea on human health. CABI. 2006.
- R. H. Raemaekers.** Crop Production in the Tropical Africa. Directorate General for International Cooperation. Ministry of foreign affairs, External trade and International Cooperation.

Brussels, Belgium. 2001.

Guy Mossu. COCOA. MACMILLAN Press limited, London and Basingstoke. CTA-The Tropical Agriculturalist, 1992.

Denis Bonheure. TEA. MACMILLAN Press limited, London and Basingstoke. CTA-The Tropical Agriculturalist, 1991.

H. R. Cambrony. COFFEE. MACMILLAN Press limited, London and Basingstoke. CTA-The Tropical Agriculturalist, 1992.

J-C Jacquemard. OIL PALM. MACMILLAN Press limited, London and Basingstoke. CTA-The Tropical Agriculturalist, 1998.

LECTURE NOTES

PLANTATION?

- ❑ Plantation is a piece of land not less than but more than 5ha dedicated to production of permanent tree crops with industrial value. It is profit oriented industry comprising of different aspects that can stand alone as a venture.
- ❑ Plantation is usually monospecific in nature.
- ❑ Economic importance of studying Plantation crops are :
 1. Job opportunities e.g. plantation manger, consultancy, research/ teaching, input supplier importer/exporter, inspectors
 2. Demand for industrial Raw materials e.g. rubber, palm oil, palm kernel oil,, Cashew nut oil, cocoa butter, e.t.c
 3. Foreign Exchange earning
 4. Environmental control in terms of creation of microclimate- canopy of trees provide shade, litters increase organic matter in the soil.

SOME PLANTATION CROPS

- Rubber- *Hevea brasillensis*
- Oil palm- *Elaeis gueneensis*
- Tea- *Camellia sinensis*
- Coffee – *Coffea arabica*
- Cocoa- *Theobroma cacao*
- Cashew- *Anarcadium occidentale*
- Citrus- *Citrus spp.*
- Coconut – *Cocos nucifera*
- Ogbono – *Irvingia gabonensis*
- Sugarcane- *Saccharum officinarum*

Plantation establishment

Some Terminologies in Plantation crops Husbandry

- **Pre- nursery** – It is a stage in propagation of tree crops where an environment that ensure uniform germination of seeds before being transferred to the nursery.
- **Nursery** – It is a piece of land dedicated to intensive care of propagules that meet salable size within the shortest time. It is an integral part of a larger plantation industry and it is responsible for required propagules for the plantation establishment.
- **Holing** – Creation or digging of appropriate size of transplanting holes at predetermined coordinates
- **Fire tracing** – Creation of a weed free corridor about 6m wide round the plantation as a preventive measure against fire out-break.
- **Pruning** – It is the systematic removal of excessive or unwanted vegetative part of the crop either to shape, prevent pests and diseases spread or ensure good fruit yield.
- **Mulching** - Mulching is an important practice of using natural or artificial plant residues or other plant materials on soil surface e.g. grasses, legumes or plant parts such as maize, cereal straw, grass thatch e.t.c.

- Rub out- Act of removing or rubbing off tender sprouts or shoots from rootstock to enhance scion growth.
- Ring-weed- Weeding round the individual plant stand.
- Beating up – replacement of missing or dead seedling stands in the plantation after transplanting
- Blocking- Partitioning or dividing the plantation land into manageable units so as to ease operations and record keeping/decisions.
- Transplanting- It is the act of transferring seedlings that are mature to the field for permanent establishment

Rationale for establishing a nursery:

- Demand for healthy propagules for plantation establishment at short notice
- Specialization i.e. an integral part of plantation that ensures cost effectiveness
- Production of seedlings of right and high quality for successful plantation i.e. true - to - type,
- To supply back up for the plantation

Principles Nursery and Plantation Establishment

- Justification- WHY?
- Budget- HOW MUCH IS NEEDED?
- Acquisition- WHAT ARE THE NEEDED MATERIALS? E.g land, labour, agrochemicals- Herbicides, Pesticides, Fertilizers, Topsoil, Tools e.t.c.
- Layout- HOW? What arrangement/Spacing?
- Nursery/Field preparation- Land clearing, Layout, mapping-out, holing, transplanting e.t.c
- Demand- WHO WANTS WHAT IS PRODUCED?

Factors to consider in Nursery/Plantation establishment

- Closeness to perennial source of good quality water
- Accessibility by good road network
- Visibility –good advertisement i.e. can be easily located
- Location- a nursery must be located on a prime land
- Routine monitoring
- Weed control
- Mulching
- Watering
- Creation of alleys between seedlings to ease movement

CITRUS SPECIES

- Citrus - family Rutaceae which contain about 150 genera and nearly 2000 species of which very few species are of economic importance.
- They are evergreen trees, small statured with thorny stems and branches.
- The fruits are small to large with leathery rind, yellow to orange in colour when ripe.
- The pulp and juice may vary in taste from sweet to acid. Examples:
- BOTANICAL NAME COMMON NAME
- *Citrus sinensis* Sweet orange
- *Citrus paradisi* Grapefruit
- *Citrus limon* Lemon
- *Citrus reticulata* Tangerine/Cleopatra mandarin(wild citrus)
- *Citrus aurantifolia* Lime
- *Citrus aurantium* Sour orange
- *Citrus grandis*(Pomelo) Shaddock
- *Citrus sinensis* x *Citrus reticulata* King orange
- *Citrus paradisi* x *Citrus reticulata* Tangelo
- *Citrus jambhiri* Rough lemon
- **Varieties of *Citrus sinensis***
- Pineapple, Parson brown, Umudike, Washington navel, Valencia, Agege 1.
- **Varieties of *Citrus limon***- Eureka, Lisbon,
- **Varieties of *Citrus paradisi***- Red blush, Duncan
- **Varieties of *Citrus reticulata*** Clementine; Dancy
- Major Producing States in Nigeria Oyo; Ogun Plateau Benue Nassarawa Imo

- Internationally Argentina Algeria Brazil California Chile Europe Florida Spain Portugal Morocco:

Economic Importance/Uses of Citrus

- The main commercial product of citrus is the juice which can then be consumed in various forms e.g. juice and wine, confectioneries (jam, marmalade).
- Other by-products that are of use may include supply of nutrients, vitamins e.g. Vitamin C, Health/Medicine, Essential Rind oils used pharmaceutical industries,
- Fruit pulp as fodder for livestock or fuel for combustion and wood from citrus can serve as source of fire wood.

PROPAGATION OF CITRUS

Can be done by Seed or Vegetatively

- Propagation by seed - collect seeds from plants with high yield /good growth, pests and disease free and of good quality
- Select seeds on the basis of size fullness and conformation
- Select from ripe and well filled fruits
- Sow immediately either at stake or in the nursery for transplanting or store for a short duration in a closed jar in a cool place
- Vegetative propagation most common is T- budding: Root stocks which is plant used for underlying or supporting scion and are not usually consumable but are vigorous drought and disease tolerant:
- Get bud wood on the day of budding early in the morning from branches 8 to 10 months for budding: OR keep in moist cotton wool wrapped in moist cloth for transportation
- Budding of bud wood to the rootstock is done at a height of 20 to 25cm from ground level on prepared rootstock keep in the nursery for at least 8months before transplanting to the field

Field establishment

- Site selection - loamy soil well drained, pH 5 to 6
- Land preparation - total clearing, plough and harrow or double plough
- Block - Line and map out at recommended spacing 10m x 10m for shaddock, 7m x 7m for sweet orange, 6m x 6m or 5m x 5m for lime
- Hole and transplant
- Employ Weed control measures
- Apply fertilizer
- Pests and Disease control
- Special treatment pruning
- Harvest when fruits mature and ripen. There two seasons -April/May fruits are acidic and November this is the best harvest, fruits are sweet.

Oil Palm

- Palms belong to Family Palmae with about 225genera 2600species. Oil palm belongs to the sub-family Cocoideae and it is the most important of the subfamily.
- Botanical name: *Elaeis guineensis* common oil palm
- *Coroza oleifera* swampy palm
- Description Monocotyledonous, monoecious plant grows up to 9m or more with stout stem with persistent leaf bases, stem may be 30 to 38 cm in diameter
- Produces fibrous root system within 25 to 50cm depth of soil
- Fronds about 20m long and 25 to 30 in number and each frond bears between 20 to 150 pair of leaflets
- Economic life span 25 to 30 years and life expectancy 60 years

VARIETIES OF OIL PALM

- The Dura type has thin esocarp thick endocarp and large kernel denoted DD genotypically
- The Pisifera type has thick mesocarp with thin endocarp and reasonable sized kernel denoted Dd genotypically
- The Tenera type has thick mesocarp with little oil content no endocarp and small kernel denoted dd genotypically It is a dual type recommended for commercial oil production

USES OF OIL PALM

- Source of fresh palm wine and alcohol production
- Domestic oil
- Industrial oil or Palm kernel oil
- Palm kernel Cake
- Local brisquettes oguso Broom Basket Roof thatch log for construction shell for smithing etc

PROPAGATION / ESTABLISHMENT

This could be by

- Tissue culture which is the most important modern method
- Seeds germination in the pre nursery and then transferred to nursery 10 to 12 months
- **Establishment and post planting operations**
- Site selection - loamy soil well drained neutral pH preferred but can tolerate a wide range of pH.
- Land preparation total clearing plough and harrow or double plough
- Employ Weed control measures
- Apply fertilizer
- Control Pests e.g Mites, Red spiders, Grasshoppers, Locusts, Termites, Rodents etc
- Control Diseases e.g Brown germ disease, Anthracnose, *Glomerella ingulata*
- Special treatment e.g rehabilitation of the plantation
- Harvest when fruits mature and ripen using:
 - (i) Chisel method (ii) Pole on Knife method (iii) Climbing rope method
- Processing – Sterilize, strip, mill, separate, press, clarify to get (1) Hard oil (2) Soft oil (3) Special oil and by product as Palm kernel oil
- Marketing- Store or decant and sell.

- Block, Line and map out at recommended spacing 8.75m x 8.75m x 8.75m 9m x 9m x 9m triangular
- Hole and transplant seedlings with ball of earth
- Provide protection for young seedlings in form of collar netting about 15cm away from plant

• **COCOA** (*Theobroma cacao*, Linn.)

Cocoa Plant And Its Distribution

- ❖ Cocoa has currently been reclassified as a member of *Malvaceae* instead of *Sterculiaceae* families. Cultivated in the tropical and subtropical regions.

Introductions Of Cocoa Plantations

- ❖ The Spaniards, Dutch, and Portuguese introduced cocoa to their overseas territories.
- ❖ Cocoa got to West African peasant farmers through:
 - ❖ Trading companies
 - ❖ Missionaries
 - ❖ Soldiers
 - ❖ Chiefs

Cultivated Species Of Cocoa

The **Criollo**, The **Amazonian forastero** and The **Trinitario**

- ❖ **The Criollo group:**
- ❖ Cultivated in Venezuela, Nicaragua, Mexico, Colombia and Guatemala.
- ❖ Most anciently cultivated.
- ❖ Poor cacao vigour.
- ❖ **The Amazonian Forastero Group**
- Cultivated in Brazil, West Africa, Central America, South East Asia and Caribbean Island.
- Staminodes with purple pigments.
- Green and varying shapes of cocoa pods.
- Thick pericarp and very woody mesocarp.
- **The Trinitario Group**
- Believed to evolve from a cross between Forastero and Criollo groups.
- Highly heterogeneous group.
- Selected from Trinidad, hence the name Trinitario.

Botany And Agronomy of Cocoa

- ❖ Cocoa is cauliflorous and semi-desidious.
- ❖ Height, leaf area, branches and canopy spread of cacao determined by planting spacing.
- ❖ When grown from seeds cacao attains anthesis between 24 and 36 MAT and fully matured at about 10 YAT.
- ❖ A well managed cocoa continue to be economic for over 50 years.
- ❖ Within 36 hours after pollination, fertilization occurs leading to the formation of a young okra-sized pod – **cherelle**.
- ❖ Cherelle continues to develop by longitudinal elongation and girth increase to become a fully-grown mature cocoa pod.

Site Selection

- ❖ 2 major factors must be considered while selecting a site for cocoa plantations establishment: **climatic and soil factors**.
- ❖ Climatic factors:
 - Cocoa is a low altitude crop, performing best within 100 – 300m above sea level (asl). It can be grown at 700m asl.
 - Cocoa is sensitive to water deficiency particularly when in competition with other plants (shade plants, wind breaks and weeds) and also to excess water in the soil.
 - It thrives within wide rainfall ranges of 1000 – 3000mm or more per year.

Soil Factors

The soil on which cocoa will be planted should satisfy the following conditions:

- The soil must be at least 1.5 m deep.
- The soil structure must be as homogenous as possible.
- It must have good water-retaining capacity, well-drained and well aerated.

Raising cocoa seedlings in the nursery.

- ❖ Cocoa beans readily germinate when sown and lose viability easily on extraction from pods within 5 – 7 days unless specially treated with moist fine sand or sawdust. They retain viability for 4 weeks inside pod after harvesting.
- ❖ Nursery establishment is done between December and February, in order to allow the seedlings a period of 4 months under intensive care.

Land Preparation For Transplanting Of Cocoa Seedlings Into The Field.

- ❖ In preparing the land for cocoa transplanting, some trees are left unfelled to act as windbreaks (upper storey).
- ❖ The field should have been planted to a temporary shade of plantain suckers the previous year or simultaneously with cocoa seedlings (middle storey) at same planting density with cocoa (100% shade density).

Vegetative / Clonal Propagation in Cocoa

- ❖ Conventionally, cocoa is clonally propagated through budding, grafting, cutting, marcutting (air layering) and soil layering. Cutting being the most popular method.

Cocoa Disease Pest

- ❖ **Black pod / Phytophthora pod rot:**
 - Most serious disease of cocoa in West Africa, especially, Nigeria and Cameroon.
 - Caused by *Phytophthora megakarya*, during the rainy season when the **relative humidity is higher than 80%**.

- **Control of Phytophthora pod rot**
- ❖ The incidence of the disease is preferably prevented in the cocoa plantation through:
 - Frequent removal of weeds / other plants that can increase the relative humidity of the plantation.
 - Removal and burning of the infected cocoa pods.
 - Application of the copper-based fungicides to control the incidence.
 - The use of resistant / tolerant varieties.

- **Swollen shoot**

- ❖ A viral disease which may not appear till 6 months after cacao is infected.
- ❖ Symptom appears at the shoots produced after infection.
 - Control measures:**
 - Removal and burning of the infected cacao
 - Breeding programme has put the disease under check through the introduction of the resistant / varieties.

- **Cherelle wilt**

- ❖ This is a physiological problem affecting only cherelles – 10cm long or less.
- ❖ The cherelles suddenly wilt and die. Dead cherelles are seen hanging on cacao.
- ❖ It results in 40 – 50% loss of the total pod set.

Charcoal Rot:

- ❖ This is a fungal disease caused by *Botryodiplodia theobromae*.
- ❖ It is a weak pathogen. It only infects wounded, overripe or weakened cocoa pods.

- **Major insect pests of cocoa**

Cocoa Mirids (Capsids or Jori-jori):

- ❖ Most serious insect pest of cocoa in West Africa.
- ❖ The insects attack both young and mature cacao.

Mealy bugs

- ❖ Mealy bugs are vectors of viral disease especially swollen shoot.
- ❖ Control methods:

- **Chemical control method**

- **Biological control method**

- **Harvesting and post-harvest handling of cocoa**

- ❖ It takes 150 – 180 days between pollination and ripening in cocoa, depending on varieties.
- ❖ Only mature and ripe pods are harvested, diseased and damaged pods must not be processed for markets.

Breaking / opening of cocoa pods:

- ❖ Use a blunt object such as a stone or a thick piece of wood for the breaking. Extracted beans with mucilaginous pulp are collected in a clean container for fermentation.

- **Preparation of Commercial Cocoa**

- In order to be sold as cocoa beans, the fresh cocoa removed from pods have to undergo two very important processes –

- **Fermentation**

- **Heap fermentation**
 - **Basket fermentation**
 - **Sweat box fermentation**
 - **Tray fermentation**

- **Drying**

- **Drying.**

- ❖ **Methods of drying.**

- Sun-drying
 - Drying autobus
 - Movable roof dryer.

- Simple dryers
- Mechanical dryers
- Automated workshops.
- **Grading of cocoa.**
 - Grade 1 cocoa
 - Grade 2 cocoa
- **Cleaning and bagging of cocoa.**
- **Storage of commercial cocoa.**
 - The international standards stipulate the following conditions.
 - The ambient humidity must not exceed 70 %.
 - Periodic checking of the moisture content of each lots must be carried out.

Economic Importance of Cocoa.

- ❖ Beverages (not tea)
- ❖ Foreign exchange earnings.
- ❖ Black soaps
- ❖ Herbs
- ❖ Chocolates

KOLA (*COLA SPECIES*)

- **Kola (*Cola sp.*)**
 - Cola nitida* (Vent) Schott and Endl.
 - Cola acuminata* (Beauv) Schott and Endl.
- ❖ Kola has a long history of cultivation and trade in West Africa, especially in Nigeria, Ivory Coast, Sierra Leone, Guinea, Liberia, Ghana, Togo, Cameroon and Republic of Benin.
 - *Cola nitida*.
 - *C. acuminata*.
 - *C. verticillata*.
 - *C. ballayi*.
- ❖ ***C. nitida*** and ***C. acuminata*** are the most important species economically and most widely cultivated.
- ❖ Cultivation and development of the 2 species became popular by the inception of CRIN.
- ❖ Today CRIN conducts research into the cultivation, development and end-uses of kola. This had boosted the global economy of the crop.
- ❖ The nuts from both species occur fresh in **red, pink and white** colours often in the same pod.
- ❖ Today, Nigeria produces over 88% of the world's crop and about 90% of this is consumed locally while the remaining 10% is exported.

Propagation of kola

- Traditionally, kola is propagated by nuts sown at stake between food crops or in traces of forest vegetation where it grows undisturbed.
- Better seedling development is achieved when kola nut is firstly germinated in a seed-box (**pre-germination** in the **pre-nursery stage**),

The Kola Nursery

- ❖ **Nursery site:**
 - Select a site near a stream / water tap.
- ❖ The following equipments are essential in kola nursery –
 - Germinating or seed boxes / Rooting propagators
 - Seedling or polythene bag
 - Protective wire netting

- ❖ **Cured kola nuts:**
 - After curing, kola nuts are pre-germinated in a pre-germinator containing a growth medium of wet sawdust.

- ❖ **Freshly harvested / uncured kola nuts:**
 - **Scarification / cotyledon wounding**
- **Vegetative Propagation**
- ❖ Conventionally feasible vegetative methods in kola consist of –
 - Rooting of stem cuttings (tips of branches)
 - Marcotting of stem
 - Budding
 - Grafting
- ❖ **Rooting of stem cuttings:**
 - **Choice of cuttings**
 - **Taking the cuttings**
 - **Setting the cuttings**
 - **Potting of rooted cuttings (ramets):**
 - **Hardening the ramets:**

- **Transplanting of kola seedlings or ramets into the field.**
 - **Selectively thinned forest:**
 - **Regrown forest or open land:**

- **Botany of kola**
- ❖ The adult tree develops into a dome-shaped pattern of growth.
- ❖ In an unpruned kola tree, the foliage and fruits produced often reach the ground level, thus makes for easy harvest and insect and disease attacks.
- ❖ Closely spaced trees tend to etiolate and grow tall thus leading to loss of foliage and branches.
- ❖ Flowering:
- ❖ Both *C. nitida* and *C. acuminata* possess functional male and female flowers in the same inflorescence. Flowers of *C. acuminata* are smaller than those of *C. nitida*.
- ❖ In both species, the stamens of the same flowers are not functional, thus self pollination does not occur within the flower – **self incompatibility.**

- ❖ **There 2 factors determining the nut colour in kola:**
 - The colour of the nut of the parent kola trees.
 - The colour of the nuts from which the surrounding kola trees were raised.
- ❖ Harvesting in kola is carried out when the pods become in-conspicuously brown.

- **Post-harvesting Handling**
 - **Primary processing:**
 - **Curing:**
- ❖ **Storage:**
 - The cured nuts are wrapped in green but partially dried leaves and packed inside large baskets and kept in shaded / cool spot for marketing.

- **Insect Pests of Kola**
- ❖ **Field pest:**
 - Stem borers (*Phosphorus virens*)
 - The kola weevil (*Balannograstris colea*)

- ❖ **Nursery pest:**
 - Caterpillar
 - Mealy bug

- Red spider

Desirable kola nut quality

A good kola nut should:

- Be slimy
- Not be astringently bitter in taste

• **Economic Uses Of Kola Nut**

- ❖ For preparation of kola type beverages such as Coca cola.
- ❖ A source of essential oils for flavourings in confectionary industries.
- ❖ For the preparation of chococola – a type of chocolate containing cocoa and *Cola*.
- ❖ A source of alkaloids – caffeine and theobromine in pharmaceutical preparations.

CASHEW (*ANACARDIUM OCCIDENTALE*, L.)

- **Cashew (*Anacardium occidentale*, L.)**

ORIGIN AND DISTRIBUTION

- Indigenous to South America. Introduced to North America, Asia, Africa and Australia by the Portuguese explorers between 15th and 16th centuries.
- Commercially grown in many countries in 4 continents: Asia, Australia, South America and Africa.

Cashew in Nigeria

- ❖ Cashew is cultivated in all agro-ecological zones of Nigeria. Thus, it tolerates wide rainfall conditions of between 600 mm and 3, 000 mm per annum.
- ❖ Price of cashew nut per ton depends on the nut-size: The bigger the nut-size the higher the price.
- ❖ Various nut sizes of cashew nuts include: Jumbo-size, Extra large, large, medium, small and Madras nuts

Raising Cashew in the Nursery

- Cashew seedlings are raised in the nursery through the nuts
- Heavier nut-size are preferably used for seedlings production.
- Seedlings produced by lighter nuts are less vigorous and hardly survive transplanting shock when eventually transplanted.

Site selection:

- Thin forest is ideal for cashew
- Clear-fell all trees

Layout:

- The field is laid out at a spacing that suits the farming technology.

Transplanting of cashew seedlings into the field.

- Cashew seedlings are transplanted into a clear-fell field after a period of 8 – 12 weeks in the nursery.
- Only vigorous seedlings are transplanted.
- The crop is transplanted at a spacing of 9m x 9m. Closer spacings of 6m x 6m, 4.5m x 4.5m are possible, but, the trees have to be later thinned to a wider plant spacing when the canopy becomes bigger.

Peculiar maintenance operations in cashew

- Weeding

- Pruning
- Selective thinning

Insect Pest of Cashew

- **Root and stem borer** (*Plocaederus ferrugineus*):
- **Stem girdler** (*Analeptis trifasciata*):

Harvesting

- Harvesting in cashew is by picking the fallen nuts.

Post harvest handling:

- Removal of foreign bodies.
- Sorting
- Sun-drying
- Bagging

Grading of cashew:

- Cashew is graded according to the size of the nuts

Marketing:

- Properly dried cashew is sold in the international market through the local buying agents of the multinational companies.

COFFEE (COFFEA SPECIES)

Family: Rubiaceae

- **Cultivated varieties**
- ❖ **Varieties of cultivated coffee:**
 - *Coffea arabica*
 - *C. canephora* (robusta coffee)
 - *C. liberica*

ORIGIN OF COFFEE

- ❖ Originated from Africa:
 - *C. arabica*, despite its name, comes from Ethiopia.
 - Wild populations of *C. Canephora* still exist in the evergreen forests from central Africa to West Africa.

- **Current distribution of cultivated coffee species**
- ❖ *C. arabica*: (**Highland Coffee**) South and Central America, **Highland regions of Africa**;
- ❖ *C. canephora*: (**Lowland Coffee**) Africa (relatively low quantity, hot and humid areas)
- **Ecology and Botany of cultivated coffee**
- ❖ *C. arabica*:

- Original source of coffee beans and has best coffee quality.
- Most suitable climate is the original (Ethiopian) climate i.e. tropical climate tempered with altitude with two contrasting seasons.
- It has a slender tree which is heavily branched and kept in shape by judicious **pruning**
- Axillary and sub-axillary buds develop into reproductive lateral branches.
- ❖ **C. canephora:**
 - It is a lowland coffee originated from equatorial Africa.
 - With the exception of *C. arabica*, all other species of coffee are lowland types.
 - All lowland coffee types are similar in vegetative and reproductive characteristics.
 - Require hot and humid equatorial to sub-equatorial climates.

Site Selection For Coffee Growing

- ❖ Site to be selected for coffee cultivation is determined by type of coffee to be grown which is on the basis of requirements for altitudes.
- ❖ Deep, slightly acid, well-drained loams, (especially, hillsides with a gentle slope) that are rich in nutrients especially potash and organic matter are ideal for coffee.

Propagation of Coffee

- ❖ **Raising of coffee seedlings:**
 - Plantable seeds or seedlings must be obtained from designated centers – Research Institutes or Colleges and Faculties of Agriculture of Universities.

Preparation of coffee seeds –

Raising coffee seedlings

- Maintenance of seedlings in the nursery:
- Watering
- Weeding
- Control of disease infection especially damping-off, leaf spot (*Cercospora spp.*)

Clonal / Vegetative Propagation of Coffee

- ❖ This ensures true-to-type in the following traits –
 - Production capacity
 - Reaction to environment (soil, climate tolerance / resistance to pest attacks)
 - Technological
 - Organoleptic properties of coffee.

- **Propagation Of Coffee By Stem Cuttings**

- **Selection and preparation of stem cuttings:**
- ❖ **Setting Of Cuttings:**
- ❖ **Maintenance of set cuttings:**
- ❖ **Transplanting and Hardening-off**

Transplanting Of Coffee Seedlings Into The Field:

- **Planting spacing / planting densities:**
- **C. canephora:**
 - 4.0 m x 2.5 m (1100 trees/ha)
 - 2.5 m x 2.0 m (2000 trees/ha)
- **C. arabica:**
 - 4.0 m x 2.5 m (1000 trees/ha)
 - 2.0 m x 2.0 m (2500 trees/ha)

- **Maintenance Of Coffee Plantation**

- **Weeding**

- **Mulching**
- **Shade**
- **Pruning:**

Pruning:

- An important maintenance operation in coffee.
- ❖ Coffee yield is directly dependent on good pruning operations.

Forms Of Pruning In Coffee Culture

- **De-suckering**
- **Topping:**
- **Single stem**
- **Double stem rotation**
- **Vertical / Upright multiple stem**
- **Leaning multiple stem**
- **Hawaiian system**
- **Colombian system**
- **Candelabra system**
- **Guatemalan system**

Harvesting And Processing Of Coffee Berry

- ❖ **Harvesting:**
 - Generally coffee plants come into bearing 3 years after transplanting into the field.
 - The immature berries are green while the mature ones are either yellow, purple or red depending on variety.

Processing / Post-harvest Handling Of Coffee Berries.

- Wet method
- Dry method

Roasting:

- Roasting brings out the proper flavour of coffee.

Grinding:

- Roasted coffee is ground into small particles before it can be used.
- Soluble coffees like Nescafe, are made from infusion of coffee from roasted and ground beans which is drastically dried in very hot air.

❖ **Grading:**

- Re-drying – for uniform moisture content.
- Cleaning – removal of foreign matter and unhulled beans.
- Hulling and polishing – removal of testa.
- Size grading – a set of cylindrical sieve used to separate smaller and broken beans.

Major Diseases Of Coffee

- ❖ **Hemileia leaf rust:** (the leaf)
 - **Causal organisms:** *Hemileia vastatrix*, *H. coffeicola*.
 - **Control:** use of resistant varieties, copper fungicides and farm hygiene / sanitation.
- ❖ **American leaf spot:** (foliage and berry)
 - **Causal organisms:** *Stilbellum flavidum*, *Agaricus citricolor*
 - **Control:** farm hygiene / sanitation, copper fungicides.
- ❖ **Black rot:** (foliage and berry)
 - **Causal organism:** *Pellicularia koleroga*
 - **Control:** farm sanitation, copper fungicides.

Major Insect Pest Of Coffee

- ❖ **Defoliator (*Epicampoptera glauca*).**
 - **Effect:** coffee plant with lace-like leaves
 - **Control:** spray plant with endosulfan directing jet upwards from underneath.
- ❖ **Berry borers (*Stephanoderes hampei*).**
 - **Effect:** Beetles bore small holes in ends of berries. Larvae feed, develop and destroy berries.

- **Control:** Regular harvesting, hygienic measures, spray with insecticides.
- ❖ **Termites.**
 - **Effect:** roots eaten up .Coffee plant falls off without any symptom.
 - **Control:** Destroy termitarium in and around coffee plots.

• TEA (*CAMELLIA SINENSIS* (L) O. Kuntze)

- **Protective Effects Of Tea On Human Health**
- ❖ Flavonoids, the most prominent of which is **catechins** and their derivative **polyphenols**, are the most abundant and most biologically active molecules that are responsible for most of the health-giving properties of tea.
- ❖ Tea contains **theanine**, (which is a unique amino acid in tea), **proteins, caffeine, vitamin C, carbohydrates, polysaccharides, and lipids**.
- ❖ Inappropriate diets and smoking generates high levels of reactive oxygen species, like peroxides in humans, which are the basic cause of heart disease. **Tea polyphenols** have strong scavenging properties for free oxygen radicals, thus **lowering the risk of heart ailment**.

Introduction

- ❖ Tea plant (*Camellia sinensis* (L) O. Kuntze) (family: **Theaceae**) was discovered by Chinese around 2700 BC in South-east Asia, in the high valley of the Brahmaputra, the Irrawaddy, the Salween and the Mekong rivers of the borders separating India, China and Burma.
- ❖ In its wild state, it forms an evergreen bush which on cultivation, is kept at a low level (**Tea Table**).
- ❖ Depending on weather the tea harvests (leaves) undergo **fermentation or not**, respectively, makes tea to be **black or green**.

Botany

- ❖ Tea was formerly named *Thea japonense*. Later **Linnaeus** renamed it *Thea sinensis*. In 1959, the generic name was changed to *Camellia*. The plant is a diploid with $2n = 2x = 30$. A number of triploids and tetraploids have been found or created by research efforts.
- ❖ There are 2 main varieties of tea – **the sinensis** (the China plant with **small leaves C. sinensis var. sinensis**) and the **assamica** (the Assam plant with **large leaves C. sinensis var. assamica**) varieties.
- ❖ The assam tea plant is a shrub which grows up to 15 m high with straight trunk.
- ❖ The China tea is also a shrub which grows up to 6 m high with several stems.
- ❖ Other minor varieties include **Cambodian tea**, of which the following varieties are being cultivated – **Manipuri, Lushai** and **Betjan** which are stable ecotypes.

Ecology Of Tea

- ❖ **Climate** and **soil characteristics** are the most important ecological factors for growing **Tea**:
- ❖ **CLIMATE:**
 - Generally, tea thrives within latitude 43^o north and 27^o south.
 - The plant performs at 1500 – 4000 mm of rainfall, with a dry season of not more than 3 months.
 - The ideal average annual temperature is between 18^oC and 20^oC.
- ❖ **Soil requirements:**
 - Generally, the best plantations of tea are found on deep soils with a good structure, well-drained with a well-developed humus-bearing layer and high mineral reserves.

- The tea plant requires soils with pH of 4.5 – 5.5, if the pH is not up to 5.5, it is better.

Agronomy Of Tea

- ❖ **Generative and Vegetative.**
- ❖ **Tea Nursery:**
- ❖ The following principles should be noted when up setting up cuttings nursery of tea:
 - **Siting**
 - **Shading**
 - **Substrate**
 - **Containers**
 - **Preparation of tea Cuttings**
 - **Maintaining humidity levels**
 - **Preventive measures**
 - **Fertilizer application**
 - **Hardening-off**
 - **Pruning**
- ❖ **Guide towards successful establishment of Tea plantation:**
 - Sit selection
 - Layout
 - Bush clearing
 - Drainage
 - Anti-erosion measures
 - Eradication of self-propagation weeds
 - Tilling
- ❖ **Management of Tea plantation:**
 - ❖ **Planting out**
 - **Planting density / spacing**
 - ❖ **Temporary shading**
 - ❖ **Mulching**
 - ❖ **Windbreaks**
- ❖ **Bringing Tea into bearing / yield:**
 - The main aim of bringing tea plant into bearing is to shape the plant into a permanent frame which is low, broad, heavily branched and capable of producing a large number of shoots (Tea Table), culminating in a high leaf yield.
- ❖ **Plucking:**
 - This is the periodic harvesting. The pluckers are equipped with an apron or waterproof against damp conditions and rains.
- ❖ **Productivity pruning:**
 - The period of the operation of productivity pruning varies from 2 – 6 years depending on climatic conditions and clonal materials planted.
- ❖ **Regenerative pruning:**
 - Regenerative pruning is carried out at 0.35 m from the ground and **tipping** is done at an height of 0.60 m.
- ❖ **Skiffing (cutting into green wood):**
 - The plant is slightly cut back in order to maintain a good yield.
 - This type of cutting is rarely required.
- ❖ **Fertilizer requirements of tea:**
 - Annually and for a yield of 1000 kg/ha of commercial-grade tea, the plant takes up an average of 40 – 50 kgN, 7 – 9 kgP and 20 – 25 kgK from the soil.
- ❖ **Weeding:**
 - The young tea plant is very sensitive to weed competition. Regular weeding (manually or chemically) becomes compulsory.

Disease and Insect pests of Tea

- ❖ **Diseases:**
 - Root rot (*Armillariella mellea*, *Rosellinia arcuata*). Common in forested land.
 - Blister blight (*Exobasidium vexans*):
- ❖ **Insect pests:**

- ❖ The leaf insect pest of tea include:
 - *Homona coffearia*
 - *Urticating caterpillars*
 - *Helopeltis spp.*
 - *Aphids*

- ❖ The branch insects pest are:
 - *Xyleborus fornicates*,
 - *Zeuxera coffeae*,
 - Termites (*Neotermes*, *Glytoterms*, *Coptotermes*)
 - Mites (*Oligonichus coffeae* or red spider)