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AGE 307

FIELD AND TREE CROP PRODUCTION

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Course code: AGE 307

Course title: Field and Tree Crop Production

Course credit load: 2 Units

Series 1: Foundations of Crop Production

- **Part 1.1: Concepts and Classification of Crop Production**
  - Sub Part 1.1.1: Meaning and scope of crop production
  - Sub Part 1.1.2: Classification of crops
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Introduction

Crop production forms the foundation of Nigerian agriculture, supplying food, feed, fibre, and raw materials for industry while supporting the livelihoods of millions of farming households. AGE 307 builds on earlier production courses to examine field crops (cereals, legumes, and tubers) and economic tree crops together, recognising that many of the underlying principles of climate, soil, variety selection, and sustainable management apply across both groups.

This opening Series introduces the concept and classification of crop production and cropping systems; the climatic and soil requirements that determine where and how crops can be successfully grown in Nigeria; and the role of improved varieties, seed systems, and sustainable practices in modern crop production. This foundation supports the field crop systems, tree crop, cultivation, and post-harvest topics covered in the remaining four Series of AGE 307.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 1.1** explain the meaning, scope, classification, and systems of crop production (Linked to Part 1.1),
- **SLO 1.2** describe the climatic requirements for crop production and the agro-ecological zones of Nigeria (Linked to Part 1.2),
- **SLO 1.3** describe the soil requirements, fertility management, and land preparation methods for crop production (Linked to Part 1.3), and
- **SLO 1.4** explain improved varieties, seed systems, and sustainable crop production practices (Linked to Part 1.4).

1.1 Concepts and Classification of Crop Production

1.1.1 Meaning and scope of crop production

Crop production is the deliberate cultivation of plants for food, feed, fibre, and industrial raw material, encompassing all the practices from site and variety selection through planting, management, harvesting, and initial handling of the harvested product. It is distinguished from natural plant growth by the intentional human intervention applied at each stage to maximise yield, quality, and economic return, guided by knowledge of plant biology, soil science, and climate, the core scientific disciplines underlying crop production as a field of study.

The scope of crop production in this course covers two broad groups: field crops (annual or short-cycle crops, including cereals such as maize, rice, and sorghum; legumes such as cowpea and groundnut; and root/tuber crops such as cassava and yam, all typically planted and harvested within a single season) and economic tree crops (longer-lived perennial crops such as oil palm, cocoa, rubber, and citrus, which occupy land for many years and require a different set of management considerations). Both groups share common underlying principles of climate matching, soil requirements, variety selection, and sustainable management explored throughout this Series.

Fill in the blank: Crop production is the deliberate _____ of plants for food, feed, fibre, and industrial raw material, distinguished from natural plant growth by intentional human intervention to maximise yield, quality, and economic return.

1.1.2 Classification of crops

Crops are classified along several useful dimensions. By life cycle: annual crops complete their life cycle (germination to seed production) within one growing season (maize, cowpea); biennial crops require two seasons; perennial crops live and produce for many years (oil palm, cocoa, citrus). By use: food crops are grown primarily for human consumption (rice, cassava); feed crops are grown primarily for livestock (some maize and forage crops); cash/industrial crops are grown primarily for sale or industrial processing (cotton, oil palm, cocoa); cover/fodder crops protect soil or feed livestock without being a primary market product.

By botanical group: cereals (grasses producing starchy grain: maize, rice, sorghum, millet); legumes (nitrogen-fixing pulses: cowpea, groundnut, soybean); root and tuber crops (cassava, yam, sweet potato); and tree/perennial crops (oil palm, cocoa, rubber, citrus, covered in detail in Series 3). By climatic adaptation: crops are also classified as tropical (adapted to warm, humid conditions typical of southern Nigeria) or temperate (requiring cooler conditions, limiting them to Nigeria highland zones), a classification closely tied to the climatic requirements discussed in Part 1.2.

Fill in the blank: _____ crops complete their life cycle from germination to seed production within a single growing season, in contrast to perennial crops, which live and produce for many years.

1.1.3 Cropping systems

A cropping system is the pattern of crops grown on a given piece of land over time and space, including the sequence, spatial arrangement, and management approach used. Monocropping (sole cropping) grows a single crop on a plot at a time, simplifying management and mechanisation but increasing pest/disease risk and nutrient depletion if continued without rotation. Mixed cropping/intercropping grows two or more crops simultaneously on the same plot (e.g. maize and cowpea), improving land use efficiency, providing risk diversification, and, where a legume is included, contributing biological nitrogen fixation benefiting the companion crop.

Crop rotation grows different crops in planned sequence on the same plot across seasons, breaking pest/disease cycles and managing soil fertility, particularly when legumes are rotated with cereals. Relay cropping plants a second crop into a standing first crop before its harvest, maximising use of the growing season. Continuous cropping repeats the same crop on the same land season after season, which, without adequate fertility management, leads to declining yields, a key reason sustainable systems (Part 1.4.3) emphasise rotation and diversification.

Fill in the blank: _____ cropping grows two or more crops simultaneously on the same plot, improving land use efficiency and, where a legume is included, contributing biological nitrogen fixation benefiting the companion crop.

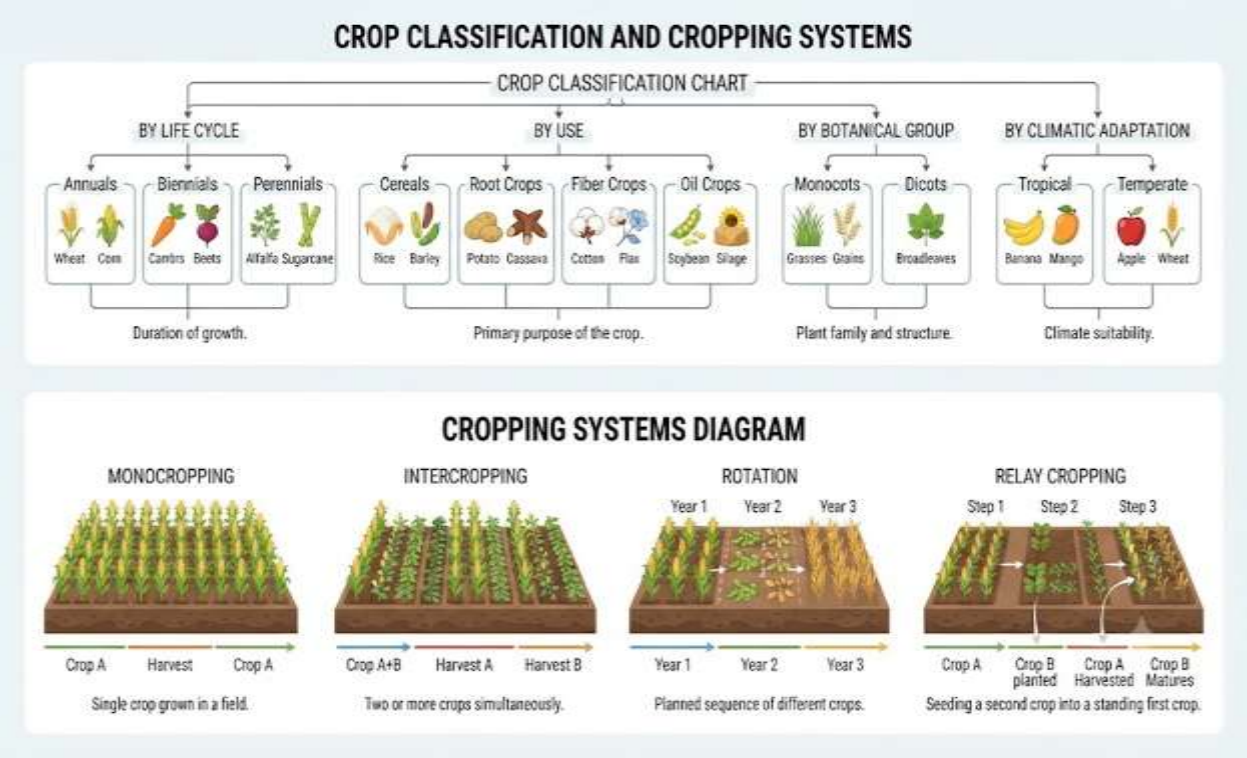

Figure 1.1: Crop classification and cropping systems

Pilot questions 1.1

1. Define crop production and distinguish it from natural plant growth.
2. Classify crops by life cycle and give one Nigerian example of each class.
3. Distinguish between food crops and cash/industrial crops, with one example each.
4. Define cropping system and name three types.
5. Explain one benefit of intercropping a legume with a cereal.

1.2 Climatic Requirements for Crop Production

1.2.1 Temperature and light requirements

Temperature governs germination, vegetative growth, flowering, and maturity rate in crops; each crop has a minimum, optimum, and maximum temperature range, with most Nigerian field crops (maize, rice, cowpea) performing best between 20 and 32 degrees Celsius, while temperate crops

(wheat, Irish potato) require the cooler conditions of the Jos and Mambilla highlands. Temperatures outside the optimum range slow growth, delay flowering, or, at the extremes, cause crop failure through heat or cold stress.

Light intensity and day length (photoperiod) also influence crop development: most field crops require full sun for maximum photosynthesis and yield, and some crops (certain sorghum and rice varieties) are photoperiod-sensitive, flowering only when day length falls within a specific range, a trait breeders consider when developing varieties for different latitudes and planting seasons across Nigeria.

Fill in the blank: Most Nigerian field crops such as maize, rice, and cowpea perform best within a temperature range of approximately _____ to 32 degrees Celsius, while temperate crops require the cooler conditions of Nigeria highland zones.

1.2.2 Rainfall and water requirements

Rainfall amount and distribution across the growing season determine which crops can be grown successfully in a given location without irrigation. Most cereals and legumes require 500 to 1,200 mm of well-distributed rainfall per season; root and tuber crops generally need more (cassava tolerates lower rainfall and is drought-tolerant relative to yam, which needs more consistent moisture). Rainfall distribution matters as much as total amount: a dry spell during flowering or grain filling can severely reduce yield even where total seasonal rainfall is adequate.

Water stress at critical growth stages (germination, flowering, grain filling) causes the greatest yield loss, while excess water/waterlogging causes root damage and disease in most field crops except rice, which tolerates flooded conditions. Where rainfall is unreliable or insufficient, irrigation (covered further in later AGE courses) extends production into the dry season, particularly important in the drier northern agro-ecological zones discussed in Part 1.2.3.

Fill in the blank: Water stress at the critical growth stages of germination, flowering, and grain filling causes the greatest yield _____ in field crops, even where total seasonal rainfall is otherwise adequate.

1.2.3 Agro-ecological zones of Nigeria

Nigeria is divided into broad agro-ecological zones based on rainfall, vegetation, and length of growing season, each suited to different crops. The humid forest zone (south; rainfall 1,500 to 3,000+ mm) suits cassava, yam, plantain, oil palm, and cocoa. The derived and Guinea savanna zone (middle belt; rainfall 1,000 to 1,500 mm) suits maize, sorghum, yam, and groundnut. The Sudan savanna zone (north; rainfall 500 to 1,000 mm) suits millet, sorghum, cowpea, and groundnut, with irrigation supporting dry-season vegetables and wheat in places.

The Sahel zone (far north; rainfall below 500 mm) supports only the most drought-tolerant crops and extensive livestock grazing, with crop production heavily dependent on irrigation. The Jos and Mambilla highlands, though geographically within the middle belt and eastern zones respectively, have a distinct cooler climate due to elevation, supporting temperate crops (Irish potato, wheat, some vegetables) not viable in the surrounding lowlands. Matching crop choice to the local agro-ecological zone is the starting point for successful, sustainable crop production planning.

Fill in the blank: The _____ savanna zone in northern Nigeria, with rainfall of 500 to 1,000 mm, suits millet, sorghum, cowpea, and groundnut, with irrigation supporting dry-season vegetables and wheat in places.

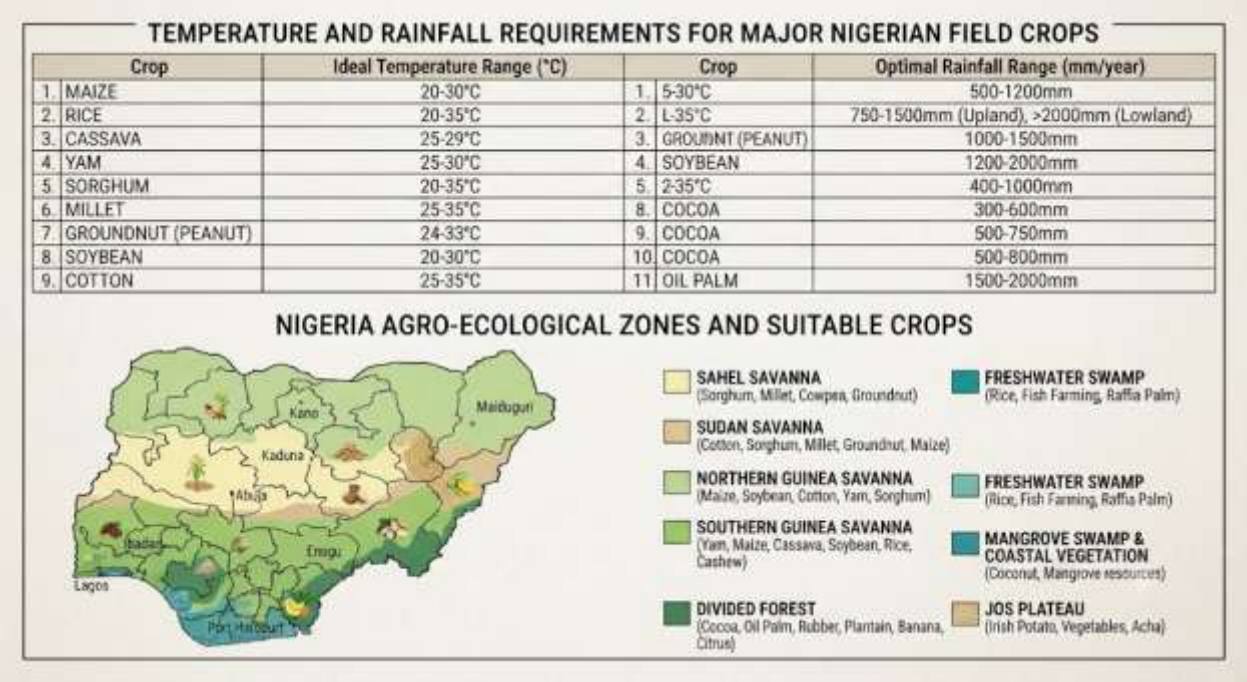

Figure 1.2: Climatic requirements and agro-ecological zones of Nigeria

Pilot questions 1.2

1. State the optimum temperature range for most Nigerian field crops.
2. Explain why rainfall distribution matters as much as total rainfall amount for crop yield.
3. State the growth stages at which water stress causes the greatest yield loss.
4. Name four agro-ecological zones of Nigeria and one crop suited to each.
5. Explain why the Jos and Mambilla highlands support temperate crops not viable elsewhere in Nigeria.

1.3 Soil Requirements for Crop Production

1.3.1 Soil physical and chemical properties

Soil texture (proportion of sand, silt, and clay) determines water-holding capacity, drainage, and aeration: loam soils, balancing all three particle sizes, generally suit most field and tree crops best, while sandy soils drain too fast and clay soils drain too slowly. Soil depth and structure

determine root development potential; a deep, friable (crumbly) soil supports stronger root systems and better drought tolerance than a shallow or compacted soil.

Soil pH affects nutrient availability: most field crops prefer a slightly acidic to neutral pH of 5.5 to 6.8; outside this range, specific nutrients become less available or, at extremes, toxic, requiring lime (to raise pH) or sulphur/organic matter (to lower pH) amendments. Essential nutrients (nitrogen, phosphorus, and potassium as primary macronutrients, plus secondary and micronutrients) must be present in adequate, balanced amounts for healthy crop growth, assessed through soil testing where available.

Fill in the blank: Most field crops prefer a slightly acidic to neutral soil pH of _____ ; outside this range, nutrient availability is reduced, requiring lime or sulphur/organic matter amendments to correct.

1.3.2 Soil fertility management

Maintaining soil fertility over successive cropping seasons requires combining organic and inorganic nutrient sources. Organic matter (compost, farmyard manure, crop residues, green manures) improves soil structure, water-holding capacity, and slow-release nutrient supply, and is especially important in Nigerian tropical soils, which lose organic matter rapidly under high temperature and rainfall. Inorganic fertilisers (NPK blends, urea, single superphosphate) supply nutrients in concentrated, readily available form, correcting deficiencies organic sources alone may not meet quickly enough.

Integrated nutrient management, combining organic and inorganic sources based on soil test results and crop need, achieves both immediate yield response and long-term soil health better than relying on either source alone. Legume rotation and intercropping (Part 1.1.3) contribute biological nitrogen fixation, reducing the nitrogen fertiliser requirement of a following or companion cereal crop, an important low-cost fertility strategy for smallholder Nigerian farmers.

Fill in the blank: _____ nutrient management, combining organic and inorganic sources based on soil test results and crop need, achieves both immediate yield response and long-term soil health better than relying on either source alone.

1.3.3 Land preparation methods

Land preparation creates a suitable physical environment for seed germination and root establishment. Manual methods (hoe and cutlass clearing and tillage) remain common on Nigerian smallholder farms, requiring high labour input but low capital cost. Mechanised methods (tractor ploughing, harrowing, ridging) cover larger areas faster and can achieve more uniform tillage, but require capital investment and are limited by terrain, field size, and tractor availability in many rural areas.

Minimum/zero tillage (leaving the soil largely undisturbed, planting directly with minimal soil disruption) reduces erosion and preserves soil structure and organic matter compared to conventional tillage, increasingly promoted as part of sustainable production (Part 1.4.3), though it requires effective weed control (often herbicide-based) to compensate for the weed-suppression benefit lost by not ploughing. Ridging and mounding (raising soil into ridges or mounds) improves drainage and is standard practice for root/tuber crops such as yam and cassava.

Fill in the blank: _____ tillage leaves the soil largely undisturbed during planting, reducing erosion and preserving soil structure and organic matter compared to conventional ploughing, but requiring effective weed control to compensate.

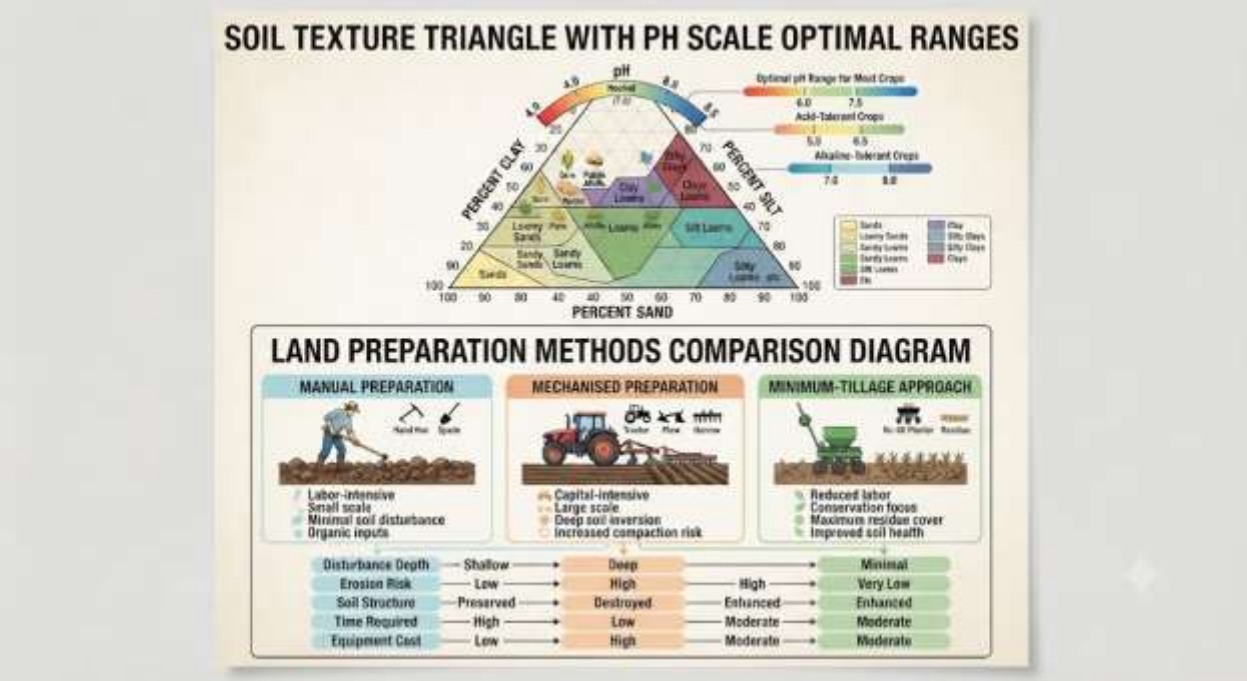

Figure 1.3: Soil requirements and land preparation methods

Pilot questions 1.3

1. State the soil texture generally most suitable for field and tree crops and explain why.
2. State the optimum soil pH range for most field crops.
3. Distinguish between organic and inorganic nutrient sources for soil fertility management.
4. Explain the benefit of legume rotation for soil fertility.
5. Distinguish between conventional tillage and minimum/zero tillage.

1.4 Improved Crop Varieties and Sustainable Production

1.4.1 Concept of improved varieties

Improved varieties are crop varieties developed through plant breeding to offer higher yield, better disease/pest resistance, improved quality, or specific adaptation (drought tolerance, early maturity) compared to local landraces. Hybrid varieties combine two parent lines for hybrid vigour but require fresh seed purchase each season; open-pollinated improved varieties breed

true from saved seed, offering a lower-cost option that still improves on unimproved local landraces.

Adoption of improved varieties in Nigeria has been a major driver of yield gains for crops such as maize, rice, and cassava, though adoption rates vary by crop, region, and farmer access to seed and information, a topic explored further in Part 1.4.2. Selecting the right variety for the local agro-ecological zone (Part 1.2.3) and intended use (food, feed, or market sale) is as important as the variety inherent yield potential.

Fill in the blank: _____ varieties are developed through plant breeding to offer higher yield, better disease/pest resistance, improved quality, or specific adaptation compared to local landraces.

1.4.2 Seed systems in Nigeria

The formal seed system involves breeder seed (developed by research institutions such as IITA and IAR), multiplied through foundation and certified seed stages by registered seed companies, and sold through agro-dealers; this system aims to deliver genetically pure, high-quality seed but reaches only a portion of Nigerian farmers due to distribution, cost, and awareness constraints. The informal seed system (farmer-saved seed, exchange among farmers, and local grain markets sold as seed) remains the dominant source for many smallholder farmers, offering low cost but variable quality and uncertain variety identity.

Community-based seed production and farmer seed cooperatives bridge the two systems, multiplying improved varieties locally for nearby farmers at lower cost than the fully formal system while maintaining better quality control than informal grain-market seed. Expanding farmer access to quality seed of well-adapted improved varieties remains a key priority for raising Nigerian field and tree crop productivity.

Fill in the blank: The _____ seed system, consisting of farmer-saved seed, exchange among farmers, and grain-market seed, remains the dominant seed source for many Nigerian smallholder farmers despite offering variable quality and uncertain variety identity.

1.4.3 Sustainable crop production practices

Sustainable crop production aims to meet current food and income needs without degrading the land and resource base needed for future production. Key practices include soil health management (organic matter building, minimum tillage, erosion control through contour farming and cover crops), water-efficient practices (matching crop choice to rainfall, efficient irrigation where used), and integrated nutrient and pest management (combining organic and inorganic inputs and cultural/biological pest control rather than relying solely on chemical inputs).

Diversification (crop rotation, intercropping, and growing a range of crops rather than continuous monocropping) spreads production and income risk and supports soil health and pest/disease management simultaneously. Climate-smart practices (drought-tolerant variety selection, adjusted planting calendars responsive to changing rainfall patterns, and water harvesting) are increasingly important as Nigerian farmers face more variable rainfall and rising temperatures, themes that recur throughout the remaining Series of this course as specific field and tree crops are examined in detail.

Fill in the blank: _____ crop production aims to meet current food and income needs without degrading the land and resource base needed for future production, combining soil health, water-efficient, and integrated management practices.

Figure 1.4: Improved varieties, seed systems, and sustainable production

Pilot questions 1.4

1. Define improved variety and distinguish between hybrid and open-pollinated improved varieties.
2. Distinguish between the formal and informal seed systems in Nigeria.
3. Explain the role of community-based seed production.
4. Define sustainable crop production and name three key practices.
5. Explain why diversification supports both risk management and soil health.

Series Summary

This Series examined **crop production as the deliberate cultivation of plants for food, feed, fibre, and industrial raw materials**. It covers annual field crops such as cereals, legumes, and tubers, as well as perennial tree crops. Crops may be classified by life cycle, use, botanical group, or climatic adaptation. Major cropping systems include monocropping, intercropping, crop rotation, relay cropping, and continuous cropping. Crop performance depends on temperature, light, rainfall, and water availability, with moisture stress being especially harmful during germination, flowering, and grain filling. Nigeria's agro-ecological zones, including the humid forest, Guinea savanna, Sudan savanna, Sahel, and highlands, differ in the crops they can support.

The Series also covered **soil and management requirements for successful crop production**. Suitable soils should have good texture, depth, structure, drainage, pH, and nutrient supply, while fertility may be improved through organic matter, inorganic fertilisers, integrated nutrient management, and legume rotation. Land may be prepared manually, mechanically, by ridging, or through minimum and zero tillage. Improved varieties, including hybrids and open-pollinated varieties, can increase yield and resistance. Seed may come from formal systems, farmer-saved sources, or community seed production. Sustainable production depends on soil health, efficient water use, integrated nutrient and pest management, crop diversification, and climate-smart practices. By completing this Series, students should achieve SLOs 1.1–1.4.

Glossary of Terms

- **Agro-ecological zone:** a broad region classified by rainfall, vegetation, and growing season length, suited to particular crops.
- **Crop production:** the deliberate cultivation of plants for food, feed, fibre, or industrial raw material.
- **Cropping system:** the pattern of crops grown on a given land over time and space, including sequence and spatial arrangement.

- **Field crop:** an annual or short-cycle crop typically planted and harvested within a single season, such as maize or cassava.
- **Improved variety:** a crop variety developed through breeding to offer higher yield, resistance, or specific adaptation compared to local landraces.
- **Integrated nutrient management:** combining organic and inorganic nutrient sources based on soil test results and crop need.
- **Intercropping:** growing two or more crops simultaneously on the same plot.
- **Minimum/zero tillage:** a land preparation approach leaving soil largely undisturbed during planting, reducing erosion and preserving soil structure.
- **Soil texture:** the relative proportion of sand, silt, and clay particles in soil, determining water-holding capacity and drainage.
- **Sustainable crop production:** production that meets current needs without degrading the land and resource base needed for future production.
- **Tree crop:** a perennial crop occupying land for many years, such as oil palm, cocoa, or citrus.

Concept Check Questions [Series 1]

Objective Questions

1. _____ crops complete their life cycle from germination to seed production within a single growing season. (Linked to SLO 1.1)
2. The _____ savanna zone in northern Nigeria suits millet, sorghum, cowpea, and groundnut. (Linked to SLO 1.2)
3. Most field crops prefer a soil pH range of _____ . (Linked to SLO 1.3)
4. _____ varieties are developed through breeding to offer higher yield or resistance compared to local landraces. (Linked to SLO 1.4)
5. The _____ seed system remains the dominant seed source for many Nigerian smallholder farmers. (Linked to SLO 1.4)

Short-Answer Questions

6. Name three classifications used to group crops. (Linked to SLO 1.1)
7. Name four agro-ecological zones of Nigeria. (Linked to SLO 1.2)
8. State the optimum soil pH range for most field crops. (Linked to SLO 1.3)
9. Distinguish between hybrid and open-pollinated improved varieties. (Linked to SLO 1.4)
10. Name three sustainable crop production practices. (Linked to SLO 1.4)

Long-Answer Questions

11. Explain the classification of crops and cropping systems. (Linked to SLO 1.1)
12. Describe the climatic requirements for crop production and the agro-ecological zones of Nigeria. (Linked to SLO 1.2)
13. Describe soil requirements, fertility management, improved varieties, and sustainable production practices. (Linked to SLOs 1.3, 1.4)

Answers to Concept Check Questions [Series 1]

Objective Questions

1. Annual.
2. Sudan.
3. 5.5 to 6.8.
4. Improved.
5. Informal.

Short-Answer Questions

6. Life cycle, use, and botanical group (or climatic adaptation).
7. Humid forest, Guinea savanna, Sudan savanna, and Sahel (or highlands).

8. 5.5 to 6.8.
9. Hybrid varieties offer higher vigour but need fresh seed each season; open-pollinated varieties breed true from saved seed.
10. Soil health management, integrated nutrient/pest management, and diversification (or water-efficient practices).

Long-Answer Questions

11. Crops are classified by life cycle (annual, biennial, perennial), use (food, feed, cash/industrial), and botanical group (cereals, legumes, tubers, tree crops). Cropping systems include monocropping, intercropping, rotation, relay cropping, and continuous cropping, each with different effects on land use, risk, and soil fertility.
12. Climatic requirements include temperature (20-32 degrees Celsius for most field crops), light/photoperiod, and rainfall (500-1,200 mm, well distributed, for cereals and legumes), with water stress most damaging at germination, flowering, and grain filling. Nigeria agro-ecological zones (humid forest, Guinea savanna, Sudan savanna, Sahel, highlands) differ in rainfall and suit different crops accordingly.
13. Soil requirements include texture (loam optimal), depth/structure, and pH (5.5-6.8); fertility is managed through organic matter, inorganic fertiliser, and integrated nutrient management. Improved varieties (hybrid or open-pollinated) raise yield and resistance, sourced through formal or informal seed systems. Sustainable production combines soil health, water efficiency, integrated pest/nutrient management, and diversification.

Answers to Pilot Questions [Series 1]

Part 1.1

1. Crop production is the deliberate cultivation of plants for food, feed, fibre, and industrial raw material; it differs from natural growth through intentional human management at each stage.
2. Annual crops complete their cycle in one season (e.g. maize); perennial crops live and produce for many years (e.g. oil palm).

3. Food crops are grown for human consumption (e.g. rice); cash/industrial crops are grown for sale or processing (e.g. cotton).
4. A cropping system is the pattern of crops grown over time and space. Three types: monocropping, intercropping, and crop rotation.
5. Intercropping a legume with a cereal contributes biological nitrogen fixation, benefiting the companion cereal crop.

Part 1.2

1. Most Nigerian field crops perform best between 20 and 32 degrees Celsius.
2. Rainfall distribution matters because a dry spell during a critical growth stage can severely reduce yield even if total seasonal rainfall is adequate.
3. Germination, flowering, and grain filling are the growth stages most affected by water stress.
4. Four zones: humid forest (cocoa), Guinea savanna (maize), Sudan savanna (millet), and Sahel (drought-tolerant crops/livestock).
5. Their elevation gives them a cooler climate than the surrounding lowlands, suiting temperate crops such as Irish potato and wheat.

Part 1.3

1. Loam soil is generally most suitable because it balances water retention, drainage, and aeration.
2. The optimum soil pH range for most field crops is 5.5 to 6.8.
3. Organic sources (compost, manure) improve soil structure and release nutrients slowly; inorganic fertilisers supply concentrated, readily available nutrients.
4. Legume rotation contributes biological nitrogen fixation, reducing the nitrogen fertiliser need of the following crop.
5. Conventional tillage disturbs the soil through ploughing; minimum/zero tillage leaves soil largely undisturbed, reducing erosion.

Part 1.4

1. Improved varieties are bred for higher yield or resistance. Hybrids need fresh seed each season; open-pollinated varieties breed true from saved seed.
2. The formal system supplies certified seed through registered companies; the informal system relies on farmer-saved or exchanged seed of variable quality.
3. Community-based seed production multiplies improved varieties locally, offering better quality than informal seed at lower cost than the fully formal system.
4. Sustainable crop production meets current needs without degrading future production capacity. Three practices: soil health management, water-efficient practices, and integrated nutrient/pest management.
5. Diversification spreads income/production risk across multiple crops while supporting soil health and breaking pest/disease cycles through rotation.

References and Attributions

Textual References (Books and External Sources)

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- Tindall, H. D. (1983). Vegetables in the tropics. Macmillan Press, London.
- Brady, N. C., & Weil, R. R. (2008). The nature and properties of soils (14th ed.). Prentice Hall.
- IITA (International Institute of Tropical Agriculture). (2020). Annual report. IITA, Ibadan.

Figures, Plates, Tables, and Boxes

- Figure 1.1: Crop classification and cropping systems Attribution: AI generated. Suggested OER search string: "crop classification cereals legumes tuber crops cropping systems intercropping rotation Nigeria OER".
- Figure 1.2: Climatic requirements and agro-ecological zones of Nigeria Attribution: AI generated. Suggested OER search string: "Nigeria agro-ecological zones rainfall temperature crop requirements humid forest Guinea savanna Sudan savanna Sahel OER".
- Figure 1.3: Soil requirements and land preparation methods Attribution: AI generated. Suggested OER search string: "soil texture pH land preparation tillage ridging Nigeria crop production OER".

- Figure 1.4: Improved varieties, seed systems, and sustainable production Attribution: AI generated. Suggested OER search string: "improved crop varieties seed system formal informal sustainable production Nigeria OER".

Series 2: Field Crop Systems and Practices

- **Part 2.1: Cereal Crop Production**
    - Sub Part 2.1.1: Maize production
    - Sub Part 2.1.2: Rice production
    - Sub Part 2.1.3: Sorghum and millet production
- **Part 2.2: Legume Crop Production**
    - Sub Part 2.2.1: Cowpea production
    - Sub Part 2.2.2: Groundnut production
    - Sub Part 2.2.3: Soybean production
- **Part 2.3: Root and Tuber Crop Production**
    - Sub Part 2.3.1: Cassava production
    - Sub Part 2.3.2: Yam production
    - Sub Part 2.3.3: Sweet potato production
- **Part 2.4: Field Crop Management Practices**
    - Sub Part 2.4.1: Planting practices for field crops
    - Sub Part 2.4.2: Weed and pest management in field crops
    - Sub Part 2.4.3: Economic aspects of field crop production

Introduction

Building on the foundational concepts of Series 1, this Series examines the specific production practices for Nigeria most important field crops, grouped into cereals, legumes, and root/tuber

crops. Each crop group has distinct history, distribution, varietal, and management characteristics, while sharing the underlying climate and soil principles established in Series 1.

This Series covers maize, rice, sorghum, and millet production among cereals; cowpea, groundnut, and soybean among legumes; and cassava, yam, and sweet potato among root/tuber crops, before closing with general field crop management practices covering planting, weed/pest control, and economic aspects. This prepares students for the tree crop topics of Series 3 and the cultivation/management and harvesting topics of Series 4 and 5.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 2.1** describe the history, distribution, and production practices of major Nigerian cereal crops (Linked to Part 2.1),
- **SLO 2.2** describe the history, distribution, and production practices of major Nigerian legume crops (Linked to Part 2.2),
- **SLO 2.3** describe the history, distribution, and production practices of major Nigerian root and tuber crops (Linked to Part 2.3), and
- **SLO 2.4** explain general field crop planting, weed/pest management, and economic aspects (Linked to Part 2.4).

2.1 Cereal Crop Production

2.1.1 Maize production

Maize (Zea mays), introduced to West Africa from the Americas in the 16th century, is now Nigeria most widely grown cereal, cultivated across the Guinea savanna and humid forest zones. It requires temperatures of 20-32 degrees Celsius, 500-1,200 mm well-distributed rainfall, and

well-drained loam soil; improved varieties (including hybrid and quality protein maize varieties from IITA and IAR) have substantially raised yields over local landraces.

Maize is typically planted at the onset of rains at a spacing of 75 cm x 25 cm (one seed per hole) or 75 cm x 50 cm (two seeds per hole), with NPK and urea top-dressing applied at planting and 4-6 weeks after emergence respectively. Harvesting occurs 90-120 days after planting depending on variety, once husks dry and kernels harden; maize serves as both a staple food and a major livestock feed ingredient.

Fill in the blank: Maize requires temperatures of _____ degrees Celsius and 500-1,200 mm of well-distributed rainfall, performing best on well-drained loam soil.

2.1.2 Rice production

Rice (Oryza sativa and the indigenous Oryza glaberrima) is grown across upland, lowland/swamp, and irrigated systems in Nigeria, with the Kebbi, Niger, and Ebonyi areas among the leading production zones. Unlike most field crops, rice tolerates flooded conditions, making lowland and irrigated systems particularly productive, while upland rice relies on rainfall alone and is more drought-vulnerable.

Improved varieties (such as FARO series releases) have raised yields and shortened maturity compared to traditional varieties; transplanting (for lowland/irrigated systems) or direct seeding (for upland systems) are the two main establishment methods, with water management (maintaining a shallow flood for lowland rice) being the most critical management factor distinguishing rice from other cereals.

Fill in the blank: Unlike most field crops, rice tolerates _____ conditions, making lowland and irrigated production systems particularly productive in Nigeria.

2.1.3 Sorghum and millet production

Sorghum (Sorghum bicolor) and millet (Pennisetum glaucum) are the dominant cereals of the drier Sudan savanna and Sahel zones, valued for their drought tolerance and ability to produce on

lower rainfall (300-800 mm) than maize or rice. Both crops are deep-rooted and have waxy leaf coatings that reduce water loss, biological adaptations suited to their semi-arid growing environment.

Sorghum is used for food (tuwo, pap), livestock feed, and local brewing, while millet is primarily a food staple in the far north. Both are typically planted at the onset of rains with wide spacing (75-100 cm), and intercropped with cowpea or groundnut is common practice, reflecting the cropping system principles introduced in Series 1.

Fill in the blank: Sorghum and millet are the dominant cereals of the drier Sudan savanna and Sahel zones, able to produce on lower rainfall of _____ mm than maize or rice.

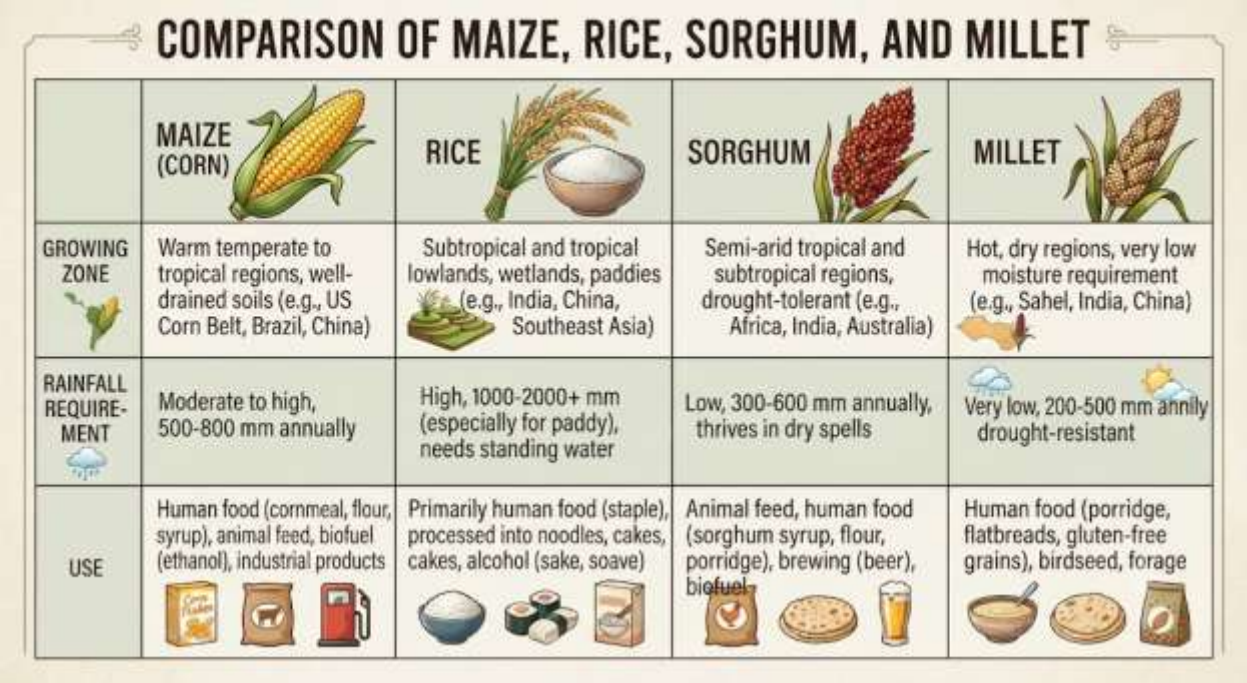

Figure 2.1: Major Nigerian cereal crops

Pilot questions 2.1

1. State the climatic requirements for maize production.
2. Distinguish between upland and lowland rice production systems.
3. Explain why rice tolerates flooded conditions unlike most other cereals.
4. State two uses of sorghum in Nigeria.
5. Explain why sorghum and millet are suited to the Sudan savanna and Sahel zones.

2.2 Legume Crop Production

2.2.1 Cowpea production

Cowpea (Vigna unguiculata), native to Africa, is Nigeria most important grain legume, widely grown across the Guinea and Sudan savanna zones, valued for its drought tolerance, short duration (60-90 days), and nitrogen-fixing ability that benefits soil fertility and companion/following crops.

Improved varieties (IITA-bred, with resistance to Striga and major insect pests) have raised yields substantially; cowpea is highly susceptible to insect pests (pod borers, aphids, bruchids in storage), making timely insecticide application at flowering and pod formation, and proper storage (airtight containers or improved bags), essential management practices.

Fill in the blank: Cowpea fixes _____ , benefiting soil fertility for companion and following crops, and is highly susceptible to insect pests requiring timely insecticide application and proper storage.

2.2.2 Groundnut production

Groundnut (Arachis hypogaea) is grown widely across the Guinea and Sudan savanna zones, historically a major Nigerian export crop and still important for food, oil, and feed (cake). It performs best on well-drained sandy loam soils, which facilitate pod development underground and ease of harvesting.

Aflatoxin contamination (from Aspergillus fungi, occurring particularly under poor drying/storage conditions) is a major quality and safety concern in groundnut, managed through prompt drying after harvest, proper storage, and resistant variety use; groundnut rosette virus, transmitted by aphids, is the most significant disease constraint in the field.

Fill in the blank: _____ contamination, from Aspergillus fungi under poor drying or storage conditions, is a major quality and safety concern in groundnut production.

2.2.3 Soybean production

Soybean (Glycine max), introduced more recently than cowpea and groundnut, has grown rapidly in Nigeria due to demand from the poultry feed and vegetable oil industries, concentrated in the Guinea savanna middle belt zone (Benue, Kaduna, Niger states). It requires effective Rhizobium inoculation for good nitrogen fixation where the crop has not previously been grown in a field.

Improved varieties bred for the Nigerian environment, combined with proper inoculation and balanced phosphorus fertilisation, have substantially raised yields; soybean is increasingly grown in rotation with maize, capturing both the nitrogen-fixation soil benefit and the diversification benefits introduced in Series 1.

Fill in the blank: Soybean requires effective _____ inoculation for good nitrogen fixation where the crop has not previously been grown in a field.

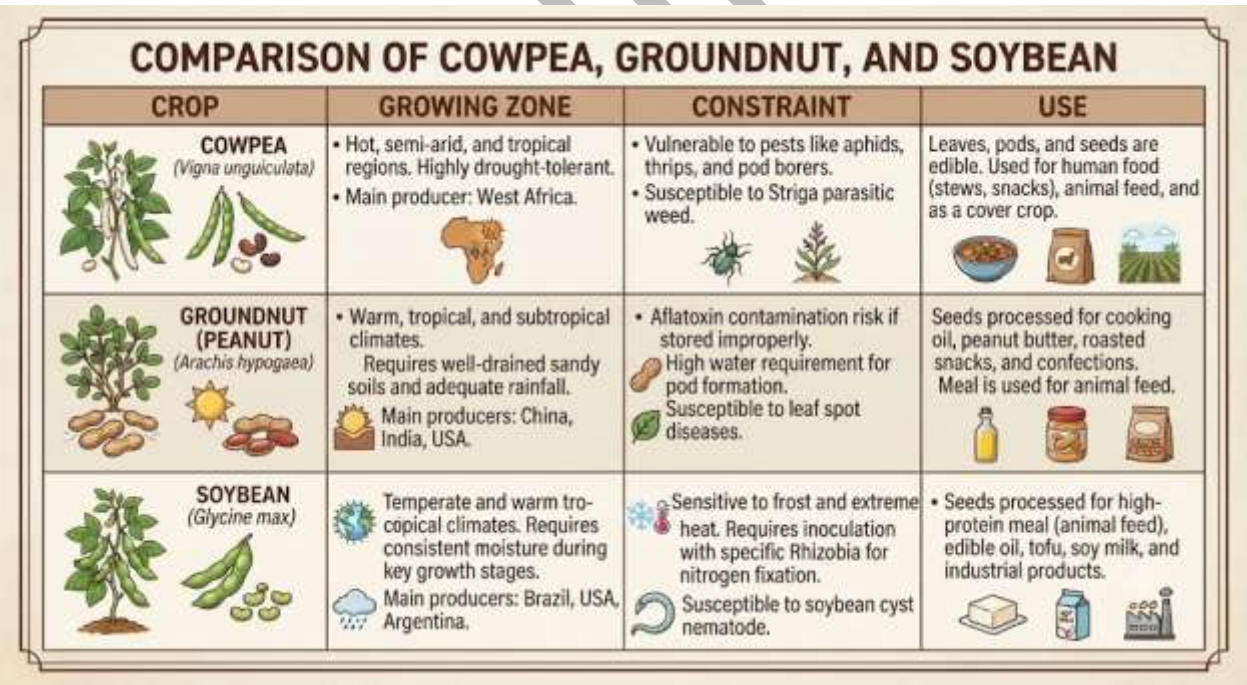

Figure 2.2: Major Nigerian legume crops

Pilot questions 2.2

1. State two benefits cowpea provides through nitrogen fixation and short duration.
2. Explain the main storage pest concern for cowpea.
3. Explain aflatoxin contamination in groundnut and how it is managed.
4. Name the main disease constraint of groundnut and its means of transmission.
5. Explain why soybean requires Rhizobium inoculation in some fields.

2.3 Root and Tuber Crop Production

2.3.1 Cassava production

Cassava (Manihot esculenta), introduced from South America, is Nigeria most widely grown root crop and a major staple, valued for its drought tolerance, ability to grow on poor soils, and flexible harvest timing (roots can remain in the ground for extended periods). It is propagated from stem cuttings rather than seed, planted at the onset of rains.

Improved varieties (IITA-bred, with higher yield and disease resistance) have raised productivity considerably; cassava mosaic disease, transmitted by whiteflies, is the most significant disease constraint, managed primarily through resistant varieties and clean planting material rather than chemical control.

Fill in the blank: Cassava is propagated from _____ rather than seed, and offers flexible harvest timing since roots can remain in the ground for extended periods after maturity.

2.3.2 Yam production

Yam (Dioscorea species), with Nigeria as the world largest producer, is concentrated in the yam belt of the middle belt and southern Guinea savanna states (Benue, Niger, Taraba). It requires more consistent moisture than cassava and is typically grown on mounds or ridges that improve drainage and ease of tuber development.

Yam is propagated from tuber setts (cut pieces of seed yam) and requires staking (providing a support structure for the climbing vine) for optimal yield; it is a high-value, labour-intensive crop with significant cultural importance in many Nigerian farming communities alongside its economic role.

Fill in the blank: Yam is typically grown on _____ or ridges that improve drainage and ease of tuber development, and is propagated from cut tuber setts.

2.3.3 Sweet potato production

Sweet potato (Ipomoea batatas) is a shorter-duration (3-4 months), more drought-tolerant root crop than yam, grown across multiple Nigerian agro-ecological zones and increasingly promoted (particularly orange-fleshed biofortified varieties) for its vitamin A content as a food security and nutrition crop.

Propagated from vine cuttings, sweet potato is typically grown on ridges or mounds similar to yam but with closer spacing and a much shorter growth cycle, making it a useful crop for filling seasonal food gaps and for relay/intercropping systems discussed in Series 1.

Fill in the blank: _____ -fleshed sweet potato varieties are increasingly promoted in Nigeria for their vitamin A content as a food security and nutrition crop.

Figure 2.3: Major Nigerian root and tuber crops

Pilot questions 2.3

1. State two advantages of cassava as a Nigerian staple crop.
2. Explain cassava mosaic disease and how it is managed.
3. Explain why yam is grown on mounds or ridges.
4. Define staking in yam production and explain its purpose.
5. State one nutritional benefit of orange-fleshed sweet potato.

2.4 Field Crop Management Practices

2.4.1 Planting practices for field crops

Planting time, aligned with the onset of reliable rains in each agro-ecological zone (Series 1), is critical for field crop establishment; planting too early risks seed/seedling loss to dry spells, while planting too late shortens the effective growing season and exposes the crop to end-of-season drought during flowering or maturity.

Planting depth and spacing vary by crop (shallow for small-seeded cereals like millet; deeper for large-seeded legumes like groundnut) and are set to optimise plant population without excessive competition for light, water, and nutrients; seed rate and spacing recommendations from research institutions (IITA, IAR) for each crop and variety should guide practical planting decisions.

Fill in the blank: Planting time aligned with the onset of reliable rains is critical for field crop establishment; planting too _____ shortens the growing season and exposes the crop to end-of-season drought.

2.4.2 Weed and pest management in field crops

Weeds compete with field crops for light, water, and nutrients, with the first 3-6 weeks after planting being the critical period for weed control before crop canopy closure; manual weeding (hoe), herbicide application, and mulching are the main control methods, often combined for cost-effective management.

Insect pests (stem borers in cereals, pod borers in legumes, weevils in stored grain) and diseases (rusts and blights in cereals, mosaic viruses in cassava and legumes) require integrated management combining resistant varieties, cultural practices (rotation, sanitation), and targeted pesticide use, following the integrated pest management principles applicable across field and tree crops alike.

Fill in the blank: The critical period for weed control in most field crops is the first _____ weeks after planting, before crop canopy closure reduces weed competition naturally.

2.4.3 Economic aspects of field crop production

Field crop profitability depends on yield, input costs (seed, fertiliser, labour, pesticide), and market price at sale, with smallholder farmers facing the seasonal post-harvest price glut and pre-harvest scarcity pattern discussed in agricultural marketing courses; storage and value addition (processing maize into flour, cassava into garri) can improve returns by allowing farmers to sell when prices are more favourable.

Government policy (input subsidy programmes, the Anchor Borrowers Programme, and commodity-specific development initiatives) and access to credit significantly influence the scale and profitability of field crop production for Nigerian smallholder farmers, alongside the underlying agronomic factors covered earlier in this Series.

Fill in the blank: Storage and _____ addition, such as processing maize into flour or cassava into garri, can improve farmer returns by allowing sale when prices are more favourable than at harvest time.

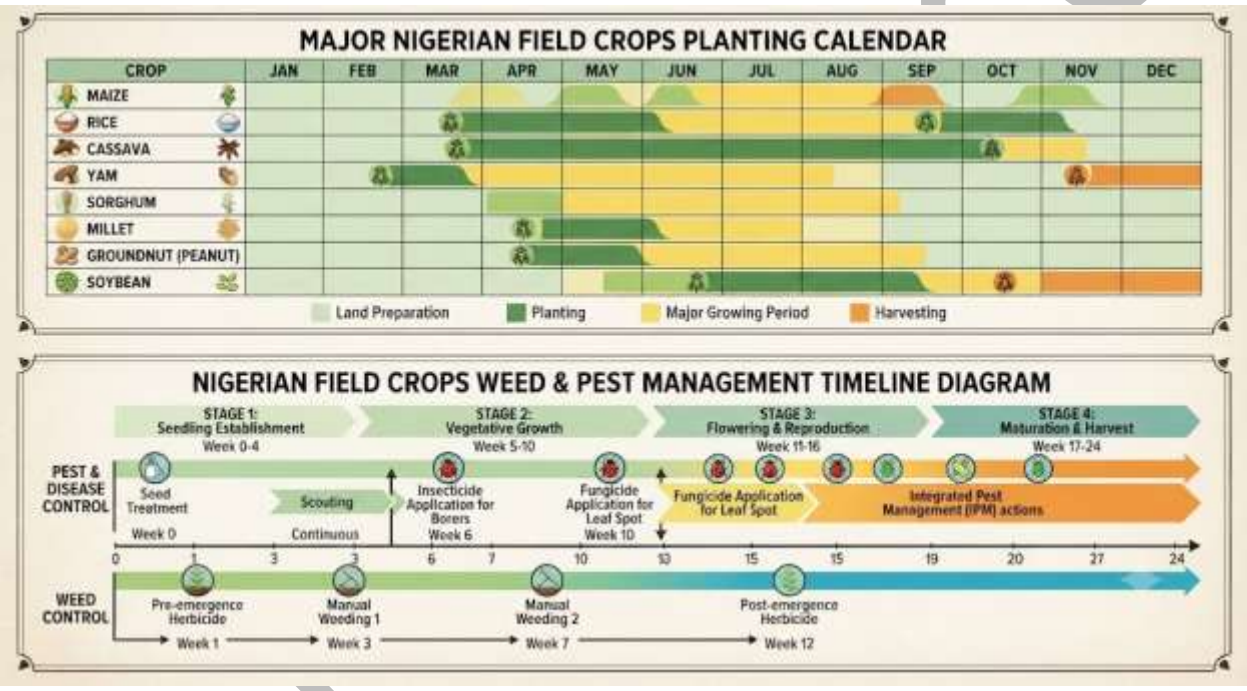

Figure 2.4: Field crop management practices

Pilot questions 2.4

6. Explain the risk of planting too early or too late relative to the onset of rains.
7. State the critical period for weed control in most field crops.
8. Name two integrated pest management methods for field crops.
9. Explain how storage and value addition can improve farmer returns.
10. Name two government policy instruments supporting Nigerian field crop production.

Series Summary

This Series examined **major Nigerian field crops and their production requirements**. Cereals include maize, which grows best under warm conditions and moderate rainfall; rice, which is cultivated under upland, lowland, and irrigated systems; and sorghum and millet, which are drought-tolerant and suited to the Sudan savanna and Sahel. Important legumes include cowpea, groundnut, and soybean. Cowpea fixes nitrogen but is highly vulnerable to pests, groundnut requires well-drained sandy loam and may suffer from aflatoxin and rosette virus, while soybean benefits from *Rhizobium* inoculation and has strong demand from the feed and oil industries. Major root and tuber crops include cassava, yam, and sweet potato, each propagated through vegetative materials such as stem cuttings, tuber setts, or vine cuttings.

The Series also covered **field crop management as the set of practices used to establish, protect, and profitably produce crops**. Planting should be timed with the onset of rainfall, while spacing and planting depth must suit each crop. Weed control is most critical during the first three to six weeks after planting. Integrated pest management combines resistant varieties, cultural practices, field monitoring, and careful pesticide use. Profitability also depends on input costs, market prices, storage, value addition, government policy, and access to credit. By completing this Series, students should achieve SLOs 2.1–2.4.

Glossary of Terms

- **Aflatoxin:** a toxic contaminant produced by Aspergillus fungi in groundnut and other crops under poor drying or storage conditions.
- **Cassava mosaic disease:** a whitefly-transmitted viral disease of cassava, managed primarily through resistant varieties and clean planting material.
- **Critical period (weed control):** the first 3-6 weeks after planting, during which weed competition causes the greatest yield loss in most field crops.
- **Lowland rice:** rice grown in flooded or swamp conditions, tolerating standing water unlike most other cereals.

- **Quality protein maize:** an improved maize type bred for higher nutritional protein quality.
- **Rhizobium inoculation:** the application of nitrogen-fixing bacteria to legume seed or soil to improve nitrogen fixation, especially where the crop is newly introduced to a field.
- **Staking:** providing a support structure for a climbing crop such as yam to optimise growth and yield.
- **Tuber sett:** a cut piece of seed yam used for propagation.
- **Upland rice:** rice grown under rainfed conditions without standing water, more drought-vulnerable than lowland rice.

Concept Check Questions [Series 2]

Objective Questions

1. Maize requires temperatures of _____ degrees Celsius for good growth. (Linked to SLO 2.1)
2. Cowpea fixes _____ , benefiting soil fertility for companion and following crops. (Linked to SLO 2.2)
3. Cassava is propagated from _____ rather than seed. (Linked to SLO 2.3)
4. The critical period for weed control in most field crops is the first _____ weeks after planting. (Linked to SLO 2.4)
5. Yam is propagated from cut tuber _____ . (Linked to SLO 2.3)

Short-Answer Questions

1. Name three major Nigerian cereal crops. (Linked to SLO 2.1)
2. Name three major Nigerian legume crops. (Linked to SLO 2.2)
3. Name three major Nigerian root/tuber crops. (Linked to SLO 2.3)
4. State two factors determining field crop profitability. (Linked to SLO 2.4)
5. Name two diseases affecting Nigerian field crops and their crop hosts. (Linked to SLO 2.4)

Long-Answer Questions

1. Describe the production practices of major Nigerian cereal crops. (Linked to SLO 2.1)
2. Describe the production practices of major Nigerian legume and root/tuber crops. (Linked to SLOs 2.2, 2.3)
3. Explain general field crop planting, weed/pest management, and economic aspects. (Linked to SLO 2.4)

Answers to Concept Check Questions [Series 2]

Objective Questions

1. 20-32.
2. Nitrogen.
3. Stem cuttings.

4. 3-6.
5. Setts.

Short-Answer Questions

1. Maize, rice, and sorghum (or millet).
2. Cowpea, groundnut, and soybean.
3. Cassava, yam, and sweet potato.
4. Yield, input costs, and market price (or storage/value addition).
5. Cassava mosaic disease (cassava) and groundnut rosette virus (groundnut).

Long-Answer Questions

1. Maize requires 20-32 degrees Celsius and 500-1,200 mm rainfall, planted at 75x25 cm spacing. Rice tolerates flooding, grown in upland, lowland, and irrigated systems. Sorghum and millet are drought-tolerant, suited to the Sudan savanna and Sahel on 300-800 mm rainfall.
2. Cowpea fixes nitrogen, short duration, pest-prone. Groundnut needs sandy loam soil, faces aflatoxin and rosette virus risks. Soybean needs Rhizobium inoculation, grown in the middle belt. Cassava is drought-tolerant, propagated from cuttings, faces mosaic disease. Yam needs mounds/ridges and staking, propagated from setts. Sweet potato is short-duration, propagated from vine cuttings.
3. Planting time should align with rains onset; spacing and depth are crop-specific. Weed control is most critical in the first 3-6 weeks. Pest/disease management combines resistant varieties, cultural practices, and targeted pesticides. Economic returns depend on yield, costs, market price, storage/value addition, and government policy support.

Answers to Pilot Questions [Series 2]

Part 2.1

1. Maize requires 20-32 degrees Celsius and 500-1,200 mm of well-distributed rainfall on well-drained loam soil.
2. Upland rice relies on rainfall alone; lowland rice grows in flooded/swamp conditions.

3. Rice has an adaptation allowing it to grow in standing water, unlike most cereals which suffer root damage when waterlogged.
4. Sorghum is used for food (tuwo, pap) and livestock feed (or local brewing).
5. They are drought-tolerant, deep-rooted crops suited to the low rainfall of these zones.

Part 2.2

1. Cowpea fixes nitrogen, benefiting soil fertility, and has a short 60-90 day duration suited to variable rainfall.
2. Cowpea is highly susceptible to storage bruchids, requiring airtight containers or improved storage bags.
3. Aflatoxin is caused by Aspergillus fungi under poor drying/storage; managed through prompt drying and proper storage.
4. Groundnut rosette virus, transmitted by aphids, is the main field disease constraint.
5. Rhizobium inoculation is needed where soybean has not previously been grown, to ensure effective nitrogen fixation.

Part 2.3

1. Cassava is drought-tolerant and offers flexible harvest timing since roots can remain in the ground.
2. A whitefly-transmitted viral disease managed through resistant varieties and clean planting material.
3. Mounds/ridges improve drainage and ease tuber development for yam.
4. Staking provides a support structure for the climbing yam vine to optimise yield.
5. Orange-fleshed sweet potato provides vitamin A, supporting nutrition and food security.

Part 2.4

1. Planting too early risks loss to dry spells; planting too late shortens the season and exposes the crop to end-of-season drought.
2. The first 3-6 weeks after planting is the critical period for weed control.
3. Resistant varieties and cultural practices such as rotation and sanitation.
4. Storage and processing allow farmers to sell when prices are more favourable than at harvest.
5. Input subsidy programmes and the Anchor Borrowers Programme.

References and Attributions

Textual References (Books and External Sources)

- FAO (Food and Agriculture Organization of the United Nations). (2025). Guidelines for sustainable agriculture. FAO.
- IITA (International Institute of Tropical Agriculture). (2020). Annual report. IITA, Ibadan.
- Tindall, H. D. (1983). Vegetables in the tropics. Macmillan Press, London.
- Purseglove, J. W. (1972). Tropical crops: Monocotyledons. Longman, London.

Figures, Plates, Tables, and Boxes

- Figure 2.1: Major Nigerian cereal crops Attribution: AI generated. Suggested OER search string: "maize rice sorghum millet Nigeria cereal crop production zones OER".
- Figure 2.2: Major Nigerian legume crops Attribution: AI generated. Suggested OER search string: "cowpea groundnut soybean Nigeria legume crop production OER".
- Figure 2.3: Major Nigerian root and tuber crops Attribution: AI generated. Suggested OER search string: "cassava yam sweet potato Nigeria root tuber crop production OER".
- Figure 2.4: Field crop management practices Attribution: AI generated. Suggested OER search string: "field crop planting calendar weed pest management Nigeria economic OER".

Series 3: Economic Tree Crops in Nigeria

- **Part 3.1: Oil-Bearing Tree Crops**
  - Sub Part 3.1.1: Oil palm origin and distribution
  - Sub Part 3.1.2: Oil palm morphology and varieties
  - Sub Part 3.1.3: Coconut production
- **Part 3.2: Beverage and Stimulant Tree Crops**
  - Sub Part 3.2.1: Cocoa origin and distribution
  - Sub Part 3.2.2: Cocoa morphology and varieties
  - Sub Part 3.2.3: Kola nut production
- **Part 3.3: Industrial and Fruit Tree Crops**
  - Sub Part 3.3.1: Rubber production
  - Sub Part 3.3.2: Cashew production
  - Sub Part 3.3.3: Citrus production
- **Part 3.4: Economic Significance of Tree Crops**
  - Sub Part 3.4.1: Contribution to the Nigerian economy
  - Sub Part 3.4.2: Smallholder versus plantation production
  - Sub Part 3.4.3: Challenges facing Nigerian tree crop sub-sector

Introduction

Economic tree crops, perennial crops occupying land for many years and producing a marketable product (oil, beverage, fibre, or fruit), form a distinct and economically important branch of

Nigerian agriculture alongside the field crops covered in Series 2. Their long productive lifespan, fixed planting investment, and often distinct geographic concentration give tree crop production a different character and set of management considerations from annual field crops.

This Series surveys the origin, distribution, and morphological characteristics of Nigeria most important economic tree crops, grouped into oil-bearing crops (oil palm, coconut), beverage/stimulant crops (cocoa, kola), and industrial/fruit crops (rubber, cashew, citrus), before examining the broader economic significance of the tree crop sub-sector. This sets up the detailed cultivation/management and harvesting/processing topics covered in Series 4 and 5.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 3.1** describe the origin, distribution, and characteristics of major Nigerian oil-bearing tree crops (Linked to Part 3.1),
- **SLO 3.2** describe the origin, distribution, and characteristics of major Nigerian beverage and stimulant tree crops (Linked to Part 3.2),
- **SLO 3.3** describe the origin, distribution, and characteristics of major Nigerian industrial and fruit tree crops (Linked to Part 3.3), and
- **SLO 3.4** explain the economic significance and challenges of the Nigerian tree crop sub-sector (Linked to Part 3.4).

3.1 Oil-Bearing Tree Crops

3.1.1 Oil palm origin and distribution

Oil palm (Elaeis guineensis), native to West Africa including Nigeria, has been cultivated in the region for centuries before becoming a globally significant export and domestic commodity. Nigeria, once the world leading producer and exporter, remains a major producer concentrated in

the humid forest zone, particularly Cross River, Akwa Ibom, Rivers, and Edo states, where the high rainfall (above 1,500 mm) and warm temperatures suit the crop well.

Production occurs through a mix of smallholder groves, semi-wild stands, and organised plantations (both government/private estate and outgrower schemes), with smallholder and semi-wild production still accounting for a substantial share of Nigerian output despite generally lower yields than well-managed plantations.

Fill in the blank: Oil palm is native to _____ Africa including Nigeria, and is concentrated in the humid forest zone where high rainfall above 1,500 mm and warm temperatures suit the crop.

3.1.2 Oil palm morphology and varieties

Oil palm is a single-stemmed palm reaching 20-30 m at maturity, bearing large compound leaves (fronds) and producing fruit bunches containing hundreds of individual fruits, each yielding both palm oil (from the fleshy mesocarp) and palm kernel oil (from the seed/kernel), giving the crop two distinct oil products from a single harvest.

Three main fruit types are distinguished by shell thickness: Dura (thick shell, lower oil yield, the traditional dominant type), Pisifera (shell-less, female-sterile, used mainly as a breeding parent), and Tenera (a Dura-Pisifera hybrid combining thin shell with high oil yield, now the preferred planting material for modern Nigerian oil palm establishment).

Fill in the blank: _____ , a Dura-Pisifera hybrid combining thin shell with high oil yield, is the preferred oil palm planting material for modern Nigerian establishment.

3.1.3 Coconut production

Coconut (Cocos nucifera), grown along Nigeria coastal belt and other suitable humid lowland areas, is a minor but locally significant tree crop valued for its fruit (consumed fresh or processed), oil, and fibre (coir), tolerating sandy, saline-influenced coastal soils poorly suited to many other tree crops.

Coconut is propagated from seed nuts, taking 5-7 years to first bearing and remaining productive for several decades; lethal yellowing and other diseases, along with limited improved variety adoption, constrain Nigerian coconut productivity relative to leading global producers.

Fill in the blank: Coconut tolerates sandy, saline-influenced coastal soils poorly suited to many other tree crops, taking _____ to 7 years to reach first bearing after propagation from seed nuts.

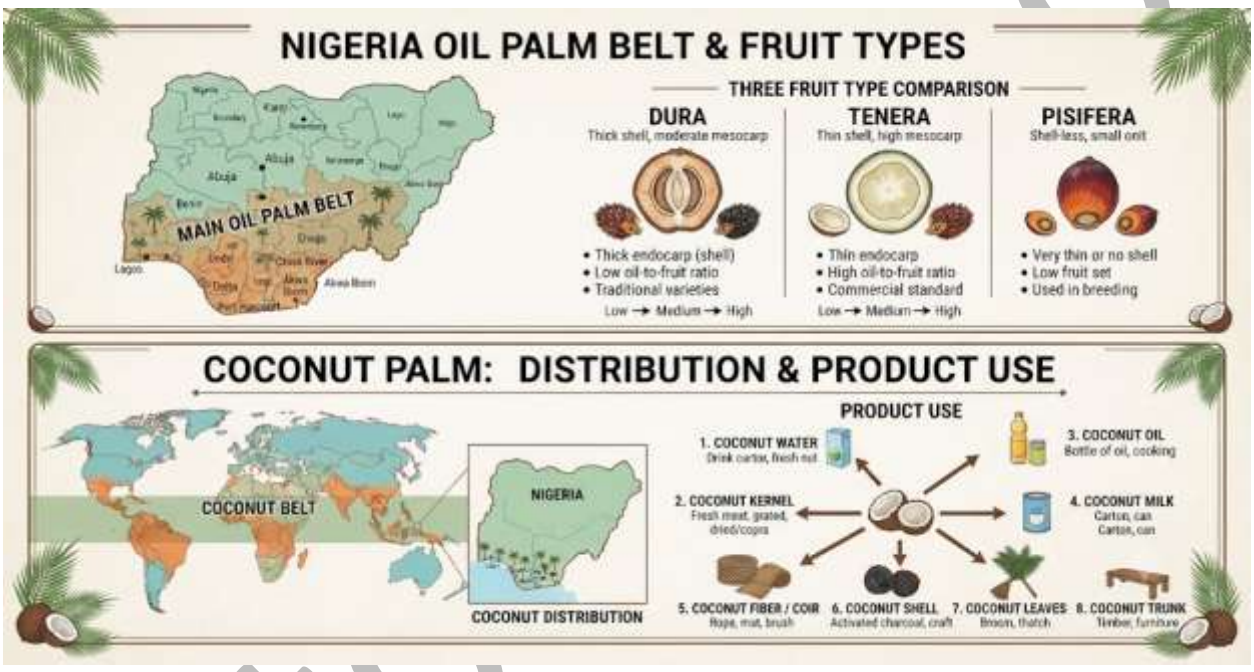

Figure 3.1: Oil-bearing tree crops in Nigeria

Pilot questions 3.1

1. State the main Nigerian states where oil palm is concentrated and why.
2. Name the two oil products obtained from oil palm fruit.
3. Distinguish between Dura, Pisifera, and Tenera oil palm fruit types.
4. State two products obtained from coconut.
5. Explain why coconut suits Nigeria coastal areas.

3.2 Beverage and Stimulant Tree Crops

3.2.1 Cocoa origin and distribution

Cocoa (Theobroma cacao), native to Central/South America, was introduced to Nigeria in the late 19th century and became a major export crop, historically concentrated in the southwestern states (Ondo, Osun, Ekiti, Oyo, Ogun) and parts of Cross River, where high rainfall and forest shade conditions suit the crop.

Nigeria remains among the world significant cocoa producers, though well below leading West African producers Cote d Ivoire and Ghana, with production dominated by smallholder farmers often cultivating aging tree stocks, a productivity constraint addressed further in Series 4.

Fill in the blank: Cocoa was introduced to Nigeria in the late 19th century and became concentrated in the _____ states, where high rainfall and forest shade conditions suit the crop.

3.2.2 Cocoa morphology and varieties

Cocoa is a small understory tree (4-8 m when managed) that flowers and fruits directly on the trunk and branches (cauliflory), producing large pods containing 20-40 seeds (beans) embedded in sweet pulp; the beans, after fermentation and drying, are the primary marketed product and raw material for chocolate and cocoa product manufacture.

Three main genetic groups exist: Criollo (high quality, low yield, susceptible to disease, now rare), Forastero (the dominant type globally and in Nigeria, higher yielding and more disease-resistant but generally lower flavour quality), and Trinitario (a Criollo-Forastero hybrid combining good quality with improved vigour), with most Nigerian cocoa being Forastero-type or Forastero-Trinitario hybrids.

Fill in the blank: _____ , the dominant cocoa genetic group globally and in Nigeria, is higher yielding and more disease-resistant but generally of lower flavour quality than Criollo.

3.2.3 Kola nut production

Kola nut (Cola nitida and Cola acuminata), native to West Africa, is grown across the southern and middle belt forest and derived savanna zones, valued for its caffeine-containing seeds used for chewing and in beverage/pharmaceutical industries, with significant cultural and ceremonial importance in many Nigerian communities.

Kola is a moderately slow-growing tree reaching first bearing after 7-10 years, typically intercropped with other tree or food crops during its early establishment period, and harvested over an extended fruiting season rather than a single concentrated harvest window.

Fill in the blank: Kola nut seeds contain _____ , used for chewing and in beverage/pharmaceutical industries, with significant cultural and ceremonial importance in Nigerian communities.

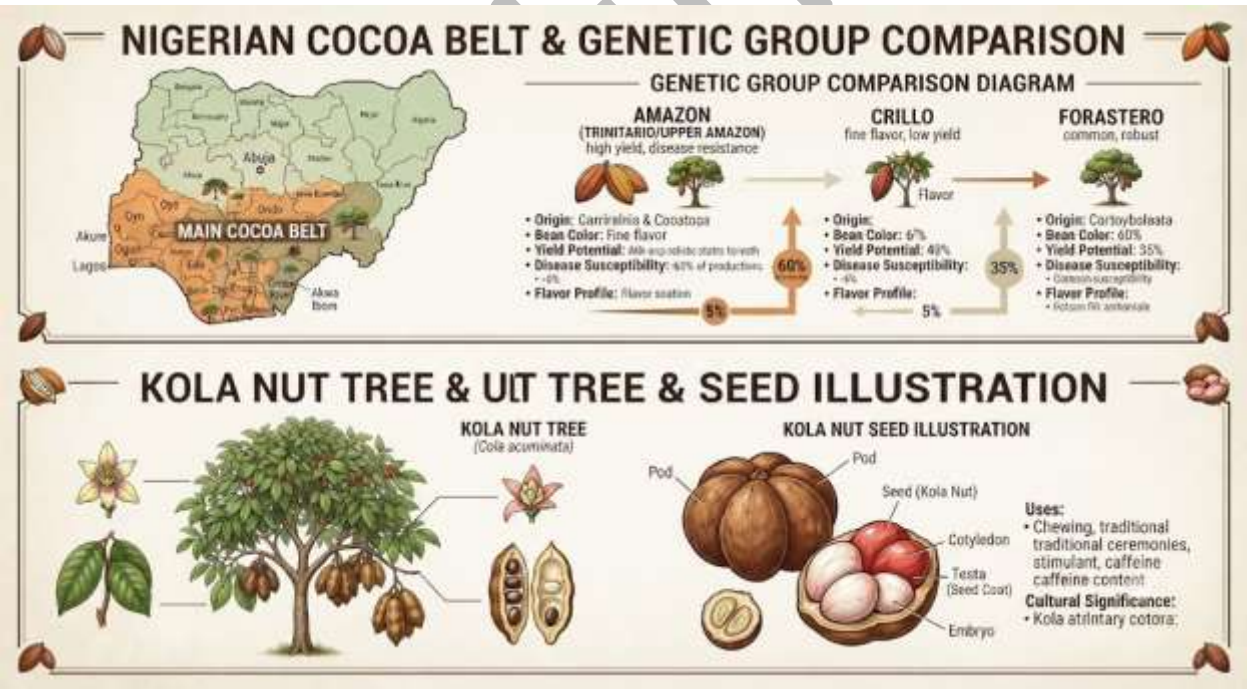

Figure 3.2: Beverage and stimulant tree crops in Nigeria

Pilot questions 3.2

1. State the Nigerian states traditionally associated with cocoa production.

2. Explain cauliflory as it applies to cocoa fruiting.
3. Distinguish between Criollo and Forastero cocoa in terms of yield and quality.
4. State the main use of kola nut in Nigeria.
5. State the time to first bearing for kola nut.

3.3 Industrial and Fruit Tree Crops

3.3.1 Rubber production

Rubber (Hevea brasiliensis), native to South America, was introduced to Nigeria in the early 20th century and is concentrated in Edo, Delta, and Ogun states, where the humid forest climate suits the crop; rubber latex (tapped from the bark) is processed into various industrial rubber products.

Rubber trees take 5-7 years to reach tapping maturity and remain productive for 25-30 years through regular bark tapping; declining global natural rubber prices and competition from synthetic rubber have constrained Nigerian rubber sub-sector investment and productivity in recent decades.

Fill in the blank: Rubber latex is obtained through regular bark _____ , with trees taking 5-7 years to reach tapping maturity and remaining productive for 25-30 years.

3.3.2 Cashew production

Cashew (Anacardium occidentale), native to South America, has grown rapidly as a Nigerian export crop, concentrated in the middle belt states (Kogi, Kwara, Niger, Enugu), valued for its cashew nut (the true marketed product) attached to the cashew apple, with Nigeria among the world leading cashew nut producers though much of the crop is exported raw rather than processed domestically.

Cashew reaches first bearing 3-4 years after planting and is relatively drought-tolerant, suiting it to drier zones than cocoa or oil palm; limited domestic processing capacity (foregoing value addition) remains a significant constraint on capturing the full economic value of Nigerian cashew production.

Fill in the blank: Limited domestic processing capacity, foregoing _____ addition, remains a significant constraint on capturing the full economic value of Nigerian cashew production, as much of the crop is exported raw.

3.3.3 Citrus production

Citrus (orange, lime, lemon, grapefruit, tangerine; various Citrus species) is widely grown across multiple Nigerian zones, both as smallholder dooryard/orchard plantings and larger commercial orchards, valued for fresh fruit consumption and increasingly for juice processing.

Citrus greening disease (Huanglongbing) and citrus canker are significant disease threats globally and an increasing concern for Nigerian production, managed through disease-free planting material, vector (psyllid) control, and orchard sanitation, building on the orchard establishment and management principles covered in related agricultural courses.

Fill in the blank: Citrus _____ disease (Huanglongbing) and citrus canker are significant disease threats requiring disease-free planting material, vector control, and orchard sanitation.

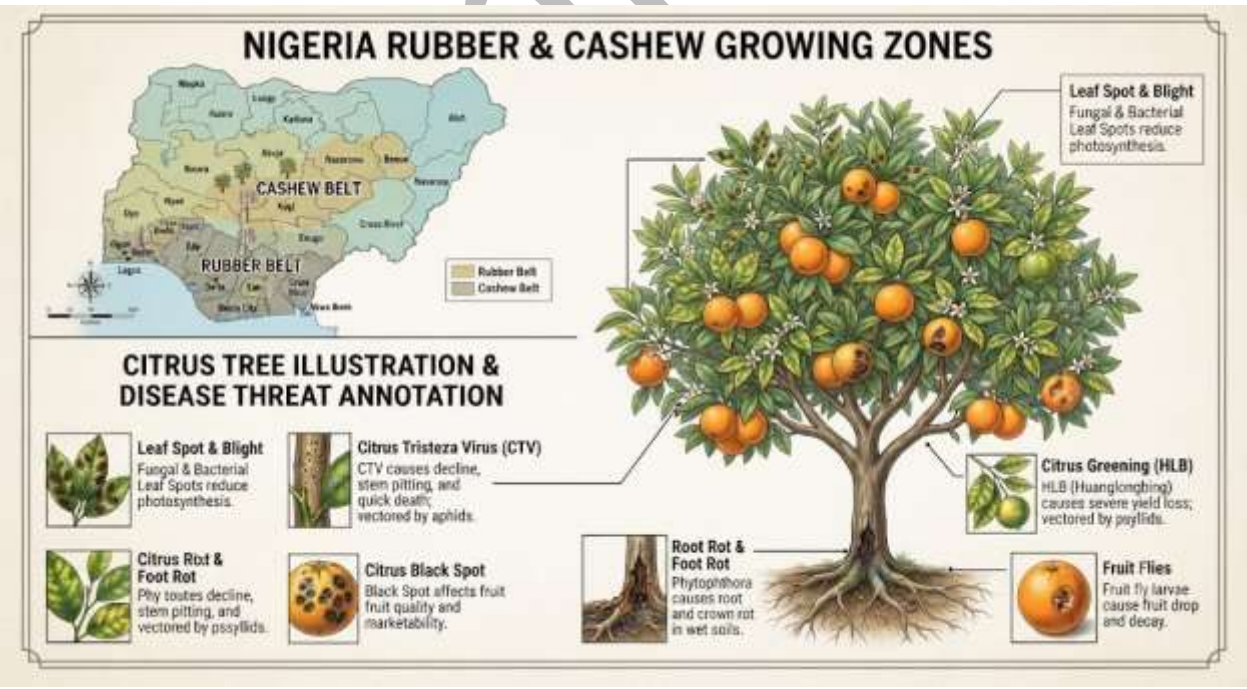

Figure 3.3: Industrial and fruit tree crops in Nigeria

Pilot questions 3.3

1. State the Nigerian states where rubber production is concentrated.
2. Explain how rubber latex is obtained from the tree.
3. State the main constraint limiting Nigerian cashew sub-sector value capture.
4. Name two diseases threatening citrus production.
5. State two uses of citrus fruit in Nigeria.

3.4 Economic Significance of Tree Crops

3.4.1 Contribution to the Nigerian economy

Tree crops contribute to the Nigerian economy through export earnings (cocoa, cashew, sesame-adjacent products), domestic food and industrial raw material supply (palm oil, rubber), employment across the production-processing-marketing chain, and foreign exchange diversification away from oil dependence, a long-standing Nigerian economic policy objective.

Historically, tree crop exports (particularly cocoa, palm oil, and groundnut, the latter a field crop but marketed similarly) were Nigeria leading foreign exchange earners before the rise of petroleum exports from the 1970s onward, a historical context relevant to understanding current efforts to revive and expand the tree crop sub-sector as part of broader economic diversification policy.

Fill in the blank: Tree crop exports, particularly cocoa and palm oil, were Nigeria leading foreign exchange earners before the rise of _____ exports from the 1970s onward.

3.4.2 Smallholder versus plantation production

Smallholder production (small individual farms, often with mixed or semi-wild stands, particularly common for oil palm and cocoa) accounts for the majority of Nigerian tree crop output, offering flexibility and low capital entry but often facing lower yields, aging tree stocks, and limited access to inputs and credit compared to organised estates.

Plantation/estate production (larger, centrally managed operations, more common for rubber and some oil palm) can achieve higher yields through better variety selection, input use, and management consistency, but requires substantial capital investment; outgrower schemes (smallholders linked contractually to a central processing estate) attempt to combine smallholder flexibility with estate-level input and market access support.

Fill in the blank: _____ schemes link smallholder farmers contractually to a central processing estate, attempting to combine smallholder flexibility with estate-level input and market access support.

3.4.3 Challenges facing Nigerian tree crop sub-sector

Aging tree stocks (many Nigerian cocoa and oil palm trees are well beyond their most productive age, planted decades ago without systematic replanting programmes) constrain national yield levels significantly below what modern improved varieties could achieve. Limited adoption of improved planting material (Tenera oil palm, improved cocoa hybrids) due to cost, availability, and farmer awareness constraints further limits productivity gains.

Limited domestic processing and value addition (raw cashew and cocoa bean exports rather than processed chocolate/cashew kernel products) forgoes significant potential economic value, echoing the value addition concerns raised for field crops and agricultural marketing generally; and infrastructure, finance access, and extension service limitations facing many smallholder tree crop farmers compound these production-level constraints, collectively shaping the cultivation, management, and processing priorities addressed in Series 4 and 5.

Fill in the blank: _____ tree stocks, many planted decades ago without systematic replanting programmes, constrain Nigerian cocoa and oil palm national yield levels significantly below what modern improved varieties could achieve.

Figure 3.4: Economic significance and challenges of Nigerian tree crops

Pilot questions 3.4

1. State three ways tree crops contribute to the Nigerian economy.
2. Distinguish between smallholder and plantation tree crop production.
3. Explain the role of outgrower schemes.
4. Explain how aging tree stocks affect Nigerian tree crop productivity.
5. Explain why limited processing capacity is a challenge for Nigerian cashew and cocoa.

Series Summary

This Series examined **major Nigerian tree and plantation crops and their economic importance**. Oil-bearing crops include oil palm, which is native to West Africa and grown mainly in the humid forest zone, and coconut, which is common in coastal areas and valued for fruit, oil, and fibre. Beverage and stimulant crops include cocoa, grown mainly in southwestern Nigeria, and kola nut, which contains caffeine and has strong cultural importance. Other important crops include rubber, produced mainly in states such as Edo, Delta, and Ogun; cashew, widely grown in the Middle Belt; and citrus, cultivated across many parts of the country but threatened by diseases such as citrus greening.

The Series also covered **the contribution and major challenges of tree-crop production**. These crops provide export earnings, employment, industrial raw materials, and rural income and were major foreign-exchange earners before petroleum became dominant. Production occurs through smallholder farms, plantations, and outgrower schemes that link farmers with larger processors or companies. Major constraints include aging tree stocks, low adoption of improved varieties, inadequate processing and value addition, weak infrastructure, and limited access to finance. By completing this Series, students should achieve SLOs 3.1–3.4.

Glossary of Terms

- **Cauliflory:** the fruiting habit of cocoa, in which flowers and pods develop directly on the trunk and branches.
- **Forastero:** the dominant cocoa genetic group globally and in Nigeria, higher yielding and disease-resistant but generally lower flavour quality.
- **Outgrower scheme:** an arrangement linking smallholder farmers contractually to a central processing estate for input and market access support.
- **Plantation/estate production:** larger, centrally managed tree crop operations achieving higher yields through consistent management but requiring substantial capital.

- **Tenera:** a Dura-Pisifera hybrid oil palm fruit type combining thin shell with high oil yield, the preferred modern planting material.
- **Tree crop:** a perennial crop occupying land for many years, such as oil palm, cocoa, rubber, cashew, or citrus.

Concept Check Questions [Series 3]

Objective Questions

1. _____ , a Dura-Pisifera hybrid, is the preferred modern oil palm planting material. (Linked to SLO 3.1)
2. _____ is the dominant cocoa genetic group globally and in Nigeria. (Linked to SLO 3.2)
3. Limited domestic _____ capacity is a key constraint on Nigerian cashew sub-sector value capture. (Linked to SLO 3.3)
4. Tree crop exports were Nigeria leading earners before the rise of _____ exports from the 1970s. (Linked to SLO 3.4)
5. _____ tree stocks constrain Nigerian cocoa and oil palm yields below modern variety potential. (Linked to SLO 3.4)

Short-Answer Questions

1. Name three Nigerian oil-bearing or beverage tree crops. (Linked to SLOs 3.1, 3.2)
2. Name three Nigerian industrial or fruit tree crops. (Linked to SLO 3.3)
3. Distinguish between smallholder and plantation tree crop production. (Linked to SLO 3.4)
4. State two challenges facing the Nigerian tree crop sub-sector. (Linked to SLO 3.4)
5. Name the three cocoa genetic groups. (Linked to SLO 3.2)

Long-Answer Questions

1. Describe the origin, distribution, and characteristics of major Nigerian oil-bearing and beverage tree crops. (Linked to SLOs 3.1, 3.2)
2. Describe the origin, distribution, and characteristics of major Nigerian industrial and fruit tree crops. (Linked to SLO 3.3)
3. Explain the economic significance and challenges of the Nigerian tree crop sub-sector. (Linked to SLO 3.4)

Answers to Concept Check Questions [Series 3]

Objective Questions

1. Tenera.
2. Forastero.
3. Processing.
4. Petroleum.
5. Aging.

Short-Answer Questions

1. Oil palm, coconut, and cocoa (or kola nut).
2. Rubber, cashew, and citrus.
3. Smallholder farms are small and flexible with lower yields; plantations are larger and centrally managed with higher yields but more capital.
4. Aging tree stocks and limited processing/value addition (or limited improved variety adoption).
5. Criollo, Forastero, and Trinitario.

Long-Answer Questions

1. Oil palm, native to West Africa, is concentrated in the humid forest zone with Tenera as the preferred variety. Coconut grows along the coast for fruit, oil, and fibre. Cocoa, introduced in the 19th century, is concentrated in southwestern states, with Forastero the dominant genetic type. Kola nut is grown for its caffeine-containing seeds with cultural significance.
2. Rubber, concentrated in Edo, Delta, and Ogun states, is tapped for latex. Cashew, concentrated in the middle belt, is grown for its nut but mostly exported raw. Citrus is widely grown for fresh fruit and juice, threatened by greening disease.
3. Tree crops contribute export earnings, employment, and economic diversification, historically dominating before petroleum. Smallholder production dominates output but plantations achieve higher yields; outgrower schemes bridge both. Key challenges include aging tree stocks, limited improved variety adoption, limited processing/value addition, and infrastructure/finance constraints.

Answers to Pilot Questions [Series 3]

Part 3.1

1. Cross River, Akwa Ibom, Rivers, and Edo states, due to high rainfall above 1,500 mm and warm temperatures.
2. Palm oil (from the mesocarp) and palm kernel oil (from the seed).
3. Dura has a thick shell and lower yield; Pisifera is shell-less and female-sterile; Tenera is a high-yielding thin-shelled hybrid of the two.
4. Coconut fruit (fresh or processed) and oil (or fibre/coir).
5. Coconut tolerates sandy, saline-influenced coastal soils poorly suited to many other tree crops.

Part 3.2

1. Ondo, Osun, Ekiti, Oyo, and Ogun states (and parts of Cross River).
2. Cauliflory means cocoa flowers and pods develop directly on the trunk and branches rather than on new shoots.
3. Criollo has lower yield but higher quality; Forastero has higher yield and disease resistance but lower flavour quality.
4. Kola nut is chewed as a stimulant due to its caffeine content.
5. Kola nut reaches first bearing after 7-10 years.

Part 3.3

1. Edo, Delta, and Ogun states.
2. Latex is obtained through regular tapping of the tree bark.
3. Limited domestic processing capacity, with much of the crop exported raw rather than processed.
4. Citrus greening disease (Huanglongbing) and citrus canker.
5. Fresh fruit consumption and juice processing.

Part 3.4

1. Export earnings, domestic raw material supply, and employment (or foreign exchange diversification).
2. Smallholder production is small-scale and flexible with lower yields; plantation production is larger and centrally managed with higher yields but greater capital need.
3. Outgrower schemes link smallholders contractually to a central estate, combining smallholder flexibility with estate-level input and market support.

4. Aging tree stocks, planted decades ago without replanting, keep national yields well below the potential of modern improved varieties.
5. Exporting raw cashew and cocoa rather than processed products forgoes the additional economic value processing would capture domestically.

References and Attributions

Textual References (Books and External Sources)

- FAO (Food and Agriculture Organization of the United Nations). (2025). Guidelines for sustainable agriculture. FAO.
- Purseglove, J. W. (1968). Tropical crops: Dicotyledons. Longman, London.
- Opeke, L. K. (2005). Tropical tree crops. Spectrum Books, Ibadan.
- IITA (International Institute of Tropical Agriculture). (2020). Annual report. IITA, Ibadan.

Figures, Plates, Tables, and Boxes

- Figure 3.1: Oil-bearing tree crops in Nigeria Attribution: AI generated. Suggested OER search string: "oil palm Nigeria Dura Pisifera Tenera coconut tree crop production OER".
- Figure 3.2: Beverage and stimulant tree crops in Nigeria Attribution: AI generated. Suggested OER search string: "cocoa Nigeria Criollo Forastero Trinitario kola nut tree crop production OER".
- Figure 3.3: Industrial and fruit tree crops in Nigeria Attribution: AI generated. Suggested OER search string: "rubber cashew citrus Nigeria tree crop production zones disease OER".
- Figure 3.4: Economic significance and challenges of Nigerian tree crops Attribution: AI generated. Suggested OER search string: "Nigeria tree crop economy export history challenges aging stock value addition OER".

Series 4: Cultivation and Management Techniques

- **Part 4.1: Nursery Establishment and Planting**
  - Sub Part 4.1.1: Nursery establishment for tree crops
  - Sub Part 4.1.2: Field establishment and spacing
  - Sub Part 4.1.3: Replanting and rehabilitation of aging stands
- **Part 4.2: Nutrition and Soil Management**
  - Sub Part 4.2.1: Nutrient requirements of tree crops
  - Sub Part 4.2.2: Fertiliser application practices
  - Sub Part 4.2.3: Cover cropping and soil conservation
- **Part 4.3: Pruning, Training, and Canopy Management**
  - Sub Part 4.3.1: Formative and maintenance pruning
  - Sub Part 4.3.2: Shade management
  - Sub Part 4.3.3: Tapping management for rubber
- **Part 4.4: Pest and Disease Management in Tree Crops**
  - Sub Part 4.4.1: Major tree crop pests
  - Sub Part 4.4.2: Major tree crop diseases
  - Sub Part 4.4.3: Integrated management approaches

Introduction

Having surveyed the major Nigerian economic tree crops in Series 3, this Series turns to the practical cultivation and management techniques that determine their productivity over their long productive lifespan. Establishment decisions and ongoing management practices applied across decades of production have a cumulative effect on yield that field crop management, operating within a single season, does not face in the same way.

This Series covers nursery establishment and field planting; nutrition and soil management; pruning, training, and canopy/tapping management; and pest and disease management for Nigerian economic tree crops. This prepares students for the harvesting, handling, and processing topics covered in the final Series of AGE 307.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 4.1** describe nursery establishment, field planting, and replanting practices for tree crops (Linked to Part 4.1),
- **SLO 4.2** explain nutrition, fertiliser application, and soil conservation practices for tree crops (Linked to Part 4.2),
- **SLO 4.3** describe pruning, shade management, and tapping management practices for tree crops (Linked to Part 4.3), and
- **SLO 4.4** describe major tree crop pests, diseases, and integrated management approaches (Linked to Part 4.4).

4.1 Nursery Establishment and Planting

4.1.1 Nursery establishment for tree crops

Most Nigerian tree crops (oil palm, cocoa, citrus, rubber) are raised first in a nursery before field transplanting, allowing concentrated early care, selection of the strongest seedlings, and protection from early-stage pests, weeds, and weather extremes that would cause higher losses if establishment were attempted directly in the field.

Nursery practices include using quality seed or vegetative propagation material (improved Tenera oil palm seed, budded citrus, or rooted cocoa cuttings), appropriate potting media and shading, and regular watering and pest monitoring; nursery duration varies by crop, typically 8-12 months for oil palm and citrus, and 4-6 months for cocoa, before seedlings reach transplantable size.

Fill in the blank: Nursery duration before transplanting is typically 8-12 months for oil palm and citrus, and _____ months for cocoa, before seedlings reach transplantable size.

4.1.2 Field establishment and spacing

Field establishment follows the general orchard/plantation site selection and land preparation principles (site selection, planting hole preparation, and timing relative to rains) applicable across tree crops. Spacing varies by crop based on mature canopy size: oil palm at 9 m triangular spacing (about 143 trees per hectare), cocoa at 3 m x 3 m under shade, rubber at 7 m x 3 m (allowing access rows for tapping), and citrus at 6-8 m square spacing depending on variety vigour.

Cocoa and some other tree crops require temporary or permanent shade trees (plantain, banana, or selected forest trees) planted before or alongside the main crop during early establishment, since young cocoa is shade-demanding, a requirement that gradually reduces as the cocoa canopy matures and can provide some of its own shade.

Fill in the blank: Oil palm is typically planted at 9 m _____ spacing, giving approximately 143 trees per hectare.

4.1.3 Replanting and rehabilitation of aging stands

As discussed in Series 3, aging tree stocks are a major Nigerian tree crop productivity constraint; systematic replanting programmes (removing unproductive old trees and replanting with improved varieties) are needed to restore yield potential but require significant capital and result in several unproductive years before new trees mature, a major disincentive for individual smallholder farmers without external support.

Rehabilitation approaches short of full replanting include selective removal and gap-filling of the least productive trees within an existing stand, top-working/grafting improved scion material onto existing rootstock (feasible for some crops such as citrus and cocoa), and improved management (nutrition, pruning) of existing stands to extract better performance even from aging trees, often a more immediately feasible option for resource-constrained smallholders than full replanting.

Fill in the blank: _____ -working, or grafting improved scion material onto existing rootstock, is feasible for some tree crops such as citrus and cocoa as an alternative to full replanting.

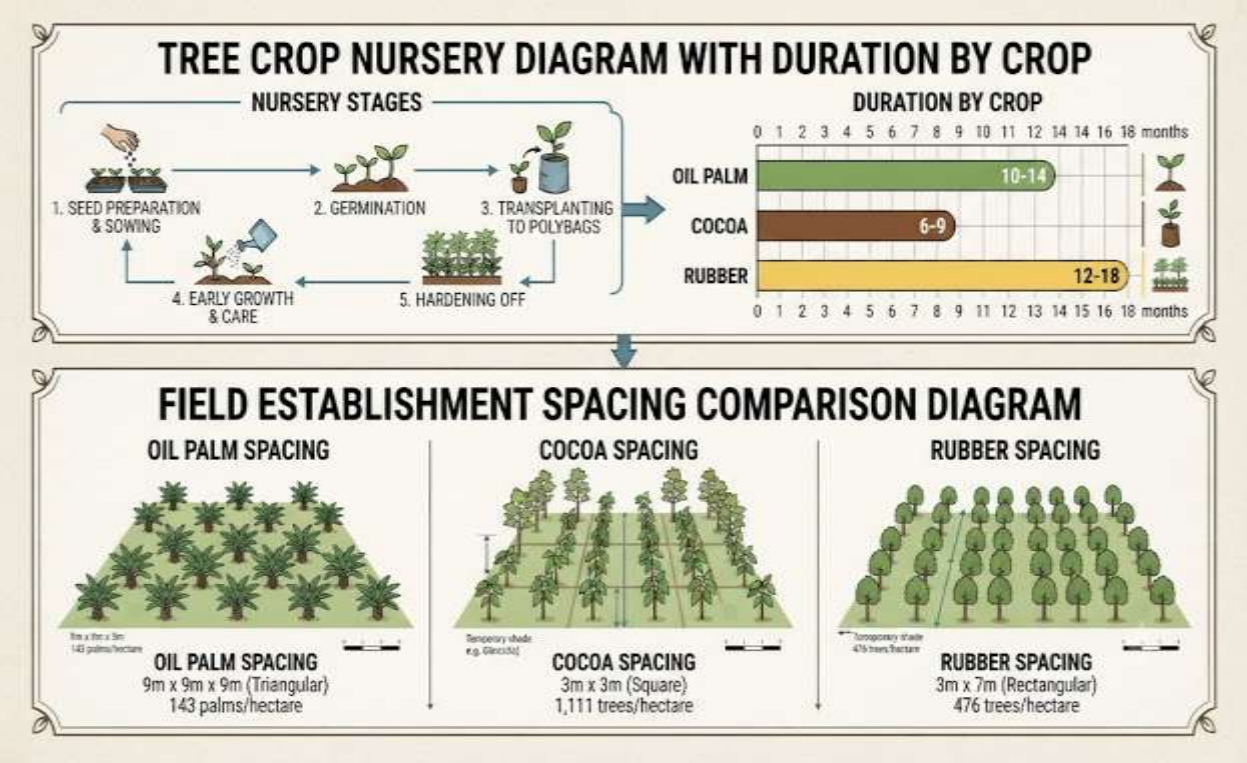

Figure 4.1: Nursery establishment and field planting for tree crops

Pilot questions 4.1

1. Explain why most Nigerian tree crops are raised in a nursery before field planting.
2. State the typical nursery duration for oil palm and for cocoa.
3. State the typical field spacing for oil palm.
4. Explain why young cocoa requires shade during early establishment.
5. Name two rehabilitation approaches short of full replanting for aging tree stands.

4.2 Nutrition and Soil Management

4.2.1 Nutrient requirements of tree crops

Tree crops require the same essential macro and micronutrients as field crops (Series 1) but in different proportions reflecting their perennial growth habit and, for fruiting crops, the heavy nutrient demand of repeated harvests; potassium demand is particularly high in oil palm and

cocoa due to its role in fruit/pod development and water regulation, while nitrogen supports the extensive vegetative growth of young, establishing trees.

Nutrient deficiency symptoms (similar in principle to those covered for field crops in earlier AGE courses) appear on leaves and, for fruiting crops, on the fruit itself; visual diagnosis combined with periodic leaf and soil analysis allows more precise nutrient management than blanket fertiliser application without testing.

Fill in the blank: _____ demand is particularly high in oil palm and cocoa due to its role in fruit/pod development and water regulation within the tree.

4.2.2 Fertiliser application practices

Fertiliser application for tree crops follows a ring or band placement around the tree base (rather than broadcast across the whole field as for some field crops), positioned at the edge of the canopy drip-line where the active feeder roots are concentrated, since misplaced fertiliser (too close to the trunk or too far beyond the root zone) is poorly utilised by the tree.

Application timing typically follows the onset of rains (to ensure dissolution and uptake) and may be split into two or more applications per year for mature, heavily fruiting trees; organic matter (mulch, compost) is commonly combined with inorganic fertiliser, particularly for young establishing trees, to improve soil moisture retention and gradual nutrient release around the root zone.

Fill in the blank: Fertiliser for tree crops is applied in a ring or band around the tree base at the edge of the canopy _____ -line, where the active feeder roots are concentrated.

4.2.3 Cover cropping and soil conservation

Cover crops (low-growing legumes or grasses planted between young tree crop rows before canopy closure) suppress weeds, reduce soil erosion on sloping land, and, where legumes are used, contribute biological nitrogen fixation benefiting the young trees, similar in principle to the cover crop benefits discussed for field crop systems.

Mulching (applying crop residues, pruned material, or other organic matter around the tree base) conserves soil moisture, suppresses weeds, and gradually adds organic matter as it decomposes, a particularly valuable practice during the establishment phase before tree canopy closure provides natural ground shading and weed suppression.

Fill in the blank: _____ crops, low-growing legumes or grasses planted between young tree rows, suppress weeds, reduce erosion, and contribute nitrogen fixation before canopy closure.

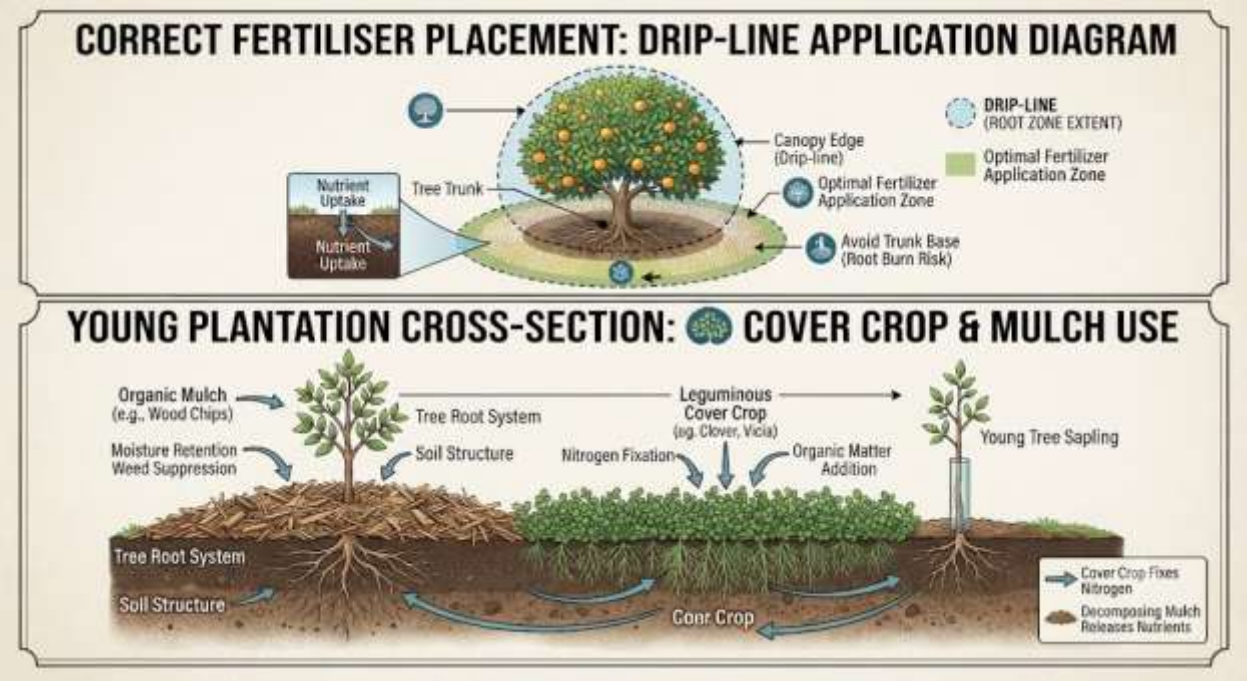

Figure 4.2: Tree crop nutrition and soil management

Pilot questions 4.2

1. Explain why potassium demand is particularly high in oil palm and cocoa.
2. Explain the correct placement zone for tree crop fertiliser application.
3. State the typical timing for tree crop fertiliser application.
4. Explain two benefits of cover cropping in young tree crop plantations.
5. Explain the benefit of mulching around young tree crops.

4.3 Pruning, Training, and Canopy Management

4.3.1 Formative and maintenance pruning

Formative pruning during the early years establishes a strong, well-balanced tree framework (similar in principle to the formative pruning of fruit trees covered in AGE 207), particularly important for cocoa (forming a low, spreading canopy on a short stem, jorquette) and citrus (selecting 3-4 main scaffold branches).

Maintenance pruning in mature trees removes dead, diseased, or crossing branches, controls tree height for ease of harvesting/spraying, and, in cocoa, removes chupons (vigorous upright shoots competing with the main canopy) and unproductive old wood, sustaining productive canopy structure throughout the tree long lifespan.

Fill in the blank: In cocoa, maintenance pruning removes _____ , vigorous upright shoots that compete with the main productive canopy, alongside dead, diseased, or crossing branches.

4.3.2 Shade management

As introduced in Part 4.1.2, cocoa requires shade management throughout much of its productive life, gradually reducing permanent or temporary shade tree density as the cocoa canopy itself matures and provides increasing self-shading, balancing light interception for cocoa photosynthesis against excessive heat/light stress that reduces yield and increases disease pressure in fully unshaded systems.

Shade tree selection (legume trees fixing nitrogen, or fruit/timber trees providing additional income) and density management represent an ongoing agronomic decision throughout cocoa stand life, distinct from the largely full-sun management approach of oil palm, citrus, and most field crops.

Fill in the blank: Shade tree density for cocoa is gradually _____ as the cocoa canopy itself matures and provides increasing self-shading over the productive life of the stand.

4.3.3 Tapping management for rubber

Rubber latex is harvested through controlled tapping, cutting a thin, angled groove into the bark to sever latex vessels without damaging the underlying cambium layer needed for bark regeneration; tapping typically begins when trees reach a minimum trunk girth (5-7 years) and follows a defined panel and frequency system (e.g. half-spiral cuts on alternate days) to sustain long-term productivity.

Over-intensive tapping (too frequent, too deep, or starting before adequate girth) damages the tree and shortens its productive tapping life, while properly managed tapping panels can be productively tapped for 25-30 years, rotating to fresh bark areas as panels are exhausted, a long-term management discipline distinct from the harvest approaches used for fruiting tree crops.

Fill in the blank: Rubber tapping typically begins when trees reach a minimum trunk girth at _____ to 7 years of age, following a defined panel and frequency system to sustain long-term productivity.

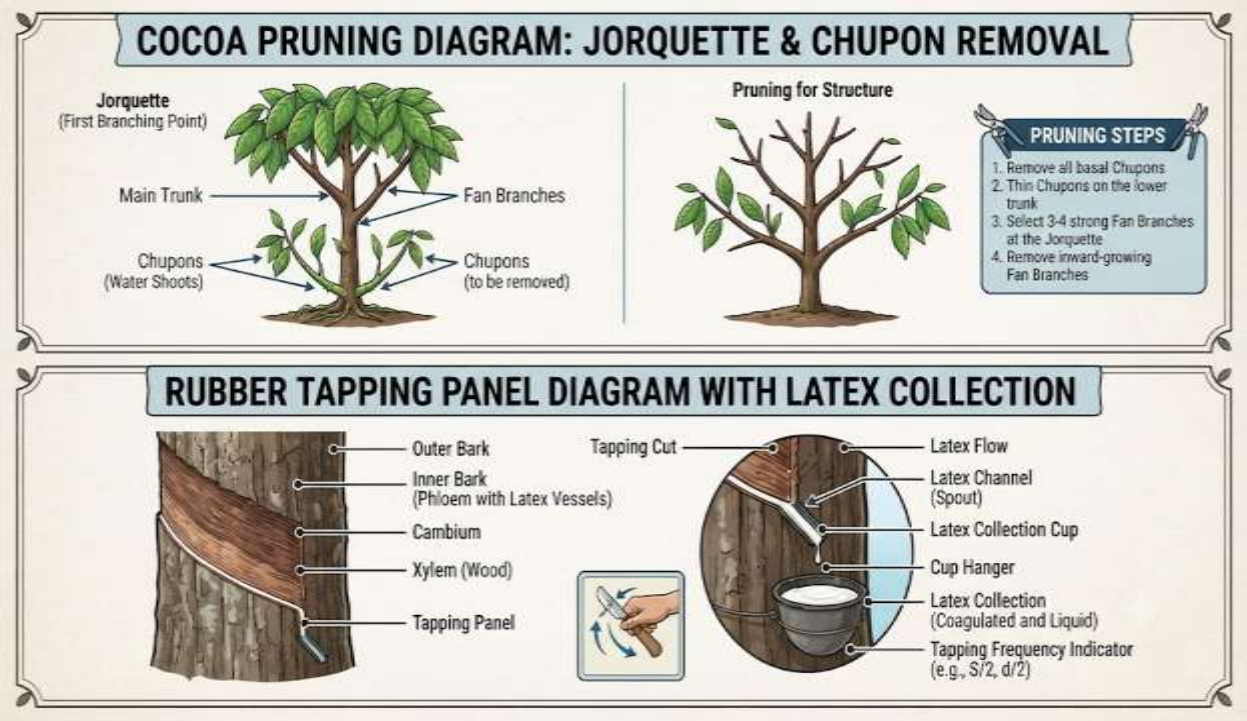

Figure 4.3: Pruning, shade management, and rubber tapping

6. Explain the purpose of formative pruning in tree crops.
7. Define chupon and explain why it is removed in cocoa maintenance pruning.
8. Explain why shade management changes over the productive life of a cocoa stand.
9. Explain how rubber tapping is carried out without damaging the tree long-term productive capacity.
10. State the typical age at which rubber tapping begins.

4.4 Pest and Disease Management in Tree Crops

4.4.1 Major tree crop pests

Cocoa mirids (capsids) are major sap-sucking pests damaging cocoa pods and shoots, managed through insecticide application and maintaining recommended shade levels, since excessive light favours mirid populations. Oil palm faces rhinoceros beetle (damaging young palms) and bagworms/leaf-eating caterpillars (defoliating mature palms), managed through field sanitation and targeted insecticide or biological control.

Citrus psyllids (vectors of citrus greening disease, Series 3) and various scale insects/mealybugs affect citrus, managed through vector control and conservation of natural predators; rubber and cashew face fewer severe insect pest pressures than cocoa and citrus but remain subject to general defoliating and sap-sucking insects requiring routine monitoring.

Fill in the blank: Cocoa _____ (capsids) are major sap-sucking pests damaging cocoa pods and shoots, with populations favoured by excessive light, making shade management an important control factor.

4.4.2 Major tree crop diseases

Black pod disease (Phytophthora species), the most economically significant cocoa disease, causes pod rot, particularly severe under high humidity and poor drainage/sanitation; managed

through field sanitation (removing infected pods), fungicide application, and adequate canopy/shade management for airflow. Citrus greening disease (Huanglongbing, Series 3) remains incurable once a tree is infected, making vector control and use of disease-free planting material the primary management strategy.

Oil palm faces vascular wilt (Fusarium) and, in some regions, basal stem rot, managed through resistant variety selection and field sanitation; cashew faces anthracnose and dieback diseases, particularly under high humidity, managed similarly through sanitation and targeted fungicide use during susceptible periods.

Fill in the blank: _____ pod disease (Phytophthora species), the most economically significant cocoa disease, is particularly severe under high humidity and poor drainage or sanitation conditions.

4.4.3 Integrated management approaches

Integrated pest and disease management for tree crops combines the cultural practices covered throughout this Series (correct spacing, shade management, sanitation, pruning for airflow) with resistant/tolerant variety selection (Series 3), biological control (conserving natural predators, avoiding unnecessary broad-spectrum insecticide use), and targeted chemical control reserved for situations where other measures are insufficient, following the same IPM hierarchy principles applicable across field crops, tree crops, and horticultural crops generally.

Regular field scouting and monitoring (detecting pest/disease problems early, before they reach damaging levels) is particularly important for tree crops given their long productive lifespan and the cumulative economic loss from chronic, unaddressed pest/disease pressure compared to a single-season field crop loss; farmer training and extension support in pest/disease identification and management remains a key priority for improving Nigerian tree crop productivity.

Fill in the blank: Regular field _____ and monitoring, detecting pest/disease problems early before they reach damaging levels, is particularly important for tree crops given their long productive lifespan.

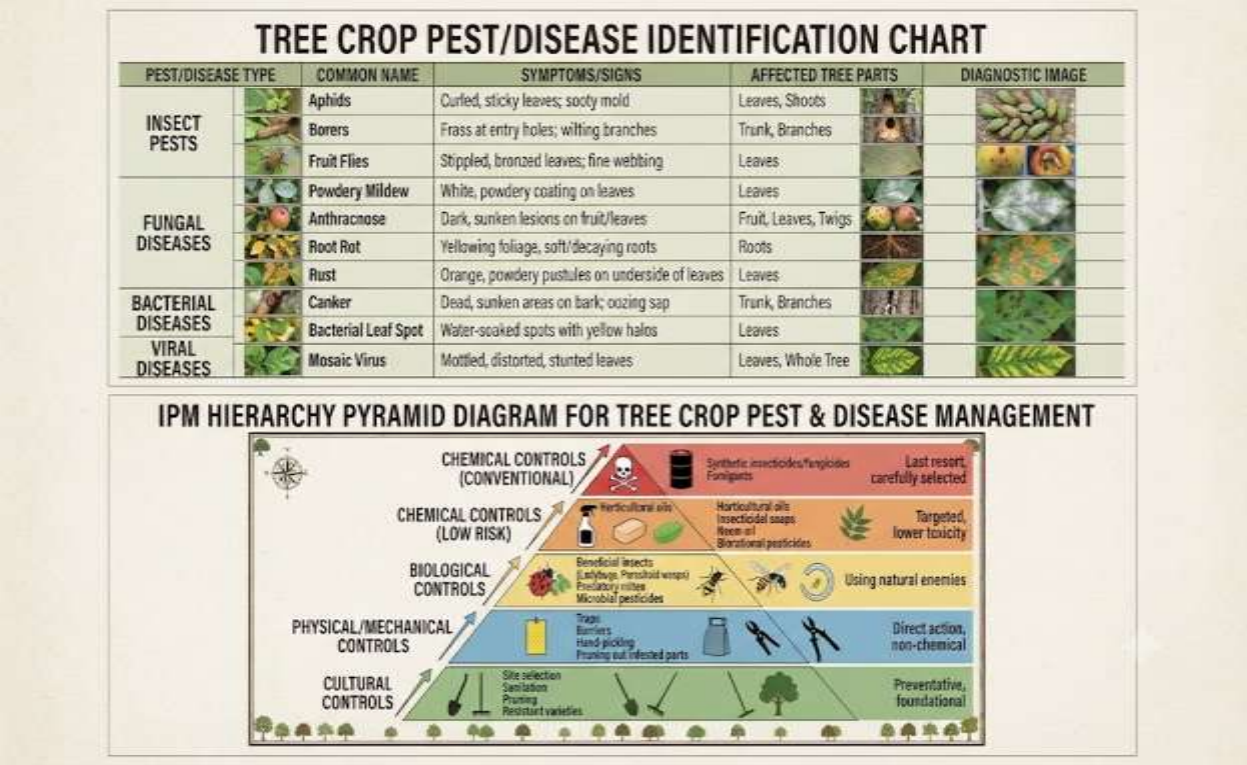

Figure 4.4: Pest and disease management in tree crops

Pilot questions 4.4

1. Name two major cocoa pests or diseases and state their primary control method.
2. Explain why citrus greening disease management focuses on prevention rather than cure.
3. Name two major oil palm pests or diseases.
4. Explain the IPM hierarchy approach to tree crop pest/disease management.
5. Explain why regular field scouting is particularly important for tree crops.

Series Summary

This Series examined **nursery establishment, field planting, and management of tree crops**. Most tree crops are first raised in nurseries before transplanting, with oil palm and citrus commonly remaining for 8–12 months and cocoa for 4–6 months. Field spacing varies by crop, such as 9 m triangular spacing for oil palm, 3 × 3 m under shade for cocoa, and 7 × 3 m for rubber. Aging plantations may be restored through complete replanting, top-working, or improved management. Proper nutrition is essential, especially potassium for oil palm and cocoa, while fertiliser is usually applied around the canopy drip-line. Cover crops and mulch help conserve moisture, suppress weeds, and improve soil conditions around young trees.

The Series also covered **pruning, canopy control, tapping, and integrated pest and disease management**. Formative pruning develops a strong tree framework, while maintenance pruning removes dead or diseased branches and unwanted shoots such as cocoa chupons. Cocoa shade is gradually reduced as trees mature, while rubber tapping usually begins after 5–7 years and may continue for 25–30 years under a proper panel system. Major threats include cocoa mirids and black pod disease, oil palm rhinoceros beetle and vascular wilt, and citrus psyllid and greening disease. Effective control combines regular scouting, cultural practices, biological methods, resistant materials, and careful use of pesticides. By completing this Series, students should achieve SLOs 4.1–4.4.

Glossary of Terms

- **Black pod disease:** a Phytophthora fungal disease causing pod rot in cocoa, the most economically significant cocoa disease.
- **Chupon:** a vigorous upright shoot in cocoa that competes with the main canopy and is removed during maintenance pruning.
- **Drip-line:** the outer edge of a tree canopy, marking the zone of concentrated feeder roots where fertiliser is best applied.

- **Jorquette:** the point where a young cocoa tree main stem branches into a spreading canopy, formed through formative pruning.
- **Mirid (capsid):** a sap-sucking insect pest of cocoa, damaging pods and shoots, favoured by excessive light.
- **Tapping:** the controlled cutting of rubber tree bark to harvest latex without damaging the underlying cambium layer.
- **Top-working:** grafting improved scion material onto existing tree rootstock as an alternative to full replanting.

Concept Check Questions [Series 4]

Objective Questions

1. Nursery duration before transplanting is typically _____ months for cocoa. (Linked to SLO 4.1)
2. Fertiliser for tree crops is applied at the canopy _____ -line, where feeder roots are concentrated. (Linked to SLO 4.2)
3. In cocoa, _____ are vigorous upright shoots removed during maintenance pruning. (Linked to SLO 4.3)
4. _____ pod disease is the most economically significant disease of cocoa. (Linked to SLO 4.4)
5. Rubber tapping typically begins at _____ to 7 years of tree age. (Linked to SLO 4.3)

Short-Answer Questions

1. Name two crops typically raised in a nursery before field planting. (Linked to SLO 4.1)
2. State the typical field spacing for oil palm. (Linked to SLO 4.1)
3. Explain why fertiliser placement at the drip-line matters. (Linked to SLO 4.2)
4. Name two major cocoa pests or diseases. (Linked to SLO 4.4)
5. State the typical productive tapping life of a well-managed rubber tree. (Linked to SLO 4.3)

Long-Answer Questions

1. Describe nursery establishment, field planting, and replanting practices for tree crops. (Linked to SLO 4.1)
2. Explain nutrition, fertiliser application, and pruning/canopy management practices for tree crops. (Linked to SLOs 4.2, 4.3)
3. Describe major tree crop pests, diseases, and integrated management approaches. (Linked to SLO 4.4)

Answers to Concept Check Questions [Series 4]

Objective Questions

1. 4-6.
2. Drip.
3. Chupons.
4. Black.
5. 5.

Short-Answer Questions

1. Oil palm and cocoa (or citrus, rubber).
2. 9 m triangular spacing, about 143 trees per hectare.
3. Feeder roots are concentrated at the drip-line, so fertiliser placed there is best absorbed by the tree.
4. Mirids/capsids and black pod disease.
5. 25-30 years.

Long-Answer Questions

1. Most tree crops are nursery-raised (8-12 months for oil palm/citrus; 4-6 months for cocoa) before field planting at crop-specific spacing. Replanting and rehabilitation (full replanting, top-working, improved management) address aging stand productivity decline.
2. Tree crops require balanced nutrition (potassium especially important for oil palm/cocoa), with fertiliser applied at the canopy drip-line and cover crops/mulch supporting young trees. Formative pruning establishes tree framework; maintenance pruning removes dead/diseased wood and chupons; shade management is important for cocoa; rubber tapping follows a controlled panel system.
3. Major pests include cocoa mirids and oil palm rhinoceros beetle; major diseases include black pod (cocoa) and citrus greening. Integrated management combines cultural practices, resistant varieties, biological control, and targeted chemical control, supported by regular field scouting.

Answers to Pilot Questions [Series 4]

Part 4.1

1. Nurseries allow concentrated early care, seedling selection, and protection from losses that would occur with direct field establishment.
2. Oil palm and citrus: 8-12 months. Cocoa: 4-6 months.
3. Approximately 9 m triangular spacing, giving about 143 trees per hectare.
4. Young cocoa is shade-demanding and benefits from reduced light/heat stress during establishment.
5. Top-working/grafting and improved management of existing stands.

Part 4.2

1. Potassium regulates fruit/pod development and water relations, both heavily demanded by these fruiting crops.
2. Fertiliser should be placed at the canopy drip-line, where active feeder roots are concentrated.
3. Typically applied at the onset of rains, sometimes split into two or more applications for mature trees.
4. Cover crops suppress weeds and reduce soil erosion (and contribute nitrogen fixation if legumes are used).
5. Mulching conserves soil moisture and suppresses weeds around young establishing trees.

Part 4.3

1. Formative pruning establishes a strong, well-balanced tree framework during early growth.
2. A chupon is a vigorous upright shoot competing with the main canopy; it is removed to maintain productive canopy structure.
3. Shade is reduced as the maturing cocoa canopy provides increasing self-shading, balancing light needs against heat/disease risk.
4. Tapping cuts a thin groove into the bark without damaging the underlying cambium, allowing bark regeneration and repeated tapping.
5. 5 to 7 years of age.

Part 4.4

1. Mirids/capsids: controlled through insecticide and shade management. Black pod disease: managed through sanitation and fungicide.
2. Because citrus greening disease is incurable once a tree is infected, so prevention through vector control and disease-free material is essential.
3. Rhinoceros beetle and vascular wilt (or bagworms/leaf-eating caterpillars).
4. IPM combines cultural practices, biological control, and targeted chemical control, prioritising the least disruptive effective methods first.
5. Because tree crops have a long productive lifespan, allowing chronic unaddressed pest/disease pressure to cause significant cumulative economic loss.

References and Attributions

Textual References (Books and External Sources)

- Opeke, L. K. (2005). Tropical tree crops. Spectrum Books, Ibadan.
- FAO (Food and Agriculture Organization of the United Nations). (2025). Guidelines for sustainable agriculture. FAO.
- IITA (International Institute of Tropical Agriculture). (2020). Annual report. IITA, Ibadan.
- Purseglove, J. W. (1968). Tropical crops: Dicotyledons. Longman, London.

Figures, Plates, Tables, and Boxes

- Figure 4.1: Nursery establishment and field planting for tree crops Attribution: AI generated. Suggested OER search string: "tree crop nursery establishment oil palm cocoa rubber citrus spacing Nigeria OER".
- Figure 4.2: Tree crop nutrition and soil management Attribution: AI generated. Suggested OER search string: "tree crop fertiliser placement cover crop mulch soil conservation Nigeria OER".
- Figure 4.3: Pruning, shade management, and rubber tapping Attribution: AI generated. Suggested OER search string: "cocoa pruning jorquette chupon rubber tapping panel latex Nigeria tree crop OER".
- Figure 4.4: Pest and disease management in tree crops Attribution: AI generated. Suggested OER search string: "cocoa mirid oil palm rhinoceros beetle citrus psyllid black pod disease IPM tree crop Nigeria OER".

Series 5: Harvesting, Handling, and Processing

- **Part 5.1: Harvesting Field Crops**
  - Sub Part 5.1.1: Maturity indices and harvest timing
  - Sub Part 5.1.2: Harvesting methods for cereals and legumes
  - Sub Part 5.1.3: Harvesting methods for root and tuber crops
- **Part 5.2: Harvesting Tree Crops**
  - Sub Part 5.2.1: Oil palm and cocoa harvesting
  - Sub Part 5.2.2: Rubber, cashew, and citrus harvesting
  - Sub Part 5.2.3: Harvest scheduling and labour considerations
- **Part 5.3: Post-Harvest Handling and Storage**
  - Sub Part 5.3.1: Drying and curing
  - Sub Part 5.3.2: Storage methods
  - Sub Part 5.3.3: Post-harvest losses and their causes
- **Part 5.4: Processing of Field and Tree Crops**
  - Sub Part 5.4.1: Primary processing of cereals and tubers
  - Sub Part 5.4.2: Processing of tree crop products
  - Sub Part 5.4.3: Value addition and quality standards

Introduction

The final stage of crop production, harvesting, handling, and processing, determines how much of the value created during cultivation (Series 1-4) is actually realised as usable, marketable product; poor practices at this stage can erase much of the benefit of good agronomic management upstream. This Series closes AGE 307 by examining harvest timing and methods, post-harvest handling and storage, and basic processing for both field and tree crops.

This Series covers harvesting practices for field crops (cereals, legumes, root/tuber crops) and tree crops (oil palm, cocoa, rubber, cashew, citrus); post-harvest handling, drying, and storage; and primary processing and value addition. This draws together the production knowledge built across all previous Series of AGE 307.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 5.1** describe maturity indices and harvesting methods for major Nigerian field crops (Linked to Part 5.1),
- **SLO 5.2** describe harvesting methods and scheduling considerations for major Nigerian tree crops (Linked to Part 5.2),
- **SLO 5.3** explain post-harvest handling, drying, storage, and causes of post-harvest losses (Linked to Part 5.3), and
- **SLO 5.4** describe primary processing, value addition, and quality standards for field and tree crops (Linked to Part 5.4).

5.1 Harvesting Field Crops

5.1.1 Maturity indices and harvest timing

Each field crop has specific visual or physical maturity indices guiding harvest timing: cereals are harvested when grain moisture drops to 18-20% and husks/leaves dry and yellow; legumes when pods dry and rattle or change colour; harvesting too early reduces yield and grain quality (high moisture, poor storage life), while harvesting too late increases losses from shattering, lodging, and pest/weather damage.

Accurate maturity assessment, often combining visual inspection with simple tools (moisture meters where available, or traditional methods such as biting/testing grain hardness), helps farmers time harvest to balance maximum yield against minimising field losses, a judgement skill developed through experience and extension guidance.

Fill in the blank: Cereals are typically harvested when grain moisture drops to _____ % and husks/leaves dry and yellow.

5.1.2 Harvesting methods for cereals and legumes

Manual harvesting (cutting with a cutlass or sickle, or hand-picking for some crops) remains dominant on Nigerian smallholder farms, followed by manual or mechanical threshing (separating grain from stalks/pods) using sticks, treading, or motorised threshers where available. Mechanised combine harvesting (cutting and threshing in one pass) is used on some larger commercial rice and maize farms but remains limited across most smallholder Nigerian production.

Legumes such as cowpea and groundnut require careful handling during harvest and threshing to minimise grain cracking and insect entry points; groundnut is typically lifted from the soil (uprooting the whole plant) before pods are picked and dried, while cowpea pods are cut or hand-picked once dry.

Fill in the blank: _____ harvesting (cutting and threshing in one pass) is used on some larger commercial rice and maize farms but remains limited across most smallholder Nigerian production.

5.1.3 Harvesting methods for root and tuber crops

Cassava is harvested by manual uprooting/digging, with flexible timing (roots can remain in the ground past maturity, Series 2) allowing farmers to stagger harvest according to labour availability and market need rather than a fixed harvest window. Yam is harvested by careful digging to avoid damaging the tuber skin (which reduces storage life and market value), often in two stages for some varieties (a partial early harvest, then full harvest later).

Sweet potato is harvested by uprooting or digging, similarly requiring care to avoid skin damage; root and tuber crop harvesting is generally more labour-intensive per unit area than cereal/legume harvesting due to the manual digging required, a significant cost and labour planning consideration for farmers.

Fill in the blank: Yam is harvested by careful digging to avoid damaging the tuber _____ , which would otherwise reduce storage life and market value.

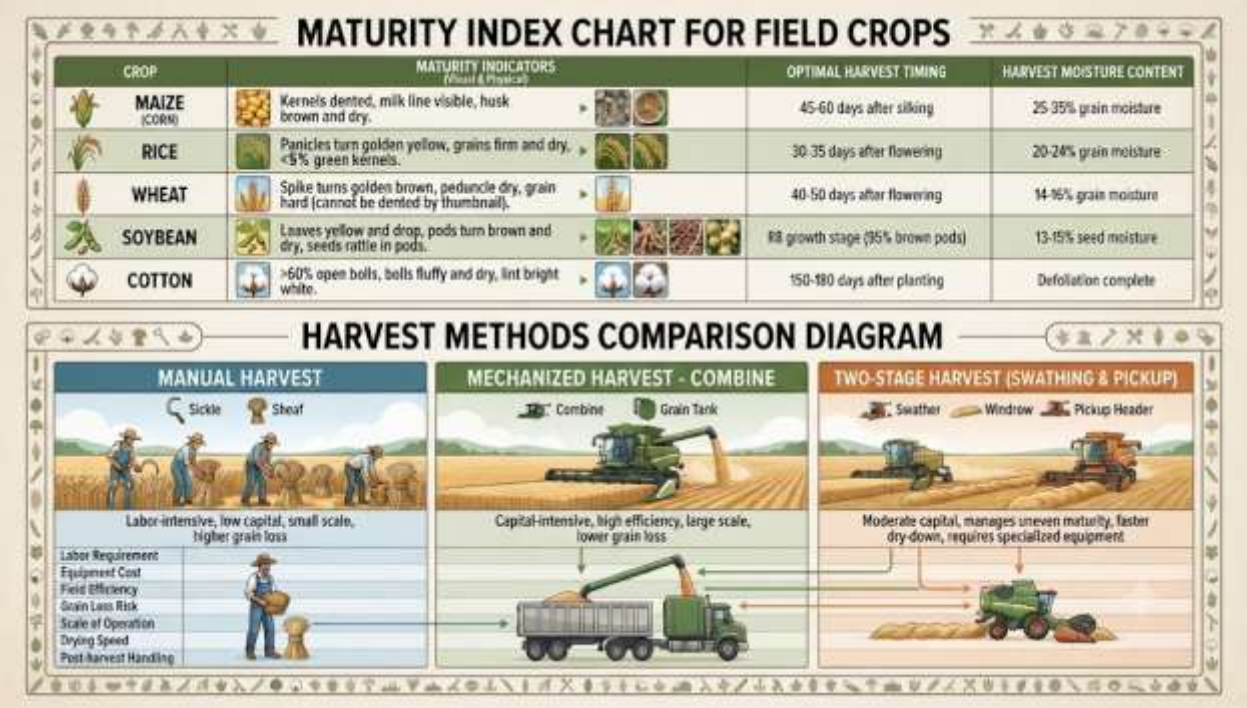

Figure 5.1: Harvesting field crops

Pilot questions 5.1

1. State the grain moisture level at which cereals are typically harvested.
2. Explain the risk of harvesting too early and too late.
3. Describe the harvesting process for groundnut.
4. Explain why cassava offers flexible harvest timing.
5. Explain why care is needed when digging yam at harvest.

5.2 Harvesting Tree Crops

5.2.1 Oil palm and cocoa harvesting

Oil palm fruit bunches are harvested when fruits begin to detach naturally (loose fruit on the ground signals ripeness), cut using a sickle/chisel on a long pole for tall palms or a cutlass for younger, shorter palms; harvest rounds repeat every 7-10 days year-round given oil palm continuous, non-seasonal fruiting pattern.

Cocoa pods are harvested when they change colour to yellow/orange/red depending on variety, cut individually from the tree using a cutlass or hook-knife to avoid damaging the flower cushion (the site of future pod development), with two main harvest peaks per year (main crop and a smaller mid-crop) reflecting the Nigerian rainfall pattern.

Fill in the blank: Cocoa pods are cut individually using a cutlass or hook-knife, taking care to avoid damaging the flower _____ , the site of future pod development on the tree.

5.2.2 Rubber, cashew, and citrus harvesting

Rubber latex is collected daily or every few days following each tapping (Series 4), gathered into buckets at the tree and transported promptly to a collection point before coagulation affects processing quality. Cashew nuts (attached to the cashew apple) are typically hand-picked from the ground after natural fruit drop, then separated from the apple before drying.

Citrus fruit is hand-picked (clipped rather than pulled, to avoid stem-end injury that accelerates spoilage) once fruit reaches the variety-specific colour and sugar/acid maturity indices, with careful handling at harvest particularly important for fresh market fruit compared to fruit destined for juice processing.

Fill in the blank: Citrus fruit should be _____ rather than pulled at harvest, to avoid stem-end injury that accelerates spoilage, particularly important for fresh market fruit.

5.2.3 Harvest scheduling and labour considerations

Tree crop harvest scheduling must account for crop-specific fruiting patterns (continuous for oil palm, seasonal peaks for cocoa, daily/periodic for rubber tapping, drop-based for cashew), requiring different labour planning and timing discipline than the single concentrated harvest window typical of most field crops.

Labour availability and cost (Series 4) significantly affect tree crop harvest timeliness, since delayed harvest (overripe oil palm fruit, overripe/diseased cocoa pods left on the tree) directly reduces yield and quality; the labour-intensive nature of most Nigerian tree crop harvesting, with

limited mechanisation compared to some field crops, makes this an ongoing production cost and scheduling challenge.

Fill in the blank: Delayed tree crop harvest, such as overripe oil palm fruit or overripe/diseased cocoa pods left on the tree, directly reduces _____ and quality.

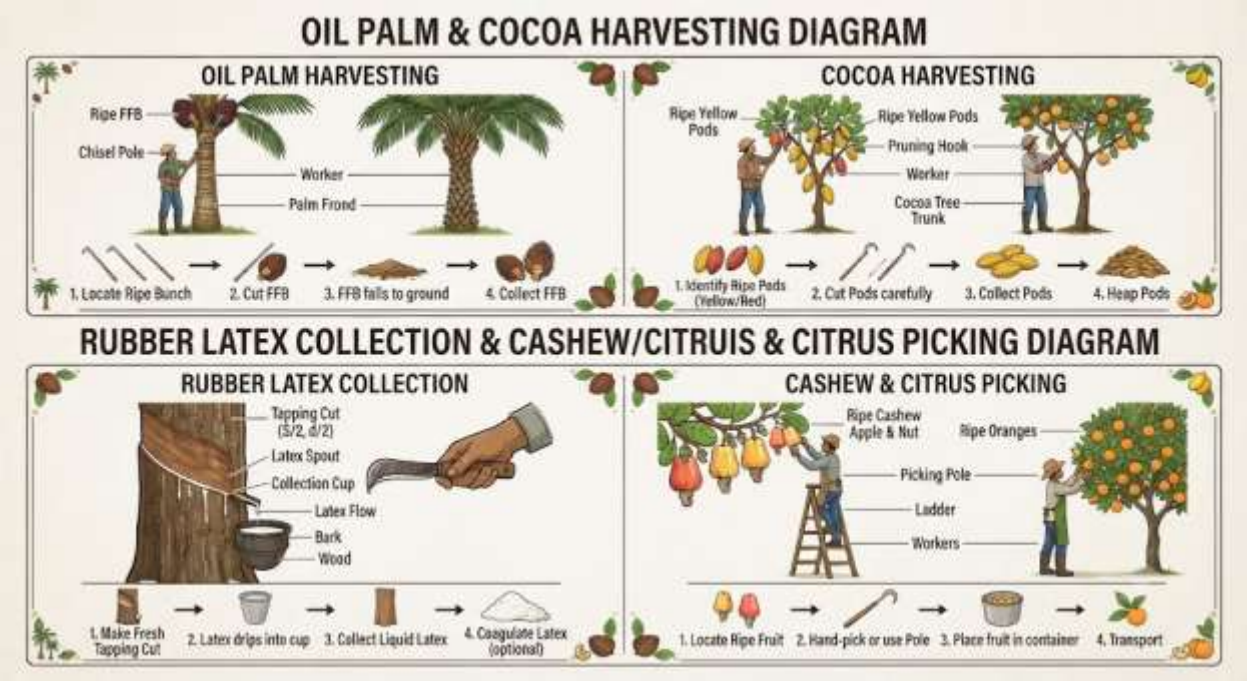

Figure 5.2: Harvesting tree crops

Pilot questions 5.2

1. Explain how oil palm fruit ripeness is recognised at harvest.
2. Explain why care must be taken when cutting cocoa pods from the tree.
3. Describe how cashew nuts are typically harvested.
4. Explain why citrus should be clipped rather than pulled at harvest.
5. Explain why tree crop harvest scheduling differs from field crop harvest scheduling.

5.3 Post-Harvest Handling and Storage

5.3.1 Drying and curing

Drying reduces moisture content to safe storage levels, preventing mould growth and insect activity; cereals and legumes are typically sun-dried on mats or hard surfaces to 12-14% moisture, while cocoa beans undergo fermentation (4-7 days, developing flavour precursors) before sun-drying to about 7% moisture, a curing process distinct from simple drying.

Coffee-style fermentation is not used for most field crops but is essential for cocoa flavour development; cashew nuts are sun-dried after separation from the apple; improper or incomplete drying/curing is a leading cause of quality loss and aflatoxin risk (groundnut, maize) discussed in earlier Series.

Fill in the blank: Cocoa beans undergo _____ for 4-7 days, developing flavour precursors, before sun-drying to about 7% moisture.

5.3.2 Storage methods

Traditional storage structures (rhombus cribs, mud silos, woven baskets) remain common for cereals and legumes on Nigerian smallholder farms, offering low cost but variable protection from moisture, pests, and rodents compared to modern storage (metal silos, hermetic/airtight bags such as PICS bags, which create a low-oxygen environment suppressing insect activity without chemical treatment).

Tuber crops are less amenable to long-term dry storage than grains; cassava is typically processed promptly or left in the ground (Series 2); yam is stored in ventilated yam barns (raised structures allowing air circulation around tubers) that can extend storage for several months under good conditions.

Fill in the blank: Hermetic/airtight storage bags create a low-_____ environment that suppresses insect activity in stored grain without chemical treatment.

5.3.3 Post-harvest losses and their causes

Post-harvest losses in Nigeria are substantial, often 20-40% for perishables and 10-20% for grains, arising from physical damage during harvest/handling, inadequate drying, poor storage (pest, rodent, and mould damage), and delays in transport to market or processing, echoing the infrastructure and marketing concerns discussed in agricultural marketing courses.

Reducing post-harvest losses requires combining improved harvesting care, adequate and timely drying, appropriate storage technology matched to the crop and farmer scale, and faster, better-organised marketing chains; these losses represent not just wasted produce but wasted inputs, labour, and land resources invested during production, making post-harvest loss reduction an efficient route to raising effective food availability without additional production.

Fill in the blank: Post-harvest losses in Nigeria are substantial, often 20-40% for perishables and 10-20% for _____ , arising from physical damage, inadequate drying, poor storage, and marketing delays.

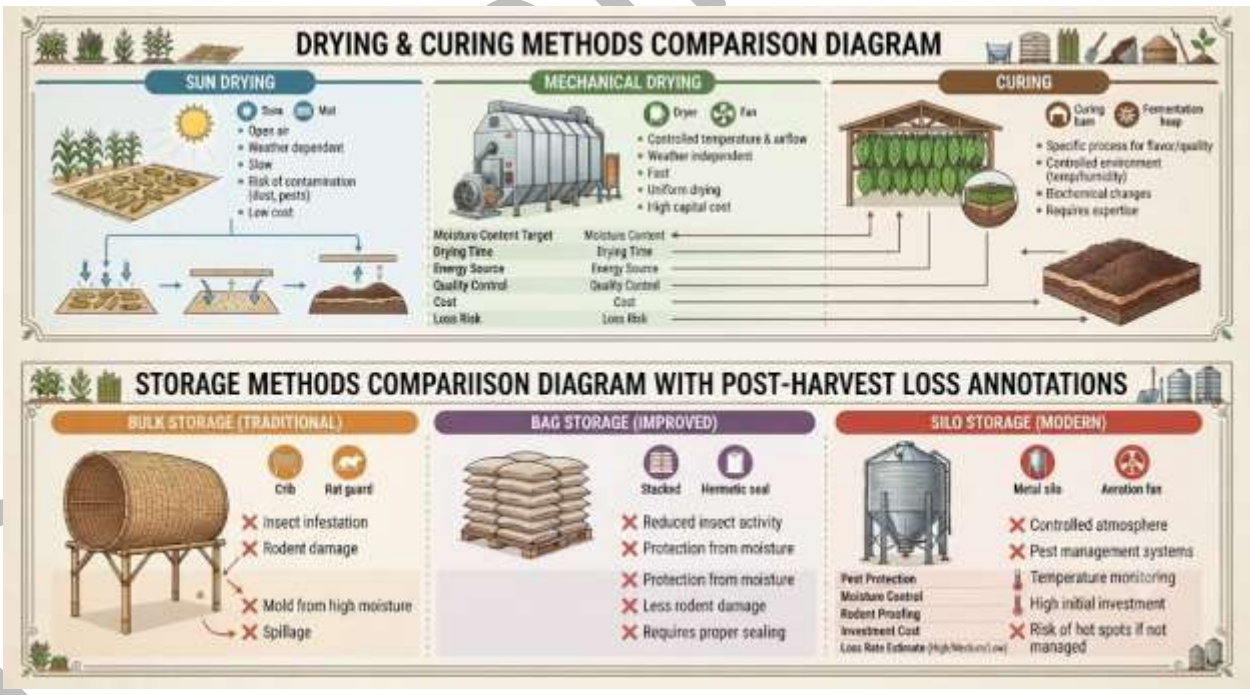

Figure 5.3: Post-harvest handling, drying, and storage

Pilot questions 5.3

1. State the typical moisture content target for safe cereal/legume storage.
2. Explain cocoa fermentation and its purpose.
3. Explain how hermetic storage bags protect grain without chemicals.
4. Explain why yam storage differs from grain storage.
5. State the typical post-harvest loss range for Nigerian perishable produce.

5.4 Processing of Field and Tree Crops

5.4.1 Primary processing of cereals and tubers

Cereal processing includes threshing, winnowing, and milling into flour or grits (maize), or dehulling/parboiling and milling for rice; these primary processing steps improve storability, cookability, and market value compared to selling unprocessed grain.

Cassava is processed into garri (peeling, grating, fermenting, dewatering, frying), fufu, or starch; yam can be processed into flour; these processing steps, covered in more depth in agricultural marketing courses, extend shelf life and create higher-value products than the raw root, directly applying the value addition concept introduced in earlier Series.

Fill in the blank: Cassava is processed into garri through peeling, grating, fermenting, dewatering, and _____ , extending shelf life compared to the raw root.

5.4.2 Processing of tree crop products

Oil palm fruit is processed (sterilising, threshing, pressing) to extract palm oil from the mesocarp and, separately, palm kernel oil from the kernel after cracking; processing scale ranges from small manual/semi-mechanised local mills to large industrial extraction plants. Fermented, dried cocoa beans are processed (roasting, winnowing, grinding) into cocoa liquor, the base for cocoa powder, cocoa butter, and chocolate manufacture, mostly carried out outside Nigeria given limited domestic processing capacity (Series 3).

Rubber latex is coagulated and processed into various forms (ribbed smoked sheet, crepe, or block rubber) for industrial use; cashew nuts are shelled (removing the hard outer shell, a delicate operation since kernel breakage reduces value) and the kernel roasted/packaged, while cashew apple, often discarded, has growing potential for juice and other product development.

Fill in the blank: Fermented, dried cocoa beans are processed through roasting, winnowing, and grinding into cocoa _____ , the base for cocoa powder, cocoa butter, and chocolate manufacture.

5.4.3 Value addition and quality standards

Quality standards and grading (Series 1 and agricultural marketing courses) apply throughout field and tree crop processing: grain moisture and foreign matter limits, cocoa bean fermentation and mould standards, palm oil free fatty acid content, and cashew kernel grade (whole versus broken) all affect price and market access, particularly for export-oriented products.

Expanding domestic processing and value addition (rather than exporting raw or minimally processed commodities) remains a recurring theme across this course and related agricultural marketing courses, representing a significant opportunity to capture more economic value within Nigeria from both field and tree crop production, closing the circle from the foundational concepts introduced in Series 1 through to the final marketable, processed product.

Fill in the blank: _____ standards and grading, covering moisture content, fermentation quality, free fatty acid content, or kernel breakage depending on the crop, affect price and market access, particularly for export-oriented products.

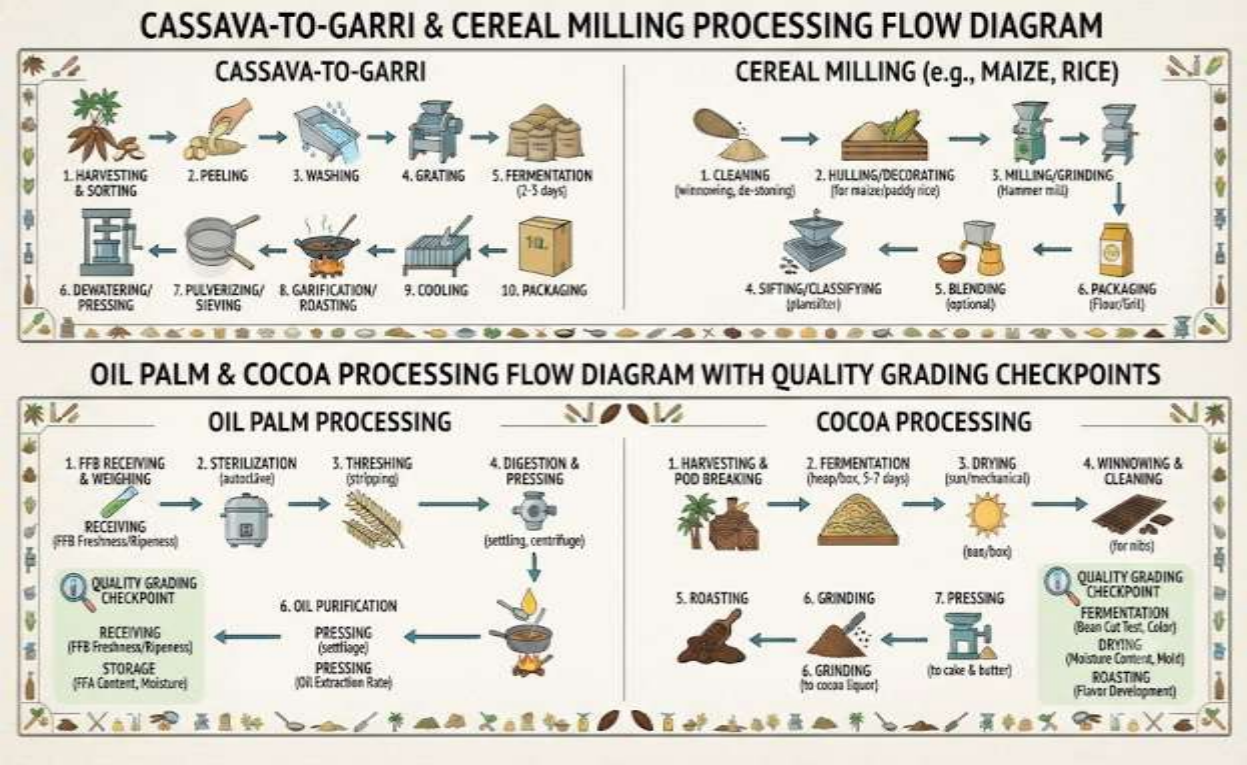

Figure 5.4: Processing of field and tree crops

Pilot questions 5.4

1. Describe the steps in processing cassava into garri.
2. Explain the difference between palm oil and palm kernel oil.
3. Describe the processing steps from dried cocoa beans to cocoa liquor.
4. Explain why cashew kernel breakage during shelling reduces value.
5. Explain why expanding domestic processing capacity is an important opportunity for Nigeria.

Series Summary

This Series examined **the harvesting, post-harvest handling, processing, and value addition of field and tree crops**. Harvesting must be carried out at the correct maturity stage using methods suited to each crop. Cereals are commonly harvested at about 18–20% grain moisture before threshing, while roots and tubers are carefully dug to prevent damage. Oil palm fruits are harvested when loose fruits indicate ripeness, cocoa pods when their colour changes, rubber through tapping and latex collection, cashew after nut fall, and citrus by clipping rather than pulling. Proper scheduling and labour planning are important because harvesting patterns differ among crops.

The Series also covered **post-harvest management and processing as activities that preserve quality, reduce losses, and increase product value**. Grains are dried to about 12–14% moisture, cocoa is fermented for 4–7 days before drying, and produce may be stored in cribs, hermetic bags, metal silos, or yam barns. Post-harvest losses may reach 20–40% for perishables and 10–20% for grains. Processing includes cereal threshing and milling, cassava conversion into garri, fufu, and starch, oil palm processing into palm and kernel oil, cocoa processing into liquor, rubber coagulation, and cashew shelling and roasting. Quality standards, proper packaging, and value addition improve prices and market access, while expanded domestic processing offers major economic opportunities. By completing this Series, students should achieve SLOs 5.1–5.4 and all AGE 307 course outcomes.

Glossary of Terms

- **Cocoa liquor:** the product of roasting, winnowing, and grinding fermented dried cocoa beans, the base for cocoa powder, butter, and chocolate.
- **Fermentation (cocoa):** a 4-7 day process developing flavour precursors in cocoa beans before drying.
- **Garri:** a processed cassava product made by peeling, grating, fermenting, dewatering, and frying cassava.

- **Hermetic storage:** airtight storage (e.g. PICS bags) creating a low-oxygen environment that suppresses insect activity without chemicals.
- **Maturity index:** a visual or physical indicator used to determine harvest readiness for a crop.
- **Post-harvest loss:** produce lost between harvest and consumption due to physical damage, poor drying, storage pests, or marketing delays.
- **Yam barn:** a raised, ventilated storage structure allowing air circulation around stored yam tubers.

Concept Check Questions [Series 5]

Objective Questions

1. Cereals are typically harvested when grain moisture drops to _____ %. (Linked to SLO 5.1)
2. Cocoa pods are cut taking care to avoid damaging the flower _____ . (Linked to SLO 5.2)
3. Cocoa beans undergo _____ for 4-7 days before drying. (Linked to SLO 5.3)
4. Cassava is processed into _____ through peeling, grating, fermenting, dewatering, and frying. (Linked to SLO 5.4)
5. Post-harvest losses in Nigeria are often 20-40% for _____ . (Linked to SLO 5.3)

Short-Answer Questions

1. State the harvest moisture target for cereals. (Linked to SLO 5.1)
2. Name two methods of harvesting oil palm or cocoa. (Linked to SLO 5.2)
3. Name two storage methods for field crops. (Linked to SLO 5.3)
4. Name two processed products of cassava. (Linked to SLO 5.4)
5. State two causes of post-harvest losses. (Linked to SLO 5.3)

Long-Answer Questions

1. Describe maturity indices and harvesting methods for field and tree crops. (Linked to SLOs 5.1, 5.2)
2. Explain post-harvest handling, drying, storage, and causes of losses. (Linked to SLO 5.3)
3. Describe primary processing, value addition, and quality standards for field and tree crops. (Linked to SLO 5.4)

Answers to Concept Check Questions [Series 5]

Objective Questions

1. 18-20.
2. Cushion.
3. Fermentation.
4. Garri.
5. Perishables.

Short-Answer Questions

1. 12-14% moisture.
2. Pole sickle/chisel cutting (oil palm) and cutlass/hook-knife cutting (cocoa).
3. Traditional cribs/baskets and hermetic PICS bags (or metal silos).
4. Garri and fufu (or starch).
5. Physical damage during harvest and poor/inadequate storage.

Long-Answer Questions

1. Field crops are harvested at crop-specific maturity indices (grain moisture, pod dryness, tuber maturity) using manual cutting/digging methods. Tree crops are harvested using crop-specific methods: oil palm (pole sickle), cocoa (hook-knife avoiding the flower cushion), rubber (latex collection), cashew (hand-picked after drop), citrus (clipped).
2. Drying reduces moisture to safe storage levels; cocoa undergoes fermentation before drying. Storage methods range from traditional cribs to hermetic bags and yam barns. Losses (20-40% perishables, 10-20% grains) arise from physical damage, poor drying, storage pests, and marketing delays.
3. Cereals are threshed and milled; cassava is processed into garri, fufu, or starch. Oil palm yields palm oil and palm kernel oil; cocoa beans are processed into cocoa liquor; rubber is coagulated into sheet/block; cashew is shelled and roasted. Quality standards and grading affect price and market access, with domestic processing expansion a key opportunity.

Answers to Pilot Questions [Series 5]

Part 5.1

1. 18-20% grain moisture.
2. Too early reduces yield/quality; too late increases shattering and pest/weather losses.
3. Groundnut is uprooted whole, then pods are picked and dried.
4. Cassava roots can remain in the ground past maturity without major quality loss.
5. Damaging the tuber skin reduces storage life and market value.

Part 5.2

1. Loose fruit on the ground signals ripeness for oil palm.
2. Damaging the flower cushion would reduce future pod development at that site.
3. Cashew nuts are hand-picked from the ground after natural fruit drop.
4. Clipping avoids stem-end injury that would accelerate spoilage.
5. Tree crops have varied fruiting patterns (continuous, seasonal, periodic) requiring different scheduling than a single field crop harvest window.

Part 5.3

1. 12-14% moisture content.
2. Fermentation develops flavour precursors in cocoa beans before drying.
3. They create a low-oxygen environment that suppresses insect activity without chemical treatment.
4. Yam is stored in ventilated barns rather than dried like grain, since it is not dried before storage.
5. 20-40% for perishables.

Part 5.4

1. Cassava is peeled, grated, fermented, dewatered, and fried into garri.
2. Palm oil comes from the fruit mesocarp; palm kernel oil comes from the seed/kernel.
3. Dried beans are roasted, winnowed, and ground into cocoa liquor.

4. Broken kernels are lower grade and sell for less than whole kernels.
5. It would capture more economic value domestically rather than exporting raw or minimally processed commodities.

References and Attributions

Textual References (Books and External Sources)

- FAO (Food and Agriculture Organization of the United Nations). (2025). Guidelines for sustainable agriculture. FAO.
- Opeke, L. K. (2005). Tropical tree crops. Spectrum Books, Ibadan.
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Figures, Plates, Tables, and Boxes

- Figure 5.1: Harvesting field crops Attribution: AI generated. Suggested OER search string: "field crop harvest maturity cereal legume tuber Nigeria harvesting methods OER".
- Figure 5.2: Harvesting tree crops Attribution: AI generated. Suggested OER search string: "oil palm cocoa harvest rubber latex cashew citrus picking Nigeria tree crop OER".
- Figure 5.3: Post-harvest handling, drying, and storage Attribution: AI generated. Suggested OER search string: "crop drying cocoa fermentation storage PICS bags yam barn post-harvest losses Nigeria OER".
- Figure 5.4: Processing of field and tree crops Attribution: AI generated. Suggested OER search string: "cassava garri processing oil palm cocoa processing quality standards Nigeria OER".