



La-Net

# AGE 101

## INTRODUCTION TO AGRICULTURE



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**Course code: AGE 101**

**Course title: Introduction to Agriculture**

**Course credit load: 2 Units**

## **Series 1: Foundations of Agriculture**

- **Part 1.1: Definition, Scope, and Branches of Agriculture**
  - Sub Part 1.1.1: What is agriculture?
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## Introduction

Agriculture is the oldest and most fundamental human economic activity. It is the source of food, fibre, fuel, and raw materials that sustain civilisation. Understanding what agriculture is, how it developed from prehistoric times to the modern era, how it relates to population growth and food security, and what measures can improve it in Nigeria provides the conceptual foundation for the entire AGE 101 course.

This opening Series defines agriculture and its branches, traces the history of agriculture from its origins to the modern era, examines the relationship between world population growth and food supply, and surveys the specific challenges and improvement measures relevant to Nigerian agriculture. The knowledge built here underpins every subsequent Series in this course.

## Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 1.1** define agriculture and describe its scope, branches, and importance to Nigeria (Linked to Part 1.1),
- **SLO 1.2** describe the origin and historical development of agriculture and its transformation in Nigeria (Linked to Part 1.2),
- **SLO 1.3** explain the relationship between world population growth and food supply, and describe food security in Nigeria (Linked to Part 1.3), and
- **SLO 1.4** describe the land use and tenure system, government programmes, and mechanisation as measures for improving Nigerian agriculture (Linked to Part 1.4).

## 1.1 Definition, Scope, and Branches of Agriculture

### 1.1.1 What is agriculture?

Agriculture is the science, art, and practice of cultivating the soil, growing crops, and raising livestock for food, fibre, fuel, medicinal plants, and other products used to sustain and enhance



human life. The word agriculture comes from the Latin words ager (field) and cultura (cultivation). Agriculture therefore encompasses everything done to manage land, crops, and animals for useful products and services. It is both a science (applying biological, chemical, and physical knowledge) and an art (requiring skill, judgment, and experience).

Agriculture is also an industry and a way of life for the majority of Nigeria's population. Approximately 70% of the Nigerian rural population depends on agriculture for their livelihood. Agriculture contributes approximately 24-26% of Nigeria's gross domestic product (GDP) and employs over 30% of the labour force. It provides the raw materials for food processing industries, earns foreign exchange through export of agricultural products (cocoa, groundnut, rubber, palm oil, sesame, cashew), and supports rural community development.

Fill in the blank: Agriculture is the science, art, and practice of cultivating the soil, growing \_\_\_\_\_, and raising livestock; it contributes approximately 24-26% of Nigeria's GDP and employs over 30% of the labour force.

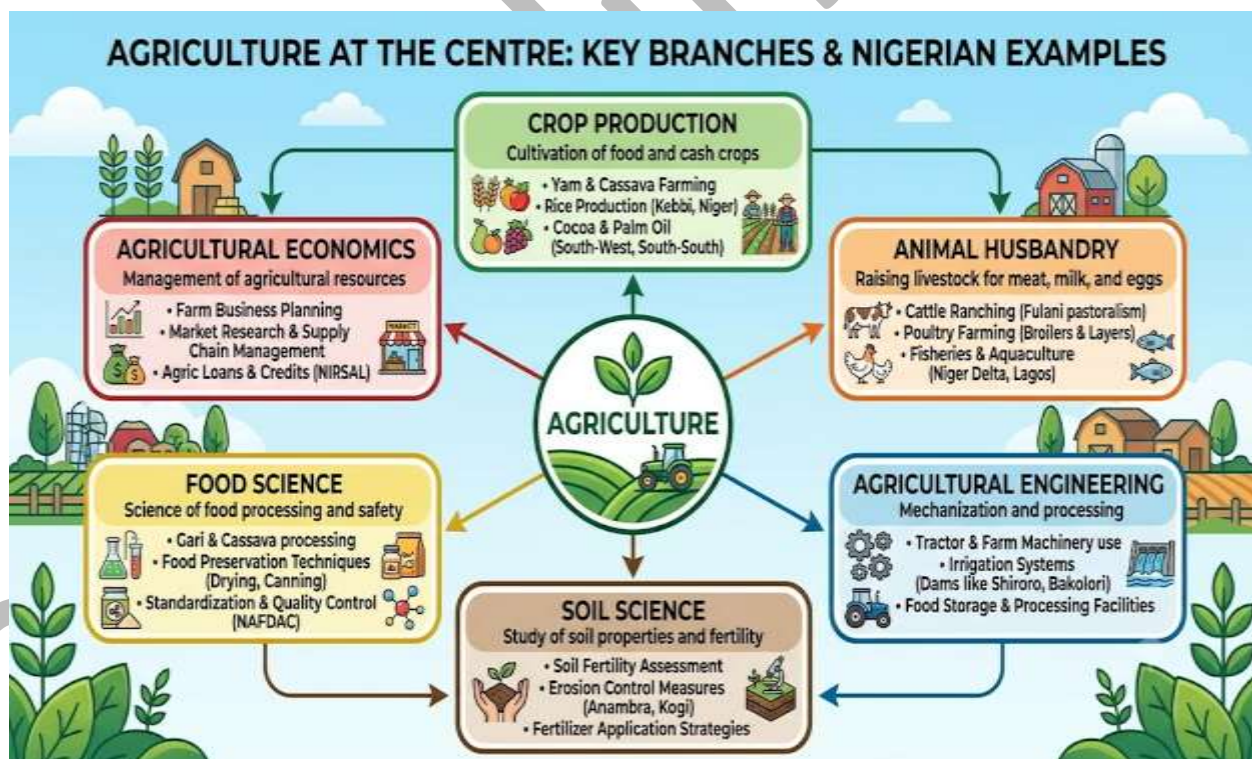


Figure 1.1: The scope and branches of agriculture



### 1.1.2 Branches of agriculture

Agriculture is subdivided into several major branches. Crop production (agronomy): the science and practice of growing field crops (cereals, legumes, roots and tubers, oil crops, fibre crops) for food and raw materials; the largest branch of agriculture in terms of area and output.

Horticulture: the cultivation of fruits, vegetables, ornamental plants, and flowers; requires more intensive management than agronomy. Animal husbandry (livestock farming): the breeding, management, and utilisation of domesticated animals (cattle, sheep, goats, pigs, poultry, rabbits) for food (meat, milk, eggs), fibre (wool, hides), and draught power.

Agricultural engineering: applies engineering principles to farm mechanisation, irrigation, drainage, farm buildings, and post-harvest equipment. Soil science (pedology): studies the formation, classification, and management of soils for crop production. Agricultural economics: applies economic principles to farm management, marketing, agricultural policy, and rural development. Forestry: the management of forests for timber, fuelwood, and environmental services. Fisheries: the production of fish and other aquatic organisms. Food science and technology: the preservation, processing, and quality control of agricultural products. Veterinary science: the health and disease management of farm animals.

Fill in the blank: \_\_\_\_\_ is the branch of agriculture concerned with the cultivation of fruits, vegetables, ornamental plants, and flowers; it requires more intensive management than agronomy and is important for urban and peri-urban food supply.

### 1.1.3 Importance of agriculture

Agriculture is important to Nigeria and to humanity for seven major reasons: (1) Food supply: agriculture is the primary source of food for the growing Nigerian population; it produces staple crops (cassava, yam, maize, rice, sorghum, millet) and protein sources (poultry, beef, fish, beans, groundnut). (2) Raw materials for industry: agriculture supplies cotton for textiles, rubber for tyres, palm oil for soap and cosmetics, groundnut for oil, and timber for furniture and construction. (3) Employment: agriculture is the largest single employer in Nigeria; it provides rural livelihoods and reduces urban-rural migration.





(4) Foreign exchange earnings: Nigeria earns foreign exchange from cocoa, rubber, sesame, cashew, and horticultural products; before the oil boom, agriculture was the dominant source of foreign exchange. (5) Government revenue: taxes on agricultural trade and processing contribute to government income. (6) Raw materials for agro-industries: sugar mills, cotton ginneries, flour mills, and breweries depend on agricultural raw material supply. (7) Ecological services: agriculture, when practised sustainably, maintains soil cover, prevents erosion, and contributes to biodiversity; agroforestry enhances carbon sequestration and watershed functions.

Fill in the blank: Before the discovery of petroleum, \_\_\_\_\_ was Nigeria's dominant source of foreign exchange earnings, contributing cocoa, groundnut, palm oil, and rubber exports; restoring this role is a major national agricultural policy goal.

#### Pilot questions 1.1

1. Define agriculture in your own words.
2. Name five branches of agriculture and state what each involves.
3. State five reasons why agriculture is important to Nigeria.
4. Explain why agriculture is described as both a science and an art.
5. State the approximate percentage contribution of agriculture to Nigeria's GDP.

## 1.2 History and Development of Agriculture

### 1.2.1 Origin and spread of agriculture

Agriculture began approximately 10,000-12,000 years ago during the Neolithic revolution (New Stone Age), when human populations in several independent centres began to domesticate plants and animals rather than relying solely on hunting and gathering. The primary centres of agricultural origin include: the Fertile Crescent (Southwest Asia; wheat, barley, lentils, goats, sheep); China (rice, millet, pigs); Mesoamerica (maize, beans, squash); sub-Saharan Africa (sorghum, millet, cowpea, yam); and South America (potato, quinoa, llama).

Pre-agricultural humans were hunter-gatherers who moved constantly to follow game and seasonal plant foods; they lived in small nomadic groups. The shift to settled farming allowed



permanent villages, food surpluses, population growth, specialisation of labour, and eventually the development of cities, writing, and complex civilisations. In Africa, agriculture developed independently in multiple centres: the West African savanna (sorghum, pearl millet); the Sahel; the Ethiopian highlands (teff, coffee); and West African forest margins (yam, oil palm). Agriculture spread from these centres along trade routes, river valleys, and through migration over thousands of years.

Fill in the blank: Agriculture originated approximately \_\_\_\_\_ -12,000 years ago during the Neolithic revolution; the Fertile Crescent (Southwest Asia) is recognised as one of the earliest and most important centres of agricultural origin.

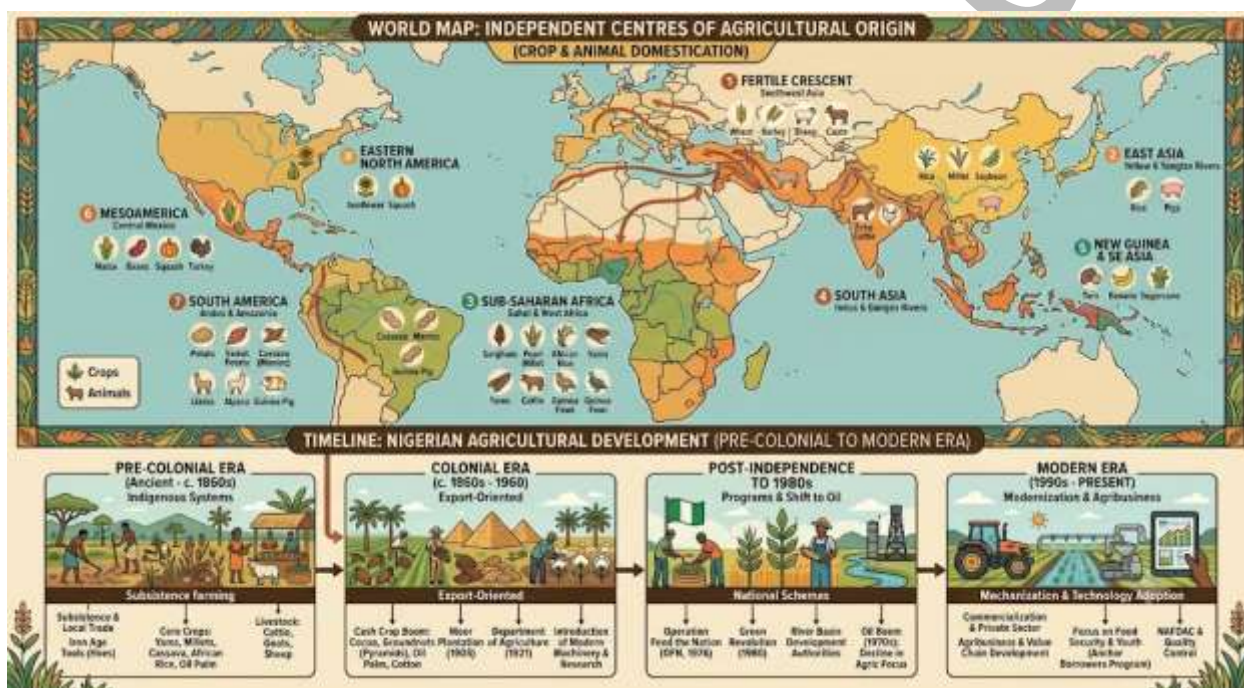


Figure 1.2: Origins and spread of agriculture and Nigeria's agricultural history

### 1.2.2 Development of agriculture in Nigeria

Pre-colonial Nigerian agriculture: farming in Nigeria dates back several thousand years; indigenous farming systems were adapted to local ecology; they included shifting cultivation (bush fallowing) in forest zones; mixed farming (crops + livestock) in the Sudan and Sahel savannas; permanent cultivation in densely populated areas such as Kano close-settled zone; and integrated tree-crop farming in the forest zone. Crops cultivated included yam, cassava, sorghum,



millet, cowpea, groundnut, oil palm, and rice. Trade in agricultural surpluses was practised through local and long-distance markets.

Colonial era (1900-1960): the British colonial administration introduced export crop production at a large scale; cocoa in southwestern Nigeria (Yoruba farmers); groundnut in the north (Hausa farmers, symbolised by the groundnut pyramids of Kano); palm oil and palm kernels in the southeast; cotton in the north and middle belt; rubber in the midwest. Colonial agricultural policies emphasised export crop production at the expense of food crop development; marketing boards were established to purchase and export these crops. Post-independence: after 1960, the oil boom of the 1970s reduced attention to agriculture; food imports increased; population pressure and land degradation intensified; government programmes were introduced to revive the sector.

Fill in the blank: The \_\_\_\_\_ pyramids of Kano became a symbol of northern Nigeria's agricultural prosperity during the colonial era, when groundnut was the dominant export crop of the region.

### **1.2.3 Modern agricultural revolution**

The First Agricultural Revolution (Neolithic; ~10,000 years ago): domestication of crops and animals; shift from nomadic to settled farming. The Second Agricultural Revolution (17th-19th century Europe): crop rotation (Norfolk four-course: wheat, turnip, barley, clover); improved livestock breeds; better drainage; mechanisation (seed drill by Jethro Tull 1701). The Third Agricultural Revolution (Green Revolution; 1960s-1970s): development by Norman Borlaug and CGIAR (Consultative Group on International Agricultural Research) of high-yielding varieties (HYVs) of wheat and rice; combined with irrigation, chemical fertilisers, and pesticides; dramatically increased food production in Asia and Latin America.

Nigeria and the Green Revolution: Nigeria formally adopted a Green Revolution programme in 1980 under President Shehu Shagari; it introduced improved seed varieties, fertilisers, and farm credit to smallholders; results were mixed because of poor infrastructure, limited extension services, and policy inconsistency. Subsequent programmes: Operation Feed the Nation (OFN, 1976); the Agricultural Development Projects (ADPs, 1975 onwards); the Directorate for Food,





Roads and Rural Infrastructure (DFRRI, 1986); the Fadama Development Projects (World Bank-supported, 1990s to present); the Anchor Borrowers Programme (CBN, 2015); and the Agriculture Promotion Policy (the Green Alternative, 2016-2020).

Fill in the blank: The \_\_\_\_\_ Revolution of the 1960s-70s, pioneered by Norman Borlaug, produced high-yielding wheat and rice varieties that dramatically increased food production in Asia and Latin America; Nigeria adopted a related programme in 1980.

#### Pilot questions 1.2

1. Name three independent centres of agricultural origin and a crop domesticated in each.
2. Describe the farming systems practised in pre-colonial Nigeria.
3. State three export crops introduced in Nigeria during the colonial era.
4. Explain what the Green Revolution was and state its key components.
5. Name three government programmes aimed at improving Nigerian agriculture after independence.

### 1.3 World Population, Food Supply, and Food Security

#### 1.3.1 World population growth

World population has grown from approximately 1 billion in 1800 to approximately 8 billion in 2023, with projections reaching 9.7 billion by 2050 and approximately 11 billion by 2100.

Population growth is driven by declining death rates (improved sanitation, medicine, and nutrition) while birth rates, especially in developing countries, remain relatively high. The most rapid population growth is occurring in sub-Saharan Africa, including Nigeria. Nigeria's population was approximately 213 million in 2021, making it the most populous country in Africa and the sixth most populous in the world; it is projected to reach approximately 400 million by 2050.

The demographic transition model describes how countries move from high birth rates and high death rates (Stage 1; pre-industrial) through declining death rates and still-high birth rates (Stage 2; early industrial; rapid population growth) to low birth and death rates (Stage 4; mature



industrial). Most of sub-Saharan Africa, including Nigeria, is at Stage 2-3 of the transition; this means population growth rates of approximately 2.5-3.0% per year. At this rate, Nigeria's population doubles approximately every 25 years, placing enormous pressure on food production systems, land, and natural resources.

Fill in the blank: Nigeria's population is projected to reach approximately \_\_\_\_\_ million by 2050, making it one of the most populous countries in the world; this growth places enormous pressure on food production and land resources.

### 1.3.2 Food production and the food gap

The food gap is the difference between the food needed to adequately feed a population and the food actually produced or available. Despite significant increases in food production globally since the Green Revolution, hundreds of millions of people remain undernourished, particularly in sub-Saharan Africa and South Asia. Global food production has generally kept pace with population growth due to yield improvements, expansion of irrigated area, and increased use of fertilisers; however, Nigeria faces a growing domestic food gap because: population growth outpaces agricultural productivity growth; post-harvest losses are high (estimated 20-40% of food produced); and distribution infrastructure is inadequate.

Malthusian theory: Thomas Malthus (1798) predicted that population grows geometrically (1, 2, 4, 8...) while food production grows arithmetically (1, 2, 3, 4...); therefore population would eventually outgrow food supply, leading to famine. This prediction has been partially avoided by agricultural technology, but the food-population balance remains precarious in many developing countries. Boserup's counter-argument: Ester Boserup argued that population pressure itself drives agricultural innovation and intensification; farmers adopt new methods when land becomes scarce. Both theories have relevance to understanding Nigerian agricultural development.

Fill in the blank: Thomas \_\_\_\_\_ predicted in 1798 that population grows geometrically while food production grows arithmetically, meaning population would eventually exceed food supply; technological advances have partially avoided this outcome.



### 1.3.3 Food security in Nigeria

Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO definition, 1996). Food security has four dimensions: availability (enough food exists at the national or local level); access (people can obtain food through production, purchase, or transfer); utilisation (the body can use the food; depends on dietary quality, safe water, and health); stability (access is maintained over time, including during crises and seasonal shortfalls).

Nigeria's food security situation: Nigeria is paradoxically both a large agricultural producer and a country with widespread food insecurity. An estimated 25 million Nigerians face food insecurity; child stunting rates due to chronic malnutrition exceed 37% in some regions. Causes of food insecurity in Nigeria: low agricultural productivity; inadequate rural infrastructure (roads, storage, electricity); post-harvest losses; conflict and insecurity in food-producing areas (Borno, Zamfara, Plateau States); climate change impacts (desertification in the north, flooding in the south); poverty limiting economic access to food. Improving food security requires interventions across all four dimensions.

Fill in the blank: Food security has four dimensions: \_\_\_\_\_ (sufficient food exists), access (people can obtain food), utilisation (the body can use it), and stability (access is maintained over time).

#### Pilot questions 1.3

1. State the world population in 2023 and the projection for 2050.
2. Explain the demographic transition model and state Nigeria's current stage.
3. Define the food gap and state two causes of the food gap in Nigeria.
4. State the four dimensions of food security.
5. List three causes of food insecurity in Nigeria.



## 1.4 Measures of Improving Nigerian Agriculture

### 1.4.1 Land use and tenure

Land is the most fundamental agricultural resource. Land tenure refers to the system by which land is owned, occupied, and used. Land tenure systems in Nigeria: customary tenure (the most widespread in rural Nigeria; land is held by a family, clan, or community; the family head allocates use rights to members; land is generally not sold to outsiders; may restrict women's access to land); freehold ownership (land is privately owned with a certificate of occupancy; allows sale, mortgage, and long-term investment; more common in urban areas); leasehold (land is leased for a defined period from the owner or government).

The Land Use Act 1978 (Nigeria): the most important land legislation in Nigeria; vests all land in each state in the Governor of that state to be held in trust and administered for the use and common benefit of all Nigerians; the Governor can grant a Certificate of Occupancy to individuals and organisations; it reduced fragmentation of land holdings and simplified administration; however, critics argue it has reduced farmers' incentive to make long-term investments since they do not have freehold ownership. Land reform needs: adequate plot size (fragmentation reduces efficiency); secure tenure (to encourage investment); access for women; simplified titling (to allow use of land as collateral for credit).

Fill in the blank: The Nigerian Land Use Act of \_\_\_\_\_ vests all land in each state in the Governor, who holds it in trust for all Nigerians and can grant Certificates of Occupancy; this legislation aimed to rationalise land administration across the country.



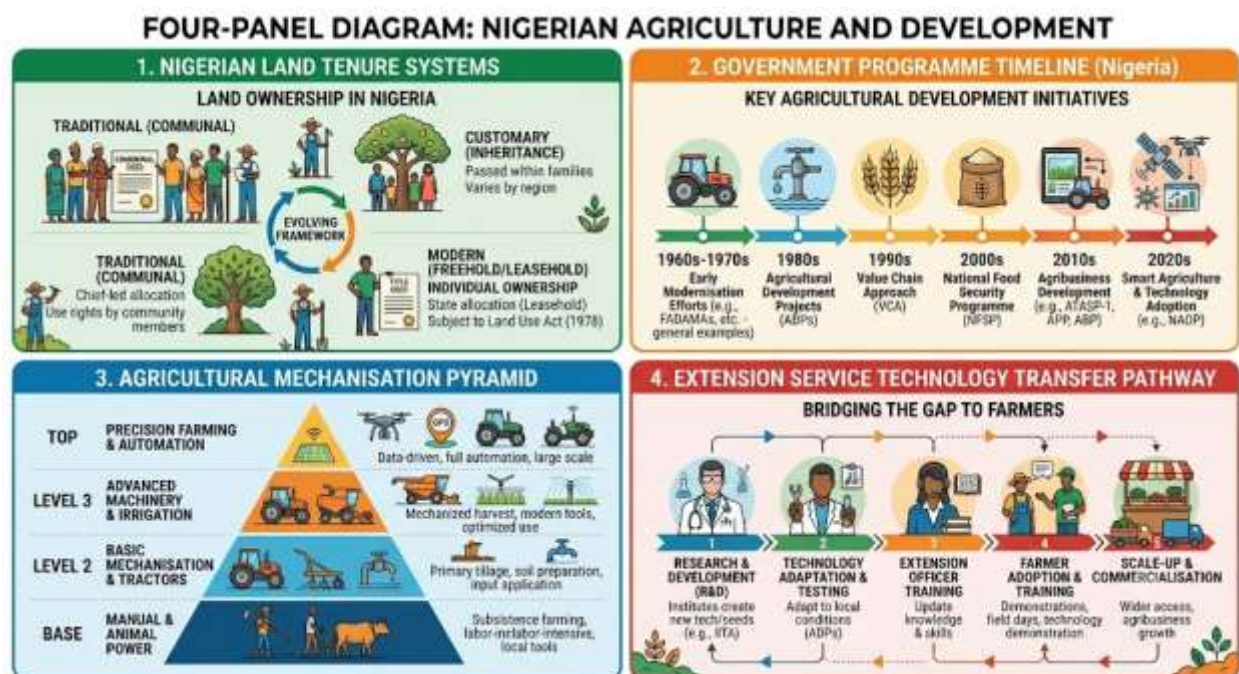


Figure 1.4: Measures for improving Nigerian agriculture

### 1.4.2 Government policies and programmes

Nigerian governments have introduced numerous agricultural development programmes since independence. Key programmes: Operation Feed the Nation (OFN, 1976): launched by General Obasanjo; encouraged urban Nigerians to grow food; provided subsidised inputs and free land to farmers; had limited success due to poor planning. The Green Revolution (1980): under President Shagari; introduced high-yielding seed varieties, fertiliser subsidies, and farm credit; had mixed results. Agricultural Development Projects (ADPs, 1975 onwards): World Bank-funded; provided extension services, rural roads, and inputs to smallholder farmers in all states; the most sustained and impactful programme.

National Agricultural Land Development Authority (NALDA, 1993): developed large irrigation schemes and mechanised farms. Fadama Development Projects (Fadama I-III, 1992-2015): World Bank-supported; developed fadama (inland valley) irrigation for dry-season vegetable and rice production in northern states. National Agricultural Credit Guarantee Scheme Fund (ACGSF, 1977 to present): provides guarantees for bank loans to farmers who lack adequate collateral; administered by the Central Bank of Nigeria. Anchor Borrowers Programme (ABP,





2015): CBN programme that provides inputs and credit to smallholder farmers linked to commodity processors (rice, wheat, maize, cotton, cassava) as anchor companies. Agriculture Promotion Policy (APP/"Green Alternative," 2016-2020): strategy for transforming Nigerian agriculture from subsistence to commercial scale.

Fill in the blank: The Anchor \_\_\_\_\_ Programme (ABP), launched by the Central Bank of Nigeria in 2015, provides inputs and credit to smallholder farmers linked to anchor commodity processors; it has focused particularly on rice, wheat, maize, and cotton.

### **1.4.3 Agricultural mechanisation and extension**

Agricultural mechanisation is the use of machines and implements to replace or supplement human labour in agricultural operations; it increases the area that can be cultivated, reduces labour costs, improves timeliness of operations, and increases yields. Levels of mechanisation in Nigeria: (1) hand tools (hoe, cutlass, digger; used by the majority of smallholder farmers; covers 1-2 ha per family); (2) animal traction (ox plough, donkey; used mainly in northern Nigeria; covers 2-5 ha); (3) tractor mechanisation (two-wheel power tillers; four-wheel tractors; covers 5-50 ha); (4) full mechanisation (combine harvesters, planters, sprayers; commercial farms; above 50 ha). Nigeria's mechanisation ratio is very low (approximately 0.27 tractors per 1,000 ha compared to 19 in the USA).

Agricultural extension is the system of education, communication, and advisory services that helps farmers adopt improved technologies and practices. Extension workers (agricultural extension officers) act as a link between agricultural research institutions (e.g. IITA, NAERLS) and farmers. The Training and Visit (T&V) system was the dominant extension approach in Nigeria from the 1970s to 1990s, delivered through ADPs. Farmer Field Schools (FFS): participatory approach where farmers learn by doing experiments on their own farms; more effective than purely top-down extension. Challenges to extension in Nigeria: too few extension workers (ratio of 1 extension worker to approximately 1,500 farmers, against a recommended ratio of 1:400); poor funding; weak linkage between research and extension.



Fill in the blank: Agricultural \_\_\_\_\_ is the system of education, communication, and advisory services that helps farmers adopt improved technologies; extension workers link research institutions to farmers; the recommended ratio is one extension worker per 400 farmers.

#### Pilot questions 1.4

1. Define land tenure and describe the customary land tenure system in Nigeria.
2. State the main provisions of the Nigerian Land Use Act 1978.
3. Name four government agricultural programmes in Nigeria and state the objective of each.
4. Explain what agricultural mechanisation is and describe four levels of mechanisation in Nigeria.
5. Explain the role of agricultural extension in improving Nigerian agriculture.



## Series Summary

This Series covered the meaning, branches, importance, and historical development of agriculture. Agriculture is the science and practice of cultivating land, producing crops, and raising livestock. Its major branches include agronomy, horticulture, animal husbandry, agricultural engineering, soil science, agricultural economics, forestry, fisheries, food science, and veterinary science. Agriculture supports food production, employment, industrial raw materials, foreign exchange, government revenue, and environmental services. It began with the Neolithic Revolution about 10,000–12,000 years ago in different centres of domestication. In Nigeria, pre-colonial systems included shifting cultivation, mixed farming, and permanent agriculture in areas such as Kano. The colonial period promoted export crops such as cocoa, groundnut, rubber, palm oil, and cotton, while the post-independence oil boom reduced the relative importance of agriculture and led to several government intervention programmes.

The Series also examined population growth, food security, land tenure, mechanisation, and agricultural extension. The Green Revolution introduced high-yielding varieties, irrigation, and fertiliser use, while Malthus argued that population could grow faster than food supply and Boserup proposed that population pressure could stimulate innovation. Food security depends on availability, access, utilisation, and stability, but Nigeria faces challenges including low productivity, poor infrastructure, post-harvest losses, insecurity, and climate change. Land may be held under customary, freehold, or leasehold systems, while the Land Use Act of 1978 vested land administration in state governors. Major programmes include Operation Feed the Nation, the Green Revolution Programme, Agricultural Development Projects, Fadama, ACGSF, and the Anchor Borrowers Programme. Nigerian agriculture still relies heavily on hand tools, with limited tractor use and inadequate extension coverage. By completing this Series, students should achieve SLOs 1.1–1.4.



## Glossary of Terms

- **Agronomy:** the science and practice of crop production and soil management; the branch of agriculture dealing with field crop cultivation.
- **Animal husbandry:** the branch of agriculture concerned with the breeding, management, and production of domesticated animals for food, fibre, and draught power.
- **Anchor Borrowers Programme (ABP):** a CBN agricultural financing programme (2015) that links smallholder farmers to commodity processors for inputs and credit; focused on rice, wheat, maize, cassava, and cotton.
- **Agricultural Development Projects (ADPs):** World Bank-funded projects launched in Nigerian states from 1975; provided extension services, rural roads, and inputs to smallholder farmers; the most sustained post-independence agricultural programme.
- **Agricultural extension:** an education and advisory service that helps farmers adopt improved practices and technologies; the link between research and farmer.
- **Agricultural mechanisation:** the use of machines and implements in agricultural operations to replace or supplement human labour; increases area cultivated and improves timeliness and efficiency.
- **Boserup's hypothesis:** the argument that population pressure stimulates agricultural innovation and intensification; farmers adopt new techniques when land becomes scarce.
- **Bush fallowing (shifting cultivation):** a traditional farming system in which a plot is cultivated for a few years then abandoned to natural vegetation to restore fertility; the farmer shifts to a new plot.
- **Certificate of Occupancy:** a legal document granted by the Governor of a Nigerian state under the Land Use Act 1978, conferring the right to occupy and use land for a defined period.
- **Demographic transition:** the historical process by which countries move from high birth and death rates to low birth and death rates as they develop; rapid population growth occurs in the intermediate stages.



- **Fadama:** seasonally flooded inland valleys or low-lying areas adjacent to rivers in Nigeria; used for dry-season irrigation farming of vegetables, rice, and other crops.
- **Fertile Crescent:** the arc of productive land in Southwest Asia (present-day Iraq, Syria, Lebanon, Israel, Jordan, and southeastern Turkey) regarded as one of the earliest centres of agricultural origin.
- **Food gap:** the difference between the food required to adequately feed a population and the food actually produced or available.
- **Food security:** exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs (FAO, 1996).
- **Green Revolution:** the international agricultural development initiative of the 1960s-70s that produced high-yielding varieties of wheat and rice combined with fertilisers and irrigation, dramatically increasing food production in developing countries.
- **Horticulture:** the branch of agriculture concerned with the cultivation of fruits, vegetables, flowers, and ornamental plants; requires intensive management.
- **Land tenure:** the system by which land is owned, occupied, and used; includes customary, freehold, and leasehold systems in Nigeria.
- **Land Use Act 1978:** Nigerian legislation that vests all land in each state in the Governor, who holds it in trust for all Nigerians and grants Certificates of Occupancy.
- **Malthus, Thomas:** English economist (1766-1834) who argued that population grows geometrically while food production grows arithmetically, predicting eventual famine; his ideas are known as Malthusian theory.
- **Neolithic revolution:** the transition, beginning approximately 10,000-12,000 years ago, from nomadic hunter-gathering to settled farming and animal domestication.
- **Operation Feed the Nation (OFN):** a Nigerian government agricultural programme launched in 1976 under General Obasanjo to encourage food production and reduce food imports.





- **Post-harvest losses:** losses in quantity and quality of agricultural produce that occur after harvest during storage, transport, processing, and marketing; estimated at 20-40% in Nigeria.
- **Soil science (pedology):** the branch of agriculture that studies the formation, classification, and management of soils; includes soil fertility and soil conservation.
- **Training and Visit (T&V) system:** an agricultural extension approach in which extension workers receive regular subject-matter training and visit farmer groups on a scheduled basis; was the dominant system in Nigerian ADPs.



## Concept Check Questions [Series 1]

### Objective Questions

1. Agriculture is the science, art, and practice of cultivating soil, growing crops, and raising \_\_\_\_\_ for food, fibre, fuel, and other products. (Linked to SLO 1.1)
2. \_\_\_\_\_ is the branch of agriculture concerned with the cultivation of fruits, vegetables, and ornamental plants; it requires more intensive management than agronomy. (Linked to SLO 1.1)
3. Agriculture originated approximately 10,000-12,000 years ago during the \_\_\_\_\_ revolution. (Linked to SLO 1.2)
4. Food security has four dimensions: availability, access, \_\_\_\_\_, and stability. (Linked to SLO 1.3)
5. The Nigerian Land Use Act of \_\_\_\_\_ vests all land in each state in the Governor, who holds it in trust for all Nigerians. (Linked to SLO 1.4)

### Short-Answer Questions

6. Define agriculture and state three branches. (Linked to SLO 1.1)
7. State five reasons why agriculture is important to Nigeria. (Linked to SLO 1.1)
8. Name three export crops introduced in Nigeria during the colonial era. (Linked to SLO 1.2)
9. Define food security and state its four dimensions. (Linked to SLO 1.3)
10. State three measures for improving Nigerian agriculture. (Linked to SLO 1.4)

### Long-Answer Questions

11. Define agriculture; describe its scope, branches, and importance to Nigeria. (Linked to SLO 1.1)



12. Describe the history and development of agriculture in Nigeria from pre-colonial times to the modern era. (Linked to SLO 1.2)
13. Explain world population growth and its relationship to food supply; describe food security in Nigeria; and describe three measures for improving Nigerian agriculture. (Linked to SLOs 1.3, 1.4)



## Answers to Concept Check Questions [Series 1]

### Objective Questions

1. Livestock.
2. Horticulture.
3. Neolithic.
4. Utilisation.
5. 1978.

### Short-Answer Questions

6. Agriculture is the science, art, and practice of cultivating soil, growing crops, and raising livestock for food, fibre, and other products. Three branches: crop production (agronomy), horticulture, animal husbandry.
7. (1) Provides food; (2) raw materials for industry; (3) employment for over 30% of the labour force; (4) foreign exchange earnings from cocoa, rubber, cashew; (5) raw materials for agro-industries such as flour mills and breweries.
8. Cocoa (south-west), groundnut (north), palm oil/palm kernels (south-east).
9. Food security: all people, at all times, have physical and economic access to sufficient, safe, and nutritious food. Four dimensions: availability, access, utilisation, stability.
10. (1) Land reform (secure and adequate land tenure under the Land Use Act); (2) government agricultural programmes (ADPs, Anchor Borrowers Programme); (3) agricultural mechanisation and extension services.

### Long-Answer Questions

11. Agriculture: science, art, and practice of cultivating soil, growing crops, and raising livestock for food, fibre, fuel, and raw materials. Scope: encompasses crop production,



animal husbandry, forestry, fisheries, food processing, and related services. Branches: agronomy (field crop production); horticulture (fruits, vegetables, ornamentals); animal husbandry (cattle, poultry, goats, pigs); agricultural engineering (machinery, irrigation); soil science (soil fertility and conservation); agricultural economics (farm management, marketing); forestry; fisheries; food science; veterinary science. Importance to Nigeria: food supply for ~220 million people (cassava, yam, rice, maize); raw materials for industry (cotton, rubber, palm oil); employment for over 30% of workforce; foreign exchange from cocoa, rubber, cashew, sesame; government revenue; raw materials for agro-industries; ecological services (soil cover, biodiversity).

12. Pre-colonial era: shifting cultivation in forest zones; mixed farming in savanna; permanent cultivation in densely populated areas (Kano); crops: yam, cassava, sorghum, millet, oil palm. Colonial era (1900-1960): British introduced export crops at scale; cocoa in southwest, groundnut in north (groundnut pyramids), palm oil/kernels in southeast, cotton; marketing boards established; food crops neglected. Post-independence: oil boom of 1970s reduced attention to agriculture; food imports rose; government programmes launched: Operation Feed the Nation (1976), Green Revolution (1980), ADPs (1975 onwards), Fadama Development Projects (1992), Anchor Borrowers Programme (2015). Nigeria's challenge remains transforming agriculture from subsistence to commercial scale.
13. World population: ~8 billion in 2023; projected ~9.7 billion by 2050; Nigeria ~213 million, projected ~400 million by 2050; growth rate ~2.5-3.0% per year. Food gap: difference between food needed and food available; Nigeria faces growing gap due to population growth outpacing productivity, high post-harvest losses (20-40%), and poor distribution infrastructure. Malthus: population grows geometrically, food arithmetically; Boserup: population pressure drives innovation. Food security: availability, access, utilisation, stability; ~25 million Nigerians food insecure; causes include low productivity, insecurity, climate change, poverty. Three improvement measures: (1) Land reform (Land Use Act 1978; secure tenure encourages investment); (2) Government programmes (ADPs provided extension and inputs; Anchor Borrowers Programme links



farmers to processors); (3) Mechanisation and extension (increase area cultivated; reduce labour costs; extension workers transfer improved technologies).

## Answers to Pilot Questions [Series 1]

### Part 1.1

1. Agriculture is the science, art, and practice of cultivating soil, growing crops, and raising livestock for food, fibre, fuel, and other products that sustain and enhance human life.
2. Five branches: (1) Crop production/agronomy: growing field crops for food and raw materials. (2) Horticulture: cultivation of fruits, vegetables, and ornamentals. (3) Animal husbandry: breeding and managing livestock for meat, milk, eggs, and fibre. (4) Soil science: study of soil formation, classification, and management for crop production. (5) Agricultural economics: application of economic principles to farm management and marketing.
3. Five reasons: (1) Provides food for Nigeria's population. (2) Supplies raw materials for industry (cotton, rubber, palm oil). (3) Employs over 30% of the labour force. (4) Earns foreign exchange from cocoa, rubber, cashew, sesame exports. (5) Provides raw materials for agro-industries such as flour mills, cotton ginneries, and breweries.
4. Agriculture is a science because it applies biological, chemical, soil, and engineering knowledge to improve production systems, select varieties, and manage pests. It is an art because success depends on the farmer's judgment, skill, and practical experience in applying knowledge to specific local conditions of soil, climate, and market.
5. Agriculture contributes approximately 24-26% of Nigeria's GDP and employs over 30% of the labour force; about 70% of the rural population depends on agriculture for their livelihood.

### Part 1.2





1. Three centres: (1) Fertile Crescent: wheat and barley. (2) China: rice and millet. (3) West Africa: sorghum, pearl millet, and yam.
2. Pre-colonial Nigerian farming: shifting cultivation (bush fallowing) in forest zones; mixed farming (crops and livestock together) in Sudan and Sahel savannas; permanent cultivation in densely populated areas such as the Kano close-settled zone; integrated tree-crop farming in forest margins. Crops included yam, cassava, sorghum, millet, cowpea, groundnut, oil palm, and rice.
3. Three colonial-era export crops: cocoa (south-west); groundnut (north); palm oil and palm kernels (south-east).
4. The Green Revolution (1960s-70s) was an international agricultural initiative that developed high-yielding varieties (HYVs) of wheat and rice. Key components: HYVs (bred by CGIAR; Norman Borlaug led wheat programme); chemical fertilisers; irrigation; pesticides. It dramatically increased food production in Asia and Latin America; Nigeria adopted a related programme in 1980.
5. Three post-independence programmes: (1) Operation Feed the Nation (OFN, 1976): encouraged urban and rural food production with subsidised inputs. (2) Agricultural Development Projects (ADPs, 1975): World Bank-funded; provided extension services, rural roads, and inputs to smallholders. (3) Anchor Borrowers Programme (2015): CBN programme linking smallholder farmers to commodity processors for inputs and credit.

### Part 1.3

1. World population in 2023: approximately 8 billion. Projection for 2050: approximately 9.7 billion.
2. The demographic transition model shows how countries move from high birth and death rates (Stage 1: pre-industrial) through declining death rates with high birth rates (Stage 2-3: rapid population growth) to low birth and death rates (Stage 4: stable population). Nigeria is currently at Stage 2-3: death rates have fallen due to improved healthcare but birth rates remain high; population grows at approximately 2.5-3.0% per year.



3. The food gap is the difference between the food needed to adequately feed a population and the food actually available. Two causes in Nigeria: (1) Population growth outpaces agricultural productivity growth; (2) High post-harvest losses (estimated 20-40% of food produced is lost before it reaches consumers).
4. Four dimensions: (1) Availability: sufficient food exists at national or local level. (2) Access: people can obtain food through production, purchase, or transfer. (3) Utilisation: the body can use the food to maintain health. (4) Stability: food access is maintained over time, including during crises and seasonal shortfalls.
5. Three causes of food insecurity in Nigeria: (1) Low agricultural productivity due to limited use of improved inputs and technology. (2) Insecurity and conflict in key food-producing areas (Borno, Zamfara, Plateau). (3) Climate change impacts including desertification in the north and flooding in the south.

#### Part 1.4

1. Land tenure is the system by which land is owned, occupied, and used. Customary land tenure: land is held collectively by a family, clan, or community; the family head allocates use rights to members; land is generally not sold to outsiders; the system is widespread in rural Nigeria. It provides land access to community members but may limit women's rights and restrict investment because farmers do not have formal title.
2. The Land Use Act 1978 vests all land in each state in the Governor, who holds it in trust for all Nigerians. Key provisions: the Governor may grant a Certificate of Occupancy (C of O) conferring the right to occupy land; all existing land rights were converted to rights of occupancy; the Act aimed to reduce land speculation, simplify administration, and end fragmentation. Criticism: farmers lack freehold ownership, reducing incentive for long-term investment.
3. Four programmes: (1) ADPs (1975): World Bank-funded; provided extension, rural roads, and inputs to smallholders in all states. (2) Fadama Development Projects (1992): World Bank-supported; developed inland valley irrigation for dry-season production. (3)



ACGSF (1977): CBN-administered credit guarantee scheme for farmers lacking collateral. (4) Anchor Borrowers Programme (2015): CBN-financed; links smallholders to commodity processors; focused on rice, wheat, and maize.

4. Agricultural mechanisation is the use of machines and implements in farming to replace or supplement human labour. Four levels in Nigeria: (1) Hand tools (hoe, cutlass; most farmers; 1-2 ha); (2) animal traction (ox plough, donkey; northern Nigeria; 2-5 ha); (3) tractor mechanisation (power tillers, four-wheel tractors; medium scale; 5-50 ha); (4) full mechanisation (combine harvesters, planters; commercial farms; above 50 ha). Nigeria's mechanisation level is very low (~0.27 tractors per 1,000 ha).
5. Agricultural extension helps farmers adopt improved technologies through education, demonstrations, and advisory services. Extension workers link research institutions to farmers. Key roles: disseminating improved seed varieties, fertiliser application methods, pest management, and post-harvest handling. In Nigeria, extension is delivered through ADPs and the T&V system; the current ratio of approximately 1 extension worker per 1,500 farmers is far below the recommended 1:400, limiting the system's impact.



## References and Attributions [Series 1]

### Textual References (Books and External Sources)

- Olayide, S. O., & Heady, E. O. (1982). Introduction to agricultural production economics. University Press, Ibadan.
- FAO (Food and Agriculture Organization of the United Nations). (2025). Guidelines for sustainable agriculture. FAO.
- Federal Republic of Nigeria. (1978). Land Use Act, Cap L5, Laws of the Federation of Nigeria 2004.
- World Bank. (2022). World development indicators: Agriculture. World Bank Group.

### Figures, Plates, Tables, and Boxes

- Figure 1.1: Scope and branches of agriculture Attribution: AI generated. Suggested OER search string: "branches of agriculture crop production animal husbandry soil science agricultural engineering Nigeria OER".
- Figure 1.2: Origins and spread of agriculture and Nigeria's agricultural history Attribution: AI generated. Suggested OER search string: "agricultural origin Neolithic revolution Fertile Crescent Africa crop domestication Nigeria agricultural history OER".
- Figure 1.4: Measures for improving Nigerian agriculture Attribution: AI generated. Suggested OER search string: "land tenure Nigeria Land Use Act agricultural programmes Green Revolution mechanisation extension service OER".



## Series 2: Agriculture and the Environment

- **Part 2.1: Climate and Agriculture**
  - Sub Part 2.1.1: Climatic factors affecting crop production
  - Sub Part 2.1.2: Rainfall and temperature in Nigeria
  - Sub Part 2.1.3: Agro-ecological zones of Nigeria
- **Part 2.2: Soil and Land Resources**
  - Sub Part 2.2.1: Soil formation and properties
  - Sub Part 2.2.2: Soil fertility and plant nutrients
  - Sub Part 2.2.3: Soil degradation and conservation
- **Part 2.3: Characteristics of Tropical Agriculture**
  - Sub Part 2.3.1: Features of tropical farming systems
  - Sub Part 2.3.2: Challenges of tropical agriculture
  - Sub Part 2.3.3: Social and economic factors
- **Part 2.4: Sustainable Agricultural Practices**
  - Sub Part 2.4.1: What is sustainable agriculture?
  - Sub Part 2.4.2: Soil and water conservation
  - Sub Part 2.4.3: Agroforestry and integrated farming

### Introduction

Agriculture is directly shaped by the natural environment. Climate, soil, topography, and biodiversity determine what crops can be grown and how livestock can be kept in any given location. Understanding these environmental factors is essential for planning productive and sustainable farming.



In Nigeria, the diversity of agro-ecological zones stretching from the Sahel savanna in the far north to the rainforest and mangrove swamps of the south creates widely different farming opportunities and constraints. This Series examines climate, soils, the features of tropical agriculture, and sustainable practices relevant to Nigerian conditions.

### Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 2.1** describe the climatic factors affecting crop production and identify the agro-ecological zones of Nigeria (Linked to Part 2.1),
- **SLO 2.2** describe soil formation, soil fertility, soil degradation, and soil conservation measures (Linked to Part 2.2),
- **SLO 2.3** describe the features and challenges of tropical agriculture in Nigeria (Linked to Part 2.3), and
- **SLO 2.4** explain sustainable agricultural practices including soil and water conservation, agroforestry, and integrated farming (Linked to Part 2.4).

## 2.1 Climate and Agriculture

### 2.1.1 Climatic factors affecting crop production

Climate is the long-term average pattern of atmospheric conditions at a location. The five main climatic factors affecting crop production are: rainfall (total amount, seasonal distribution, and reliability); temperature (controls germination, growth rate, and maturity; most tropical crops grow best at 25-35 degrees Celsius); solar radiation (drives photosynthesis and dry matter production); relative humidity (affects transpiration, pollination, and disease development); and wind (aids pollination but also causes erosion and increases evapotranspiration).

Each factor interacts with the others to determine what crops are suitable in a given area.

Adequate rainfall at the right time is the most critical factor in Nigeria because irrigation is not widely available. Where rainfall is unreliable or insufficient, drought-tolerant crops such as



sorghum, millet, and cowpea are preferred. Where rainfall is high and well-distributed, high-value crops such as cocoa, rubber, and oil palm are cultivated.

Fill in the blank: The principal climatic factor affecting crop production in Nigeria is \_\_\_\_\_; its total amount, seasonal distribution, and reliability determine which crops can be grown and when.

### 2.1.2 Rainfall and temperature in Nigeria

Nigeria has two distinct rainfall patterns. In the north, rainfall is unimodal: there is one wet season (approximately April-September) and one long dry season. In the south, rainfall is bimodal: there are two wet seasons separated by a short dry spell (the "August break"). Annual rainfall ranges from below 500 mm in the extreme northeast (Lake Chad basin) to over 3,000 mm in coastal areas of the Niger Delta and Calabar.

Temperature across Nigeria ranges from about 22 degrees Celsius on the Jos Plateau to over 34 degrees Celsius in the semi-arid north. The harmattan, a dry and dusty northeast trade wind, blows from November to March. It reduces relative humidity, increases evapotranspiration, causes wilting of sensitive crops, and promotes the spread of bush fires. Farmers in the north rely on the harmattan dry season for threshing and drying grain crops.

Fill in the blank: Nigeria has a \_\_\_\_\_ rainfall pattern in the north (one wet season) and a bimodal pattern in the south (two wet seasons separated by an August break).

### 2.1.3 Agro-ecological zones of Nigeria

Nigeria is divided into six agro-ecological zones based on vegetation, annual rainfall, and soil type. From north to south they are: (1) Sahel savanna (extreme north; below 500 mm; sparse vegetation; crops: millet, cowpea; livestock dominant); (2) Sudan savanna (500-1,000 mm; short grasses and shrubs; crops: groundnut, sorghum, cotton, millet); (3) Guinea savanna (1,000-1,500 mm; the largest zone covering the middle belt; crops: yam, maize, sorghum, cowpea, soybean); (4) Derived savanna (transitional zone between forest and savanna; 1,200-1,500 mm; formerly forested; crops: cassava, yam, maize).





(5) Rainforest zone (southwest and southeast; 1,500-3,000 mm; high humidity; crops: cocoa, rubber, oil palm, plantain, vegetables); (6) Mangrove and freshwater swamp (coastal delta; heavily waterlogged soils; rice production; fishing industry dominant). The Guinea savanna is the largest zone and has the greatest agricultural diversity. The rainforest zone produces Nigeria's major tree export crops (cocoa, rubber, oil palm). Matching the right crop to the right agro-ecological zone is a fundamental principle of Nigerian agriculture.

Fill in the blank: The Guinea \_\_\_\_\_ is the largest agro-ecological zone in Nigeria, covering the middle belt states; it receives 1,000-1,500 mm of rainfall annually and supports yam, maize, sorghum, cowpea, and soybean production.

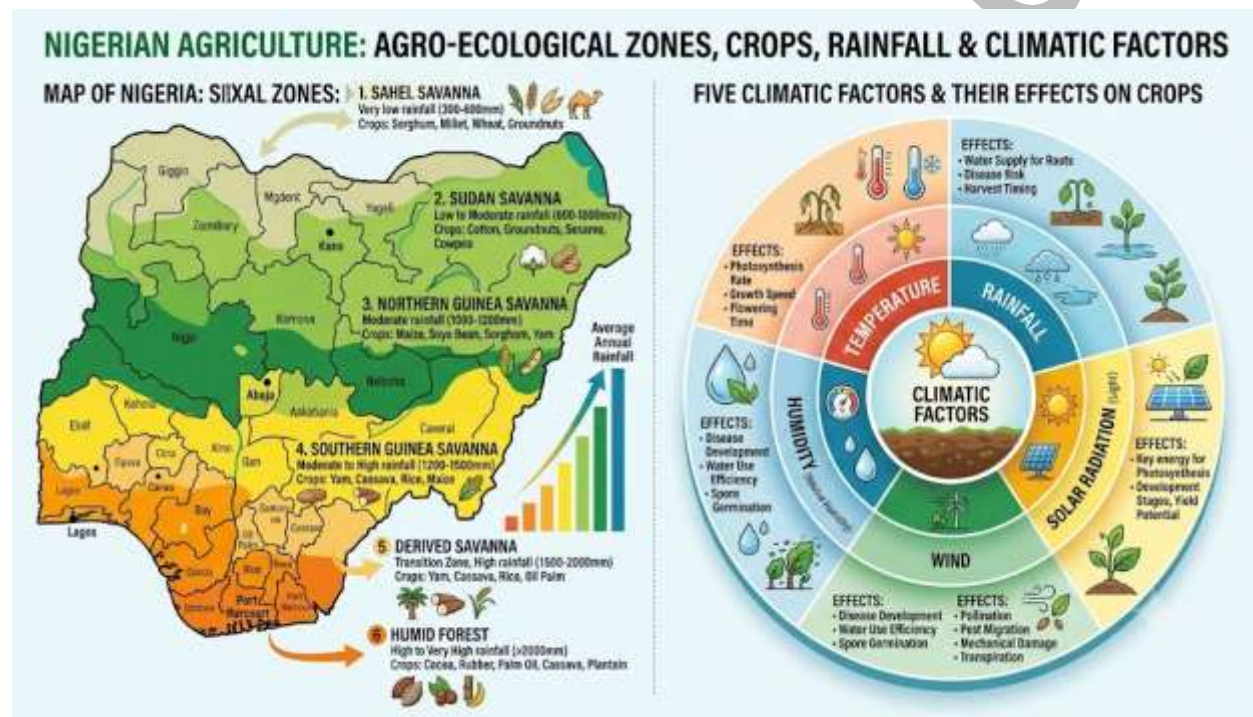


Figure 2.1: Agro-ecological zones of Nigeria and climatic factors

Pilot questions 2.1

- State five climatic factors that affect crop production.
- Describe the rainfall pattern of Nigeria.
- Name the six agro-ecological zones of Nigeria and state the main crop of each.
- Explain the effect of the harmattan on crop production in northern Nigeria.



10. State the optimum temperature range for most tropical crops.

## **2.2 Soil and Land Resources**

### **2.2.1 Soil formation and properties**

Soil is the thin upper layer of the earth's surface formed by the weathering of parent rock material over thousands of years under the influence of climate, living organisms, topography, and time. It is the medium in which plant roots grow and from which plants absorb water and nutrients. Soil has four important physical properties: texture (relative proportions of sand, silt, and clay particles; determines water-holding capacity, drainage, and workability); structure (arrangement of soil particles into aggregates; good structure improves aeration and drainage); colour (dark soils indicate high organic matter; grey or mottled colour indicates poor drainage); and depth (deep soils store more water and nutrients).

Sandy soils drain rapidly, warm up quickly, and are easy to work but hold little water and nutrients. Clay soils hold water and nutrients well but become waterlogged if poorly drained and crack when dry. Loamy soils (balanced mixture of sand, silt, and clay) are considered ideal for most crops because they combine adequate drainage with good water and nutrient retention. In Nigeria, soils in the rainforest zone are generally deep but heavily leached; soils in the savanna are often shallow with low organic matter.

Fill in the blank: Soil \_\_\_\_\_ refers to the relative proportions of sand, silt, and clay particles; it determines the soil's water-holding capacity, drainage, and workability.

### **2.2.2 Soil fertility and plant nutrients**

Soil fertility is the capacity of a soil to supply essential plant nutrients in adequate amounts and proper balance for sustained crop production. Plants require 17 essential nutrients divided into macronutrients (required in large amounts) and micronutrients (required in trace amounts). The three primary macronutrients are nitrogen (N), phosphorus (P), and potassium (K). Nitrogen promotes vegetative (leafy) growth and is part of chlorophyll and proteins; deficiency causes yellowing of older leaves. Phosphorus promotes root development and energy transfer;



deficiency causes purple discolouration of leaves. Potassium improves drought tolerance, disease resistance, and fruit quality; deficiency causes scorching at leaf margins.

Secondary macronutrients include calcium, magnesium, and sulphur. Micronutrients include zinc, iron, manganese, boron, and copper; although needed in very small amounts, their deficiency causes distinct symptoms and significant yield loss. Soil fertility can be maintained or improved by adding organic matter (compost, farmyard manure, green manure), applying inorganic fertilisers (urea for N; single superphosphate or DAP for P; muriate of potash for K), practising crop rotation (including legumes that fix atmospheric nitrogen), and reducing erosion.

Fill in the blank: The three primary macronutrients for plant growth are nitrogen (N), \_\_\_\_\_ (P), and potassium (K); deficiency of any one of them reduces crop yield significantly.

### **2.2.3 Soil degradation and conservation**

Soil degradation is the decline in the quality and productive capacity of soil due to physical, chemical, or biological processes. The most common forms in Nigeria are: water erosion (rainfall and runoff remove the topsoil; most serious in the southeast where gully erosion in Anambra, Imo, and Enugu States has destroyed large areas of farmland); wind erosion (common in the Sahel north where low vegetation cover leaves soil exposed to the harmattan wind); nutrient depletion (continuous cultivation without replenishment reduces organic matter and fertility); and compaction (heavy machinery or cattle trampling destroys soil structure).

Soil conservation measures aim to reduce erosion and maintain productivity. Key practices include: contour ploughing (ploughing along lines of equal elevation to slow runoff); terracing (constructing step-like platforms on slopes to trap water); mulching (covering the soil surface with crop residues to reduce splash erosion and conserve moisture); cover cropping (growing a plant to protect bare soil); windbreaks and shelterbelts (rows of trees or shrubs planted perpendicular to the prevailing wind to reduce wind speed and protect the soil); and afforestation (planting trees on degraded land).



Fill in the blank: Soil \_\_\_\_\_ by water is the most serious form of soil degradation in Nigeria, especially in the southeast where gully erosion has devastated farmland in Anambra, Imo, and Enugu States.

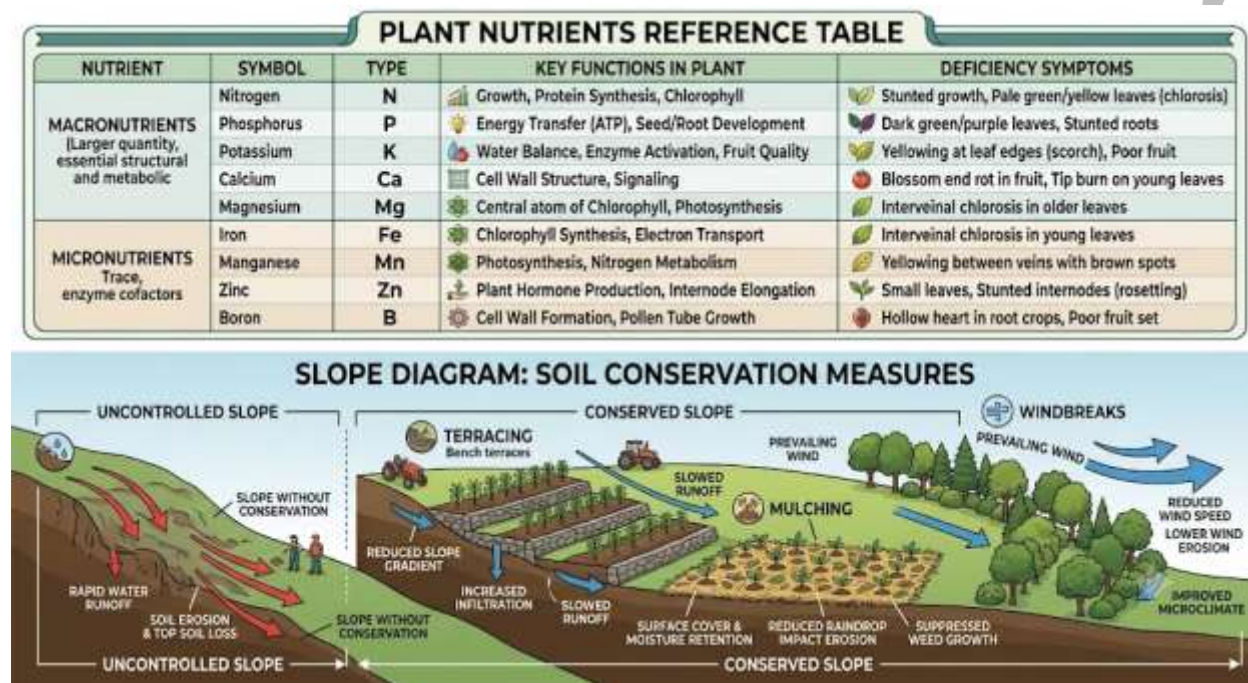


Figure 2.2: Soil nutrients and conservation measures

### Pilot questions 2.2

- Define soil and state four physical properties.
- Define soil fertility and name the three primary macronutrients.
- State the function and deficiency symptom of nitrogen in plants.
- Define soil degradation and state its two most common forms in Nigeria.
- State four soil conservation measures.

## 2.3 Characteristics of Tropical Agriculture

### 2.3.1 Features of tropical farming systems



Tropical agriculture, practised between the Tropics of Cancer and Capricorn, is characterised by high temperatures year-round, distinct wet and dry seasons, and high biodiversity. In Nigeria, the dominant farming system is smallholder subsistence agriculture: most farmers cultivate small plots (0.5-2 ha) primarily to feed their families, with limited marketable surplus. Holdings are often fragmented (several small fields scattered in different locations), which complicates mechanisation and management. Mixed cropping (growing two or more crops simultaneously on the same plot) is the most common cropping system because it reduces the risk of total crop failure and maximises use of land, light, and water.

Shifting cultivation (bush fallowing) is widely practised, especially in the forest zone: a plot is farmed for 2-3 years then left under natural vegetation fallow for several years to restore soil fertility before being farmed again. Population pressure has reduced fallow periods in many areas, causing soil fertility decline. Other common systems include compound farming (intensive cultivation of the plot immediately around the homestead, heavily manured and continuously cropped), mixed farming (combining crops and livestock on the same farm), and permanent cultivation in densely settled areas such as the Kano close-settled zone.

Fill in the blank: \_\_\_\_\_ cropping is the practice of growing two or more crops simultaneously on the same land; it reduces the risk of total crop failure and is the dominant cropping system of Nigerian smallholder farmers.

### **2.3.2 Challenges of tropical agriculture**

Tropical agriculture faces several constraints that limit productivity. The hot and humid conditions that favour crop growth also support year-round development of pests (insects, rodents, birds) and diseases (fungi, bacteria, viruses, nematodes), making pest and disease management more difficult than in temperate climates. Intensive rainfall leaches nutrients rapidly from tropical soils, requiring more frequent fertilisation. High temperature and humidity promote rapid decomposition of organic matter, reducing soil carbon stocks. Post-harvest losses are high (estimated 20-40% in Nigeria) because heat, humidity, insects, fungi, and poor storage infrastructure degrade produce quickly after harvest.





Additional challenges include: declining soil fertility caused by shortened fallow periods; inadequate rural infrastructure (roads, electricity, storage) that raises production and marketing costs; limited access to improved seed varieties, fertilisers, and agrochemicals; poor access to credit at affordable interest rates; and inadequate extension services that leave most farmers relying on traditional knowledge. Collectively, these constraints result in yields well below the potential demonstrated in research stations; closing the yield gap is a central challenge of Nigerian agricultural development.

Fill in the blank: Post-harvest losses in Nigeria are estimated at 20-\_\_\_\_\_ % of food produced; they occur because heat, humidity, insects, fungi, and poor storage infrastructure rapidly degrade produce after harvest.

### **2.3.3 Social and economic factors**

Beyond biophysical constraints, Nigerian agriculture is shaped by social and economic factors. Most farmers are smallholders with limited capital for inputs and machinery; the average farm size of 0.5-2 ha prevents economies of scale and makes mechanisation impractical. Agriculture depends heavily on family labour supplemented by seasonal hired labour; the cost and availability of labour at planting and harvest peaks is a major production constraint. Land tenure systems (particularly customary tenure) may restrict women's land access, reduce long-term investment incentives, and limit the use of land as collateral for credit.

Women perform an estimated 60-80% of food production labour in Nigeria yet have less access than men to land, credit, improved inputs, and extension advice. This gender gap in resource access reduces overall agricultural productivity. Market access is also a constraint: poor rural roads, inadequate storage facilities, and limited market information increase transaction costs and reduce the farm-gate prices that smallholders receive. Improving physical infrastructure, financial access, and gender equity in Nigerian agriculture are therefore as important as improving production technology.

Fill in the blank: Women perform 60-80% of food production labour in Nigeria but have less access to \_\_\_\_\_ , credit, and agricultural extension services, limiting their productivity and income.



### Pilot questions 2.3

6. State five characteristic features of tropical farming in Nigeria.
7. Explain mixed cropping and state two advantages.
8. State four challenges facing tropical agriculture in Nigeria.
9. Explain how labour constraints affect Nigerian smallholder farmers.
10. Explain the role of women in Nigerian food production.

## 2.4 Sustainable Agricultural Practices

### 2.4.1 What is sustainable agriculture?

Sustainable agriculture is a system of farming that meets the food and fibre needs of the present without compromising the ability of future generations to meet their own needs (adapted from the Brundtland Commission definition of sustainable development, 1987). It has three interconnected pillars: economic sustainability (the farm enterprise is profitable enough for the farmer to continue; inputs, labour, and credit are accessible and affordable); environmental sustainability (production maintains soil health, water quality, biodiversity, and climate stability rather than depleting them); and social sustainability (the system is equitable, supports rural communities, provides decent livelihoods, and considers future generations).

In Nigeria, sustainable agriculture is particularly urgent because rapid population growth, soil degradation, deforestation, and climate change are threatening the long-term capacity of the land to feed the growing population. Unsustainable practices such as continuous cultivation without replenishment, burning of crop residues, and removal of vegetation cover from slopes are widespread. Promoting sustainable practices requires changes in technology, policy, and land tenure that together encourage farmers to invest in maintaining the productive capacity of their land.

Fill in the blank: Sustainable agriculture meets \_\_\_\_\_ food production needs without compromising the ability of future generations to meet their own needs; it has economic, environmental, and social pillars.





### 2.4.2 Soil and water conservation

Soil and water conservation practices aim to maintain or restore soil productivity, reduce runoff, and prevent erosion. Cover cropping involves growing a quick-establishing plant to cover the soil surface between cash crops or during the off-season; it reduces raindrop splash erosion, adds organic matter when incorporated, and in the case of leguminous cover crops (*Mucuna*, *Stylosanthes*, cowpea) also fixes atmospheric nitrogen. Mulching covers the soil with crop residues, cut grass, or plastic sheeting; it conserves soil moisture, suppresses weed growth, moderates soil temperature, and adds organic matter as it decomposes.

Terracing constructs step-like platforms across a slope to slow down and spread runoff, allowing water to infiltrate rather than erode the hillside; stone or earthen bunds are used as risers.

Contour farming involves ploughing and planting along lines of equal elevation rather than up and down the slope; this creates natural barriers to runoff. Minimum tillage and no-till systems reduce mechanical disturbance of the soil, preserving its structure, organic matter, and biological community. Windbreaks (rows of trees or shrubs perpendicular to the wind) reduce wind erosion in the Sahel zone by lowering wind speed at the soil surface.

Fill in the blank: \_\_\_\_\_ covers the soil surface with crop residues or cut grass to conserve moisture, suppress weeds, moderate soil temperature, and add organic matter as it decomposes.

### 2.4.3 Agroforestry and integrated farming

Agroforestry is the deliberate integration of trees and shrubs with crops and/or livestock on the same piece of land to obtain ecological and economic benefits that would not be possible from crops or trees alone. Benefits include: nitrogen fixation by leguminous trees (*Leucaena leucocephala*, *Gliricidia sepium*) that provide free nitrogen to associated food crops; reduction of soil erosion through root binding and canopy interception; improvement of microclimate (shade, reduced evaporation); and production of additional outputs such as timber, fuelwood, fodder, and fruit. Common agroforestry systems in Nigeria include oil palm-food crop intercrops, parkland systems with *Parkia biglobosa* (locust bean), and improved fallow with *Tithonia* or *Gliricidia*.



Integrated farming combines two or more agricultural enterprises on the same farm in a mutually reinforcing way so that the waste or by-product of one enterprise becomes an input for another. Examples: poultry manure applied to fish ponds stimulates algae growth and feeds fish; fish pond water (nutrient-rich) irrigates vegetable gardens; crop residues and kitchen waste are fed to poultry or goats; animal manure is composted and applied to food crops; mushrooms are grown on spent crop substrate. Integrated systems increase overall farm productivity, reduce external input costs, and decrease waste, making the farm more economically and environmentally sustainable.

Fill in the blank: \_\_\_\_\_ is the deliberate integration of trees with crops and/or livestock on the same land; it provides nitrogen fixation, erosion control, shade, and additional products such as timber, fodder, and fruit.

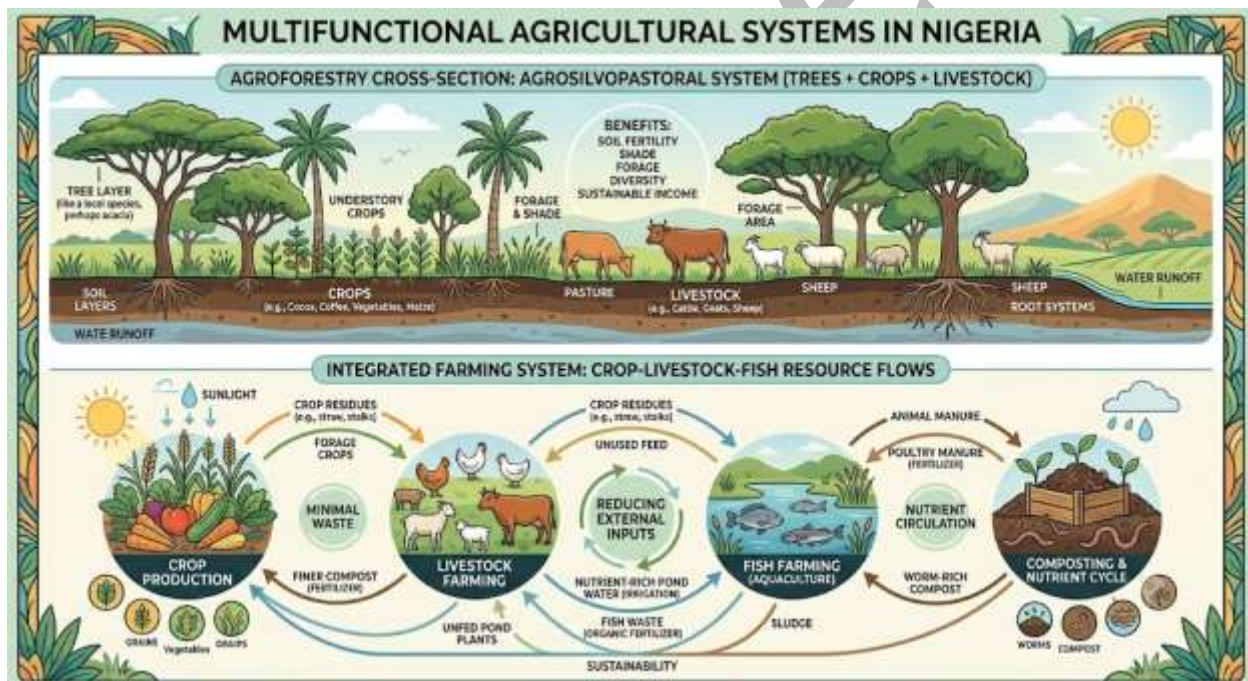


Figure 2.3: Agroforestry and integrated farming

#### Pilot questions 2.4

6. Define sustainable agriculture and state its three pillars.
7. Explain cover cropping and state two benefits.
8. Explain mulching and state three benefits.



9. Define agroforestry and state three benefits.
10. Explain integrated farming and give one example of resource flow between enterprises.



## Series Summary

This Series covered the relationship between agriculture and the environment. Major climatic factors affecting farming include rainfall, temperature, solar radiation, humidity, and wind, with rainfall being the most important. Southern Nigeria generally has bimodal rainfall, while the north has a unimodal pattern, and annual rainfall ranges from below 500 mm in the Sahel to about 3,000 mm in the rainforest and coastal zones. Nigeria's main agro-ecological zones are the Sahel, Sudan savanna, Guinea savanna, derived savanna, rainforest, and mangrove or swamp zones, each supporting different crops and farming systems. Soil develops through the weathering of parent material and is described by properties such as texture, structure, colour, and depth. The major plant nutrients are nitrogen, phosphorus, and potassium: nitrogen supports vegetative growth, phosphorus promotes root development and energy transfer, and potassium improves stress and drought resistance. Soil degradation occurs through water and wind erosion and may be reduced by terracing, contour ploughing, mulching, cover crops, and windbreaks.

Tropical agriculture is largely small-scale, subsistence-based, and characterised by mixed cropping, shifting cultivation, family labour, and customary land ownership. Major challenges include pests and diseases, nutrient leaching, shortened fallows, limited access to credit, weak infrastructure, and post-harvest losses. Women contribute greatly to food production but often have less access to land, finance, and farm inputs. Sustainable agriculture aims to meet present needs without reducing future productive capacity and is based on economic, environmental, and social sustainability. Important practices include cover cropping, mulching, contour farming, terracing, and agroforestry, where trees are combined with crops or livestock to improve soil fertility, reduce erosion, and provide shade, fodder, fuelwood, and timber. Integrated farming links crops, livestock, and fish production so that waste from one activity becomes an input for another, improving productivity while reducing costs and environmental pollution. By completing this Series, students should achieve SLOs 2.1–2.4.

## Glossary of Terms

- **Agro-ecological zone:** a land unit mapped on the basis of climate, soil, and vegetation; used to match crops to their most suitable environments.



- **Agroforestry:** the deliberate integration of trees and shrubs with crops and/or livestock on the same land for ecological and economic benefits.
- **Bimodal rainfall:** a rainfall pattern with two distinct wet seasons per year; characteristic of the southern states of Nigeria.
- **Bush fallowing (shifting cultivation):** a farming system in which a plot is cultivated for 2-3 years then left under natural vegetation fallow to restore soil fertility.
- **Contour farming:** ploughing and planting along lines of equal elevation across a slope to slow runoff and reduce erosion.
- **Cover crop:** a crop grown to protect the soil surface and add organic matter rather than primarily for harvest.
- **Harmattan:** a dry, dusty northeast trade wind that blows across Nigeria from November to March, reducing humidity and increasing evapotranspiration.
- **Integrated farming:** a system combining crops, livestock, fish, and/or trees on one farm so that waste from one enterprise becomes input for another.
- **Macronutrient:** a plant nutrient required in large quantities; primary macronutrients are nitrogen (N), phosphorus (P), and potassium (K).
- **Mixed cropping:** growing two or more crops simultaneously on the same land; the dominant cropping system of Nigerian smallholders.
- **Mulching:** covering the soil surface with organic material or plastic to conserve moisture, suppress weeds, and moderate temperature.
- **Soil degradation:** the decline in soil quality and productive capacity due to erosion, nutrient depletion, compaction, or pollution.
- **Soil fertility:** the capacity of a soil to supply essential plant nutrients in adequate amounts for sustained crop production.
- **Soil texture:** the relative proportions of sand, silt, and clay; determines water-holding capacity, drainage, and workability.



- **Subsistence farming:** farming primarily for household food consumption rather than for commercial sale.
- **Sustainable agriculture:** farming that meets current food production needs without compromising the ability of future generations to meet their own needs.
- **Unimodal rainfall:** a rainfall pattern with one wet season per year; characteristic of the northern states of Nigeria.



## Concept Check Questions [Series 2]

### Objective Questions

6. The principal climatic factor affecting crop production in Nigeria is \_\_\_\_\_ ; its total amount, seasonal distribution, and reliability determine which crops can be grown. (Linked to SLO 2.1)
7. The Guinea \_\_\_\_\_ is the largest agro-ecological zone in Nigeria; it receives 1,000-1,500 mm of rainfall and supports yam, maize, and soybean. (Linked to SLO 2.1)
8. Soil \_\_\_\_\_ is the relative proportions of sand, silt, and clay; it determines water-holding capacity and drainage. (Linked to SLO 2.2)
9. \_\_\_\_\_ cropping grows two or more crops simultaneously on the same land; it reduces risk and is the dominant system of Nigerian smallholders. (Linked to SLO 2.3)
10. \_\_\_\_\_ is the deliberate integration of trees with crops and/or livestock on the same land for ecological and economic benefits. (Linked to SLO 2.4)

### Short-Answer Questions

11. Name five climatic factors that affect crop production. (Linked to SLO 2.1)
12. Name the six agro-ecological zones of Nigeria. (Linked to SLO 2.1)
13. State the function and deficiency symptom of nitrogen in plants. (Linked to SLO 2.2)
14. State four soil conservation measures. (Linked to SLO 2.2)
15. Define sustainable agriculture and state its three pillars. (Linked to SLO 2.4)

### Long-Answer Questions

14. Describe the climatic factors affecting crop production in Nigeria and identify the six agro-ecological zones. (Linked to SLO 2.1)





15. Describe soil fertility, the three primary macronutrients, soil degradation, and four conservation measures. (Linked to SLO 2.2)
16. Describe the features and challenges of tropical agriculture; explain sustainable agriculture, agroforestry, and integrated farming. (Linked to SLOs 2.3, 2.4)

### **Answers to Concept Check Questions [Series 2]**

#### **Objective Questions**

6. Rainfall.
7. Savanna.
8. Texture.
9. Mixed.
10. Agroforestry.

#### **Short-Answer Questions**

11. Rainfall, temperature, solar radiation, relative humidity, wind.
12. Sahel savanna, Sudan savanna, Guinea savanna, derived savanna, rainforest, mangrove/freshwater swamp.
13. Nitrogen promotes leafy vegetative growth. Deficiency symptom: yellowing (chlorosis) of older leaves.
14. Terracing, contour ploughing, mulching, cover cropping.
15. Sustainable agriculture meets present needs without compromising future capacity. Three pillars: economic, environmental, social.

#### **Long-Answer Questions**



14. Five climatic factors: rainfall (most critical; total, distribution, reliability), temperature (25-35 degrees Celsius optimum), solar radiation (photosynthesis), humidity (disease, transpiration), wind (erosion, pollination). Six zones: Sahel (<500 mm; millet); Sudan savanna (500-1,000 mm; groundnut, sorghum); Guinea savanna (1,000-1,500 mm; largest; yam, maize); derived savanna (cassava, yam); rainforest (1,500-3,000 mm; cocoa, rubber, oil palm); mangrove/swamp (rice, fisheries).
15. Soil fertility: capacity of soil to supply nutrients. N (leaf growth; urea), P (root/energy; SSP), K (drought/disease resistance; MOP). Soil degradation: water erosion (southeast; gully erosion) and wind erosion (north Sahel); also nutrient depletion and compaction. Four conservation measures: terracing (reduces runoff on slopes), contour ploughing (slows runoff), mulching (covers soil; retains moisture), cover cropping (protects bare soil; adds organic matter).
16. Tropical farming features: subsistence orientation, small farms (0.5-2 ha), mixed cropping, shifting cultivation, high pest pressure. Challenges: pest/disease pressure, nutrient leaching, post-harvest losses (20-40%), shortened fallow, poor infrastructure. Social factors: labour dependence, gender gap (women 60-80% of food labour; less access to land, credit, inputs). Sustainable agriculture: meets present needs without compromising future capacity; pillars: economic, environmental, social. Agroforestry: trees + crops/livestock; nitrogen fixation (*Leucaena*, *Gliricidia*); erosion control; timber and fodder. Integrated farming: crop-livestock-fish resource flows; manure to crops; residues to livestock; waste = input.

### Answers to Pilot Questions [Series 2]

#### Part 2.1

6. Rainfall (total, distribution, reliability), temperature (controls growth and maturity), solar radiation (drives photosynthesis), relative humidity (affects disease and transpiration), wind (causes erosion, aids pollination).



7. Northern Nigeria has a unimodal pattern: one wet season (April-September) and one long dry season. Southern Nigeria has a bimodal pattern: two wet seasons separated by a short August dry spell. Annual rainfall ranges from below 500 mm (northeast) to over 3,000 mm (coastal south).
8. Sahel savanna (millet, livestock); Sudan savanna (groundnut, sorghum); Guinea savanna (yam, maize, cowpea); derived savanna (cassava, yam); rainforest (cocoa, rubber, oil palm); mangrove/freshwater swamp (rice, fisheries).
9. The harmattan is a dry, dusty northeast wind (Nov-Mar) that reduces humidity, increases evapotranspiration, causes wilting of sensitive crops, and promotes bush fires. Farmers use the dry season for grain threshing and drying.
10. Most tropical crops grow optimally at 25-35 degrees Celsius.

## Part 2.2

6. Soil is the thin upper layer of the earth that supports plant growth. Four physical properties: texture (sand/silt/clay proportions), structure (aggregate arrangement), colour (indicates organic matter and drainage), depth (determines water and nutrient storage).
7. Soil fertility is the capacity of soil to supply essential plant nutrients in adequate amounts for crop growth. Three primary macronutrients: nitrogen (N), phosphorus (P), and potassium (K).
8. Nitrogen promotes vegetative (leafy) growth and is a component of chlorophyll and proteins. Deficiency symptom: yellowing (chlorosis) of older leaves, beginning at the leaf tip.
9. Soil degradation is the decline in soil quality and productive capacity. Two most common forms in Nigeria: water erosion (gully erosion in Anambra, Imo, Enugu States in the southeast) and wind erosion (Sahel north where low vegetation cover exposes bare soil to the harmattan).
10. Contour ploughing, terracing, mulching, cover cropping.



### Part 2.3

6. Subsistence orientation (food mainly for family); small farm size (0.5-2 ha); mixed cropping (two or more crops on same land); shifting cultivation (bush fallowing); dependence on family labour with high pest and disease pressure.
7. Mixed cropping grows two or more crops on the same land at the same time. Advantages: (1) reduces risk of total crop failure since if one crop fails, the other may still yield; (2) maximises use of land, light, and water resources.
8. High pest and disease pressure (heat and humidity favour year-round activity); rapid nutrient leaching from tropical soils; high post-harvest losses (20-40%); declining fallow periods due to population pressure.
9. Most Nigerian smallholders depend on family labour and seasonal hired labour; peak demand at planting and harvest raises costs and can delay operations. Small farm size limits mechanisation, so operations remain labour-intensive and expensive per unit area.
10. Women perform an estimated 60-80% of food production labour in Nigeria. However, they have less access than men to land (customary tenure often favours men), formal credit, improved seeds, fertilisers, and extension advice, which limits their productivity.

### Part 2.4

6. Sustainable agriculture meets current food and fibre needs without compromising future generations' ability to meet their own needs. Three pillars: economic (profitable for farmers), environmental (maintains soil, water, and biodiversity), social (equitable; supports rural communities).
7. Cover cropping grows a plant over the soil between main crops to protect the surface. Two benefits: reduces raindrop splash and runoff erosion; adds organic matter (and nitrogen for legume cover crops) when incorporated into the soil.



8. Mulching covers the soil with crop residues, grass, or plastic. Three benefits: conserves soil moisture by reducing evaporation; suppresses weed growth by blocking light; moderates soil temperature extremes.
9. Agroforestry deliberately integrates trees with crops and/or livestock on the same land. Three benefits: nitrogen fixation by leguminous trees (*Leucaena*, *Gliricidia*) supplies free nitrogen to crops; trees bind soil and reduce erosion; trees provide additional outputs (timber, fodder, fruit).
10. Integrated farming combines enterprises so that waste from one becomes input for another, increasing efficiency. Example: poultry manure collected from the poultry unit is composted and applied to food crops as organic fertiliser, reducing the need for purchased chemical fertiliser.



## References and Attributions [Series 2]

### Textual References (Books and External Sources)

- Olayide, S. O., & Heady, E. O. (1982). Introduction to agricultural production economics. University Press, 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.

### Figures, Plates, Tables, and Boxes

- Figure 2.1: Agro-ecological zones of Nigeria and climatic factors Attribution: AI generated. Suggested OER search string: "Nigeria agro-ecological zones map Guinea savanna rainforest Sudan savanna climatic factors crop production OER".
- Figure 2.2: Soil nutrients and conservation measures Attribution: AI generated. Suggested OER search string: "soil nutrients nitrogen phosphorus potassium deficiency symptoms soil conservation terracing mulching windbreaks Nigeria OER".
- Figure 2.3: Agroforestry and integrated farming Attribution: AI generated. Suggested OER search string: "agroforestry Nigeria Leucaena Gliricidia Parkia integrated farming crop livestock fish resource flow OER".



## Series 3: Crop Production Systems

- **Part 3.1: Principles of Crop Production**
  - Sub Part 3.1.1: Crop classification
  - Sub Part 3.1.2: Crop growth and development
  - Sub Part 3.1.3: Land preparation and planting
- **Part 3.2: Crop Management Practices**
  - Sub Part 3.2.1: Fertiliser application and crop nutrition
  - Sub Part 3.2.2: Weed management
  - Sub Part 3.2.3: Pest and disease management
- **Part 3.3: Major Crops of Nigeria**
  - Sub Part 3.3.1: Cereal and legume crops
  - Sub Part 3.3.2: Root, tuber, and oil crops
  - Sub Part 3.3.3: Tree and industrial crops
- **Part 3.4: Post-Harvest Management and Marketing**
  - Sub Part 3.4.1: Post-harvest losses and handling
  - Sub Part 3.4.2: Storage and processing
  - Sub Part 3.4.3: Agricultural marketing

### Introduction

Crop production is the largest and most important branch of agriculture in Nigeria. It provides food for the population, raw materials for industry, and income for farmers. Understanding how crops grow, how they are managed, what major crops are produced in Nigeria, and how produce is handled after harvest forms the practical core of agricultural science.





This Series covers the principles and practices of crop production from classification and land preparation through crop management (fertilisation, weed control, pest and disease management) to the major crops of Nigeria and post-harvest handling and marketing. These topics apply directly to everyday farm decisions and are the foundation for more advanced agronomy courses.

### Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 3.1** classify crops and describe the stages of crop growth, land preparation, and planting (Linked to Part 3.1),
- **SLO 3.2** describe fertiliser application, weed management, and pest and disease management (Linked to Part 3.2),
- **SLO 3.3** describe the major cereal, legume, root, tuber, oil, tree, and industrial crops of Nigeria (Linked to Part 3.3), and
- **SLO 3.4** explain post-harvest losses, storage, processing, and agricultural marketing (Linked to Part 3.4).

## 3.1 Principles of Crop Production

### 3.1.1 Crop classification

Crops can be classified in several ways. By use: food crops (grown primarily for human consumption; e.g. maize, cassava, cowpea); cash crops or export crops (grown primarily for sale; e.g. cocoa, groundnut, rubber); industrial or raw material crops (e.g. cotton for textiles, sugarcane for sugar, tobacco). By lifespan: annual crops (complete their life cycle in one growing season; e.g. maize, cowpea, tomato); biennial crops (require two growing seasons; e.g. sugarbeet); perennial crops (live and produce for many years; e.g. cocoa, oil palm, rubber).

Crops are also classified by botanical family (e.g. Gramineae/grasses: maize, rice, sorghum, millet; Leguminosae/legumes: cowpea, groundnut, soybean; Euphorbiaceae: cassava, rubber), by growth habit (erect, climbing, prostrate), and by adaptation (lowland tropics, upland, humid



forest, semi-arid). Understanding crop classification helps farmers select appropriate varieties, plan rotations, and choose the right management practices for each crop type.

Fill in the blank: Crops that complete their entire life cycle within one growing season are called \_\_\_\_\_ crops; examples include maize, cowpea, tomato, and groundnut.

### 3.1.2 Crop growth and development

Crop growth passes through recognisable stages from germination to harvest. Germination: the seed absorbs water (imbibition), the embryo resumes growth, the radicle (embryonic root) emerges first, followed by the plumule (shoot); germination requires adequate moisture, suitable temperature (usually 25-35 degrees Celsius for tropical crops), and oxygen. Seedling establishment: the young plant becomes established and begins photosynthesising independently; this is the most vulnerable stage; seedling losses here are a major cause of poor stand. Vegetative growth: rapid increase in leaf area, stem height, and root depth; the plant builds the photosynthetic capacity needed to support reproductive growth.

Reproductive growth: flowering, pollination, fertilisation, and fruit or seed development; this stage is the most critical for yield; drought or heat stress during flowering causes the greatest yield losses. Maturity and senescence: the crop reaches physiological maturity (maximum dry weight of seeds or storage organs); leaves senesce and die; the crop is ready for harvest. The duration of each growth stage varies by crop and variety. Knowing the critical stages helps farmers time irrigation, fertilisation, and pest control to maximise yield.

Fill in the blank: The \_\_\_\_\_ growth stage (flowering, pollination, and seed development) is the most critical for crop yield; drought or heat stress at this stage causes the greatest reduction in final grain or fruit weight.

### 3.1.3 Land preparation and planting

Land preparation involves clearing vegetation, tilling the soil, and preparing a suitable seedbed for planting. Primary tillage (ploughing): deep loosening of the soil using a mouldboard plough, disc plough, or chisel plough; breaks up compacted layers, buries weeds and crop residues, and



improves drainage. Secondary tillage (harrowing): lighter operations to break clods, level the surface, and create a fine, firm seedbed using a disc harrow, tine harrow, or rotavator. In smallholder Nigerian farming, land preparation is done with a hoe (hand tillage) or, where available, a two-wheel power tiller or four-wheel tractor.

Planting involves placing seeds or propagating materials (cuttings, tubers, seedlings) at the correct depth, spacing, and time. Plant population density determines competition for light, water, and nutrients; each crop has an optimum plant population per hectare (e.g. maize: 40,000-60,000 plants/ha; cowpea: 150,000-200,000 plants/ha). Planting time must match the onset of reliable rainfall (or irrigation) and consider the maturity period of the variety. Transplanting (raising seedlings in a nursery then moving them to the field) is used for crops such as tomato, pepper, rice (paddy), and onion to extend the growing season and improve crop establishment.

Fill in the blank: \_\_\_\_\_ tillage involves deep loosening of the soil by ploughing; it buries weeds and crop residues, breaks compacted layers, and improves drainage before planting.

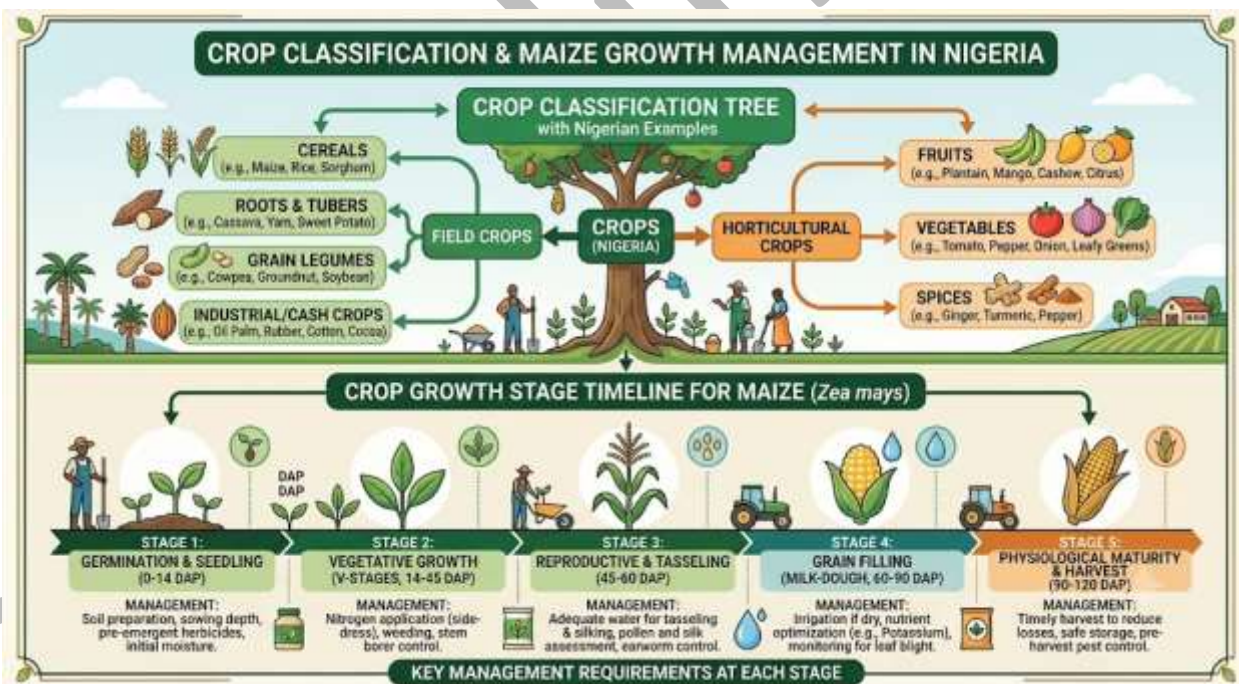


Figure 3.1: Crop classification and growth stages

Pilot questions 3.1

1. Classify crops by use and give two Nigerian examples of each class.
2. Distinguish between annual and perennial crops with two examples each.



3. Describe the five stages of crop growth and development.
4. Explain the difference between primary and secondary tillage.
5. Explain the importance of plant population density in crop production.

## 3.2 Crop Management Practices

### 3.2.1 Fertiliser application and crop nutrition

Fertilisers are materials applied to the soil or plant to supply essential nutrients for crop growth. They are classified as organic fertilisers (derived from plant or animal materials; e.g. compost, farmyard manure, green manure; supply nutrients slowly; improve soil structure and organic matter) and inorganic (mineral) fertilisers (chemically manufactured; e.g. urea for nitrogen, single superphosphate for phosphorus, muriate of potash for potassium; supply nutrients quickly in concentrated forms). In Nigeria, the most widely used fertiliser is NPK compound fertiliser (e.g. NPK 15:15:15 or NPK 20:10:10) which supplies all three primary nutrients in one application.

Correct fertiliser application requires matching the fertiliser type and rate to the soil deficiency and crop requirement; applying at the right growth stage (nitrogen is most effective during vegetative growth); and using the appropriate method (broadcasting; placement in bands beside the seed row; foliar spraying for micronutrients). Over-application of nitrogen causes lodging (stem collapse), excessive vegetative growth at the expense of yield, and environmental pollution through leaching and volatilisation. Under-application results in poor growth and low yield. Soil testing before fertilisation is the most reliable way to determine the correct rate.

Fill in the blank: NPK \_\_\_\_\_ :15:15 is a compound fertiliser widely used in Nigeria that supplies nitrogen, phosphorus, and potassium in equal proportions in a single application.

### 3.2.2 Weed management

Weeds are plants growing where they are not wanted; they compete with crops for light, water, nutrients, and space, and can significantly reduce yields. The critical period of weed competition is the first 3-6 weeks after crop emergence; weeds allowed to grow during this period cause the



greatest yield loss. Important weeds in Nigeria include *Imperata cylindrica* (spear grass; serious in the forest zone), *Striga hermonthica* (witch weed; a parasitic weed of sorghum and millet in the north), *Chromolaena odorata* (Siam weed; invasive in the forest zone), *Cyperus rotundus* (nutgrass; common sedge), and *Euphorbia heterophylla*.

Weed management methods include: physical/mechanical methods (hand weeding with a hoe; the most common method in Nigerian smallholder farms; interrow cultivation with a hand tractor or ox cultivator); cultural methods (timely planting; high plant density to shade weeds early; use of cover crops; crop rotation to break weed cycles); and chemical methods (herbicides; pre-emergence herbicides applied before weed germination; post-emergence herbicides applied after weed emergence; atrazine for maize; glyphosate for non-selective control before planting). Integrated weed management combines these approaches to achieve effective, sustainable, and cost-efficient weed control.

Fill in the blank: The critical period of weed competition is the first \_\_\_\_\_ -6 weeks after crop emergence; weeds that are allowed to grow during this period cause the greatest reduction in crop yield.

### 3.2.3 Pest and disease management

Crop pests are organisms that damage crops and reduce yield or quality. Major pest categories include: insects (stem borers such as *Busseola fusca* in maize and sorghum; pod borers; aphids; whiteflies; locusts; storage pests such as weevils); nematodes (microscopic round worms that attack roots; e.g. *Meloidogyne* species causing root-knot in vegetables); birds and rodents (particularly damaging at grain-fill and in storage); and vertebrate pests (monkeys, elephants in forest margin areas). Crop diseases are caused by fungi (e.g. early blight of tomato; late blight; maize leaf blight; groundnut rosette), bacteria (e.g. bacterial blight of cowpea), and viruses (e.g. cassava mosaic virus; maize streak virus).

Pest and disease management approaches: cultural control (crop rotation breaks pest and pathogen cycles; resistant varieties reduce losses; early planting avoids peak pest populations; proper spacing improves air circulation and reduces disease); biological control (using natural enemies: predators, parasitoids, and pathogens of the pest; e.g. *Bacillus thuringiensis* for stem





borers); chemical control (pesticides: insecticides, fungicides, bactericides; effective but costly and potentially hazardous); and integrated pest management (IPM): combining cultural, biological, and selective chemical controls to minimise pesticide use while keeping pest populations below economic damage thresholds.

Fill in the blank: \_\_\_\_\_ pest management (IPM) combines cultural, biological, and selective chemical control methods to keep pest populations below the economic damage threshold while minimising pesticide use and cost.

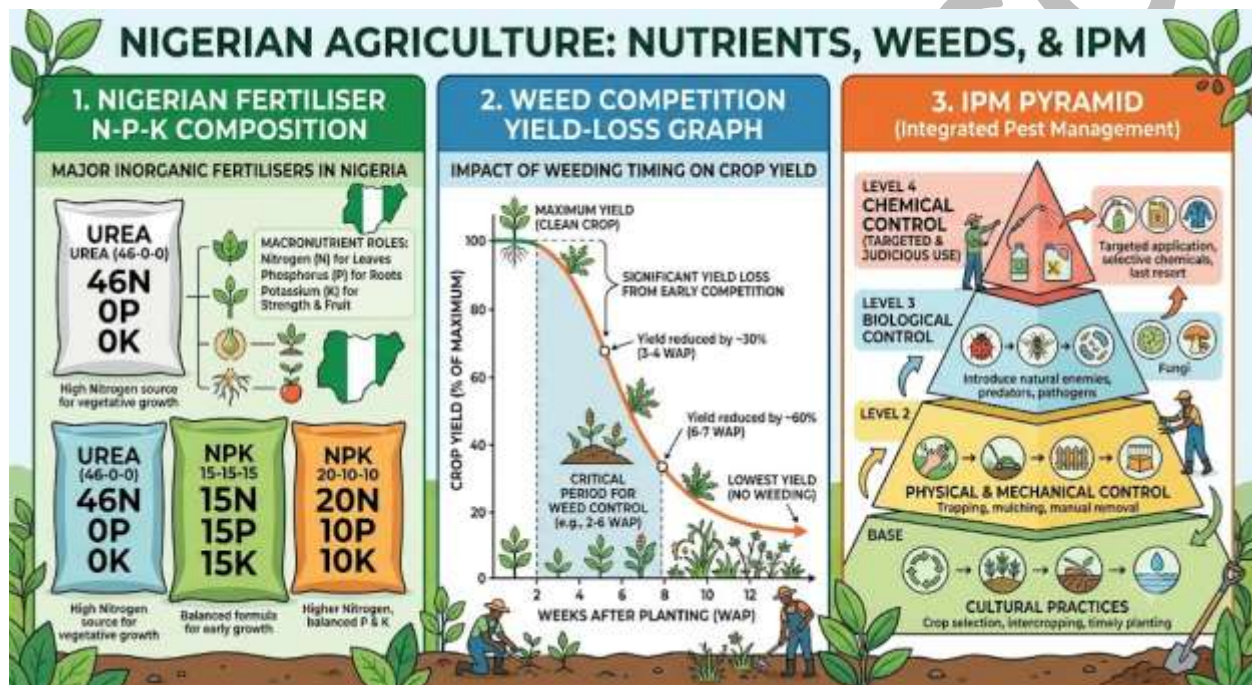


Figure 3.2: Crop management practices

### Pilot questions 3.2

11. Distinguish between organic and inorganic fertilisers with two examples each.
12. Explain the critical period of weed competition and state its importance.
13. Name four important weeds in Nigeria and state the crop each primarily affects.
14. State four methods of weed management.
15. Explain integrated pest management (IPM) and state three methods it combines.



### 3.3 Major Crops of Nigeria

#### 3.3.1 Cereal and legume crops

Cereals (members of the grass family, Gramineae) are the most important food crops in Nigeria by area and caloric contribution. Maize (*Zea mays*): the most widely grown cereal; adapted to all agro-ecological zones; used for human food (pap, tuwo, maize flour), animal feed, and industrial starch and glucose; high-yielding improved varieties available from IITA and IAR. Sorghum (*Sorghum bicolor*): the staple cereal of the northern savanna; drought-tolerant; used for food (tuwo sorghum, ogi), brewing (traditional sorghum beer), and animal feed. Millet (*Pennisetum glaucum* - pearl millet): the most drought-tolerant cereal; grown in the Sahel and Sudan savanna; used for food (fura da nono) and animal feed. Rice (*Oryza sativa*): grown in fadama lands, swamps, and upland; demand is rising rapidly; Nigeria is a major rice importer.

Legumes (Leguminosae) are important for their protein content and their ability to fix atmospheric nitrogen through symbiosis with *Rhizobium* bacteria in root nodules, improving soil fertility for subsequent crops. Cowpea (*Vigna unguiculata*): the most important food legume in Nigeria; drought-tolerant; grown throughout the country; both seeds (rich in protein: 23-25%) and leaves are consumed. Groundnut (*Arachis hypogaea*): major oil and protein crop of northern Nigeria; seeds processed for oil, cake, and peanut butter; formerly Nigeria's leading export crop. Soybean (*Glycine max*): growing in importance in the Guinea savanna; high protein (35-40%) and oil (18-20%) content; used in food, animal feed, and industrial processing.

Fill in the blank: \_\_\_\_\_ (*Vigna unguiculata*) is the most important food legume in Nigeria; it is drought-tolerant, rich in protein (23-25%), and is grown in all agro-ecological zones from the Sahel savanna to the forest belt.

#### 3.3.2 Root, tuber, and oil crops

Root and tuber crops are the most important source of dietary energy for people in the forest zone of Nigeria. Cassava (*Manihot esculenta*): Nigeria is the world's largest cassava producer; highly drought-tolerant; grown in all zones; processed into garri, fufu, tapioca, starch, and animal





feed; two types: sweet (low cyanide) and bitter (high cyanide; must be processed before consumption). Yam (*Dioscorea* species): culturally the most important food crop in Nigeria (the "king of crops" in Igbo and Yoruba cultures); *D. rotundata* (white guinea yam) is the most important species; yam is boiled, pounded, roasted, or processed into flour; the "yam belt" of the Guinea savanna and derived savanna produces over 70% of world yam supply.

Sweet potato (*Ipomoea batatas*): fast-maturing; nutritious (high beta-carotene in orange-fleshed varieties); important in the middle belt and northern Nigeria. Oil palm (*Elaeis guineensis*): Nigeria was once the world's leading palm oil producer; the oil palm produces two products from its fruit: palm oil (from the mesocarp) and palm kernel oil (from the kernel); both are widely used in cooking, soap, cosmetics, and industry; grown in the forest zone. Groundnut oil (from groundnut) is the dominant cooking oil in the north, while palm oil dominates in the south. Sesame (*Sesamum indicum*): the fastest-growing export crop; Nigeria is a major global sesame exporter; oil content approximately 50%.

Fill in the blank: Nigeria is the world's largest producer of \_\_\_\_\_ (*Manihot esculenta*); the crop is processed into garri, fufu, tapioca, starch, and animal feed and is the dominant food energy source in the forest zone.

### 3.3.3 Tree and industrial crops

Tree crops are perennial crops that produce for many years and are major sources of export income. Cocoa (*Theobroma cacao*): Nigeria's most important export crop; produced mainly in Ondo, Ekiti, Osun, Ogun, Cross River, and Edo States; seeds are fermented, dried, and exported for chocolate manufacture; Nigeria is the fourth largest cocoa producer globally. Rubber (*Hevea brasiliensis*): grown in Edo, Delta, Ondo, and Cross River States; latex tapped from the bark is processed into natural rubber for tyres and industrial products. Oil palm and coconut (*Cocos nucifera*) are also important tree crops of the southern states. Cashew (*Anacardium occidentale*): rapidly expanding; Kogi, Enugu, Oyo, Benue, and Nasarawa States are major producers; both the cashew nut and the cashew apple are commercially valuable.

Industrial crops provide raw materials for manufacturing. Cotton (*Gossypium hirsutum*): grown in Katsina, Zamfara, Kebbi, and Sokoto States; the lint (fibre) is used in textile manufacturing;



the seed is processed for cotton seed oil and animal feed cake. Sugarcane (*Saccharum officinarum*): grown in Numan (Adamawa), Bacita (Kwara), and Sunti (Kebbi); processed into sugar, molasses, and ethanol. Kenaf (*Hibiscus cannabinus*) and jute provide fibre for sack and rope making. Tobacco (*Nicotiana tabacum*): grown in Kogi and other middle belt states; processed for cigarette manufacture. These industrial crops are important for agro-industrial linkages and employment in rural areas.

Fill in the blank: Cocoa (*Theobroma* \_\_\_\_\_) is Nigeria's most important export tree crop; it is produced mainly in Ondo, Ekiti, Cross River, and Edo States; fermented and dried seeds are exported for chocolate manufacture.

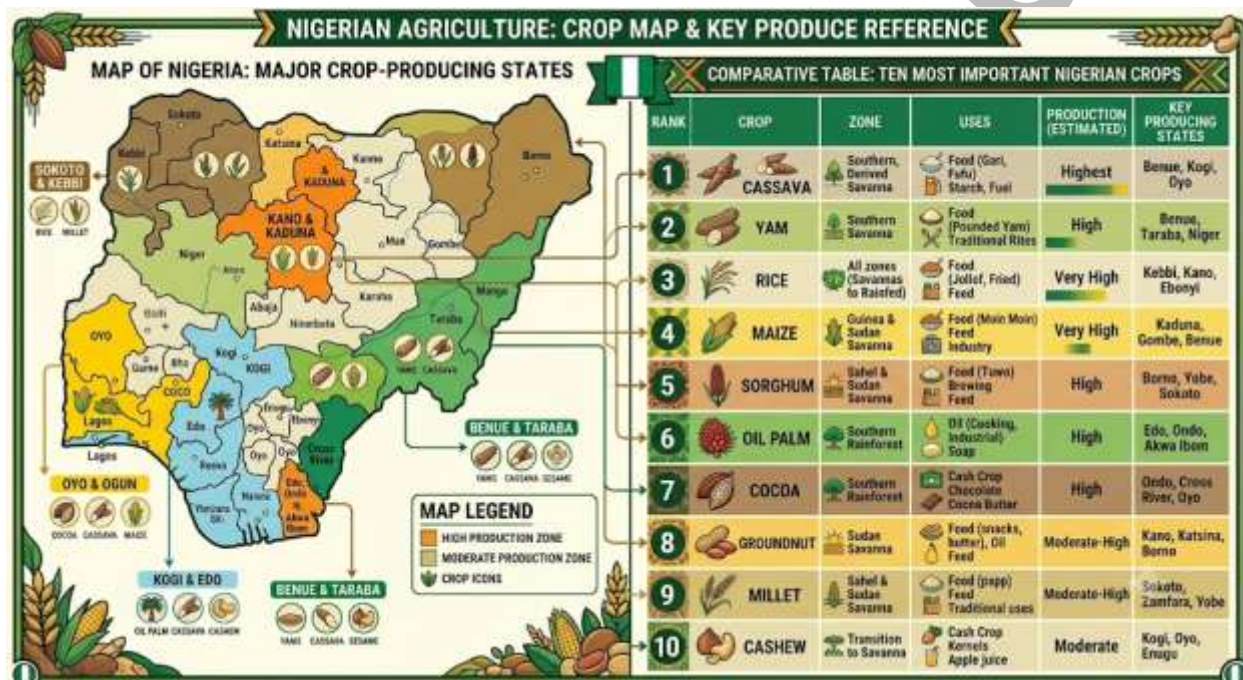


Figure 3.3: Major crops of Nigeria

### Pilot questions 3.3

- Name four cereal crops of Nigeria and state the agro-ecological zone where each is mainly grown.
- Explain the importance of legumes in crop production beyond their food value.
- Distinguish between cassava and yam as food crops in Nigeria.
- State the two oil products obtained from the oil palm fruit.



15. Name three tree or industrial crops of Nigeria and state one use of each.

### **3.4 Post-Harvest Management and Marketing**

#### **3.4.1 Post-harvest losses and handling**

Post-harvest losses are the quantitative and qualitative losses that occur in agricultural produce between harvest and final consumption. In Nigeria, post-harvest losses are estimated at 20-40% for perishable crops (vegetables, fruits, root crops) and 10-20% for dry grains and legumes.

Causes of post-harvest losses include: mechanical damage during harvesting (bruising, cutting); heat and moisture leading to microbial spoilage (mould, bacteria, yeast); insect pest infestation during storage (weevils, beetles, moths); rodent damage; and poor market access leading to over-ripening and rotting before sale.

Good post-harvest handling begins at harvest: crops should be harvested at the correct maturity stage; gentle handling minimises bruising; produce should be kept in the shade and away from direct sun immediately after harvest; pre-cooling (placing freshly harvested produce in a cool environment) slows down respiration and spoilage in perishables. For grains, proper threshing, cleaning, and drying to a safe moisture content (about 12-13% for most grains) before storage are critical steps that determine storage life and quality. Reducing post-harvest losses can significantly increase the effective food supply without increasing the area under cultivation.

Fill in the blank: Grains should be dried to a safe moisture content of approximately \_\_\_\_\_ - 13% before storage; at higher moisture levels, mould growth and insect activity rapidly degrade stored grain.

#### **3.4.2 Storage and processing**

Storage preserves agricultural produce from harvest until it is needed for consumption, processing, or sale. Storage methods in Nigeria range from traditional to modern. Traditional



storage: cribs and barns (open-sided structures for maize on the cob; allows air circulation; limited protection from rodents and insects); mud silos (hermetic clay structures; used for sorghum and millet in the north; effective if properly sealed); pit storage (underground pits for yam and cassava in the southwest). Modern storage: metallic silos and warehouses (fumigated with phosphine or stored under modified atmosphere; suitable for large quantities of grain); cold storage (refrigerated rooms for perishable fruits, vegetables, and processed products).

Processing converts raw agricultural produce into more stable, marketable, and nutritious food products. It extends shelf life, increases value, and creates employment. Key processing operations in Nigeria: milling (conversion of grain into flour; maize, sorghum, millet, rice, wheat mills); grating and pressing (cassava processed into garri by grating, dewatering, roasting); palm oil extraction (palm fruit boiled, mashed, pressed, and clarified); oil expression (groundnut oil, sesame oil, soybean oil); fermentation (locust bean seeds into dawadawa; soybean into iru); drying and smoking (fish, meat, cassava chips). Agro-processing adds significant value to raw farm produce and is a major opportunity for rural employment and income generation.

Fill in the blank: \_\_\_\_\_ is produced by grating cassava roots, dewatering (pressing out the starchy liquid), and roasting the granules in a pan; it is the most widely consumed cassava product in Nigeria.

### **3.4.3 Agricultural marketing**

Agricultural marketing encompasses all the activities involved in moving farm produce from producer to consumer, including assembling, grading, packing, transporting, storing, processing, and selling. Efficient marketing ensures that farmers receive a fair price for their produce and that consumers have access to food at reasonable prices. The marketing chain for most Nigerian smallholder produce involves: the farmer (producer); village or periodic market traders (assemblers and intermediaries); transporters (commercial vehicles; motorcycles; canoes); urban wholesale markets; and urban retailers and final consumers.

Challenges to efficient agricultural marketing in Nigeria: poor rural roads increase transport costs and cause losses in perishables; lack of accurate and timely market information leaves farmers unable to decide where and when to sell for the best price; limited storage infrastructure forces





farmers to sell immediately after harvest when prices are lowest (distress selling); inadequate grading and standardisation reduces consumer trust and price transparency; and high transaction costs due to multiple middlemen reduce the farm-gate price farmers receive. Mobile phone-based market information systems (e.g. ESOKO, AgriAid) and commodity exchange platforms (Nigeria Commodity Exchange) are emerging solutions to some of these challenges.

Fill in the blank: \_\_\_\_\_ selling is the practice of farmers selling their produce immediately after harvest when prices are at their lowest, due to lack of storage facilities; it reduces farm income and is a major cause of rural poverty.

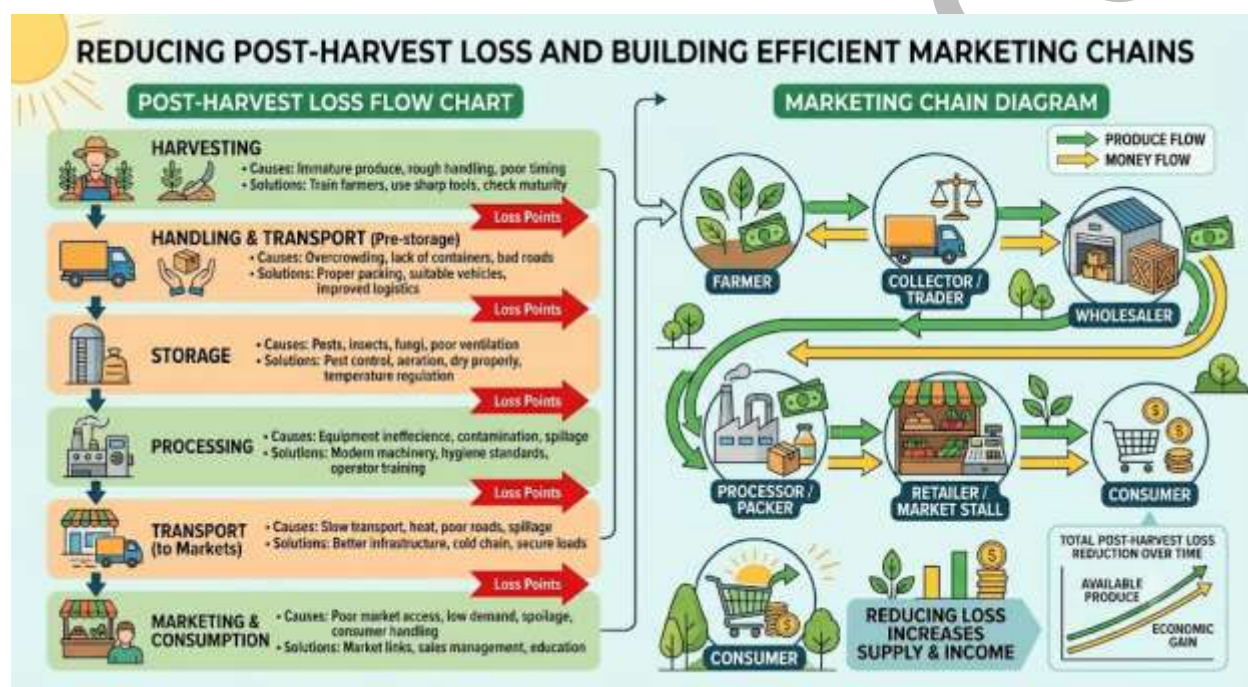


Figure 3.4: Post-harvest management and marketing chain

#### Pilot questions 3.4

11. Define post-harvest losses and state four causes.
12. Explain why drying grains to 12-13% moisture content is important.
13. Describe two traditional and two modern methods of grain storage used in Nigeria.
14. Explain what agro-processing is and give three examples of processed products derived from cassava.



15. State four challenges to efficient agricultural marketing in Nigeria.



## Series Summary

This Series covered the main principles and practices of crop production. Crops may be classified by use, lifespan, or botanical family, while their major growth stages include germination, seedling establishment, vegetative growth, reproduction, and maturity. The reproductive stage is especially important because it strongly influences yield. Land preparation involves primary tillage, such as ploughing, and secondary tillage, such as harrowing, to create a suitable seedbed. Successful planting depends on correct timing, depth, spacing, and population density. Soil fertility may be improved with organic fertilisers such as compost and manure or inorganic fertilisers such as urea, SSP, MOP, and NPK 15:15:15. Weed competition is most damaging during the first 3–6 weeks after crop emergence. Important weeds include *Imperata cylindrica*, *Striga hermonthica*, and *Chromolaena odorata*, while control methods include hand weeding, cultural practices, and pre- or post-emergence herbicides. Integrated pest management combines cultural, biological, and selective chemical methods.

Major Nigerian crops include cereals such as maize, sorghum, millet, and rice; legumes such as cowpea, groundnut, and soybean; root crops such as cassava and yam; oil crops such as oil palm, groundnut, and sesame; tree crops such as cocoa, rubber, and cashew; and industrial crops such as cotton, sugarcane, and tobacco. Post-harvest losses are caused by mechanical damage, heat, moisture, insects, and rodents and may reach 20–40% in perishable crops. Proper handling includes harvesting at the right stage, pre-cooling perishables, and drying grains to about 12–13% moisture. Storage may be traditional, using cribs, mud silos, or pits, or modern, using metallic silos and cold rooms. Processing methods include milling, cassava processing, palm-oil extraction, and fermentation. Agricultural marketing usually moves products from farmers through village markets, transporters, wholesalers, and retailers before reaching consumers, but poor roads, weak storage, limited market information, and high middlemen margins reduce farmers' returns. By completing this Series, students should achieve SLOs 3.1–3.4.

## Glossary of Terms

- **Annual crop:** a crop that completes its life cycle (germination to seed) within one growing season; e.g. maize, cowpea, tomato, groundnut.





- **Biological control:** using natural enemies (predators, parasitoids, pathogens) to suppress pest populations below economic damage levels.
- **Cash crop:** a crop grown primarily for sale rather than for subsistence; also called export crop; e.g. cocoa, groundnut, rubber, sesame.
- **Critical period of weed competition:** the period after crop emergence (usually the first 3-6 weeks) during which weed competition causes the greatest yield loss if not controlled.
- **Distress selling:** the practice of selling produce immediately after harvest at low prices because the farmer lacks storage facilities; a major cause of low farm income.
- **Garri:** a granular cassava product made by grating, dewatering, and roasting cassava roots; the most widely consumed cassava product in Nigeria.
- **Germination:** the resumption of growth by a dormant seed following imbibition of water; the radicle emerges first, followed by the plumule.
- **Integrated pest management (IPM):** a pest control strategy that combines cultural, biological, and selective chemical methods to keep pest populations below the economic damage threshold.
- **Inorganic (mineral) fertiliser:** a chemically manufactured fertiliser that supplies plant nutrients in concentrated, rapidly available forms; e.g. urea (N), SSP (P), MOP (K).
- **Nitrogen fixation:** the biological conversion of atmospheric nitrogen gas (N<sub>2</sub>) to ammonia (NH<sub>3</sub>) by bacteria (Rhizobium) living in root nodules of leguminous plants.
- **Organic fertiliser:** a fertiliser derived from plant or animal materials (compost, farmyard manure, green manure); releases nutrients slowly and improves soil structure.
- **Perennial crop:** a crop that lives and produces for many years without replanting; e.g. cocoa, oil palm, rubber, mango, cashew.
- **Post-harvest loss:** quantitative or qualitative loss of agricultural produce between harvest and final consumption due to physical damage, spoilage, or pest attack.



- **Primary tillage:** the first and deepest soil cultivation operation, usually ploughing; loosens the soil, buries weeds and residues, and improves drainage.
- **Secondary tillage:** lighter tillage operations (harrowing, ridging) that follow primary tillage to break clods and create a fine, level seedbed for planting.
- **Striga hermonthica:** a parasitic weed (witch weed) that attaches to the roots of sorghum and millet and extracts water and nutrients; causes major yield losses in the northern savanna.
- **Transplanting:** raising seedlings in a nursery and moving them to the field at the appropriate stage; used for tomato, pepper, rice (paddy), and onion.
- **Yam belt:** the region of the Guinea savanna and derived savanna of Nigeria (and West Africa) that produces over 70% of the world's yam supply.



## Concept Check Questions [Series 3]

### Objective Questions

1. Crops that complete their life cycle in one growing season are called \_\_\_\_\_ crops; examples include maize, cowpea, and groundnut. (Linked to SLO 3.1)
2. The \_\_\_\_\_ growth stage of a crop is the most critical for yield; drought or heat stress at this point causes the greatest reduction in grain or fruit weight. (Linked to SLO 3.1)
3. The critical period of weed competition is the first \_\_\_\_\_ weeks after crop emergence; weeds allowed to grow during this period cause the greatest yield loss. (Linked to SLO 3.2)
4. \_\_\_\_\_ (*Vigna unguiculata*) is the most important food legume in Nigeria; it fixes atmospheric nitrogen through symbiosis with *Rhizobium* bacteria. (Linked to SLO 3.3)
5. \_\_\_\_\_ selling is selling produce immediately after harvest at low prices because the farmer lacks storage; it is a major cause of low farm income in Nigeria. (Linked to SLO 3.4)

### Short-Answer Questions

1. Classify crops by use and give one example of each class. (Linked to SLO 3.1)
2. State four methods of weed control in Nigerian farming. (Linked to SLO 3.2)
3. Name three cereal crops and state the zone where each is mainly grown. (Linked to SLO 3.3)
4. State four causes of post-harvest losses in Nigeria. (Linked to SLO 3.4)
5. State three challenges to agricultural marketing in Nigeria. (Linked to SLO 3.4)

### Long-Answer Questions

1. Describe crop classification, the five stages of crop growth, and the steps of land preparation and planting. (Linked to SLO 3.1)



2. Describe fertiliser types, weed management, and integrated pest management in crop production. (Linked to SLO 3.2)
3. Describe the major food and export crops of Nigeria, post-harvest losses, storage, processing, and marketing challenges. (Linked to SLOs 3.3, 3.4)

### Answers to Concept Check Questions [Series 3]

#### Objective Questions

1. Annual.
2. Reproductive.
3. 3.
4. Cowpea.
5. Distress.

#### Short-Answer Questions

1. Food crops (maize); cash/export crops (cocoa); industrial crops (cotton).
2. Hand weeding, herbicide application, cover cropping, crop rotation.
3. Maize (all zones); sorghum (northern savanna); rice (fadama/swamp zones).
4. Mechanical damage at harvest, heat and moisture causing microbial spoilage, insect pest infestation, rodent damage.
5. Poor rural roads increase transport costs; lack of market information leads to distress selling; high margins of multiple middlemen reduce farm-gate prices.

#### Long-Answer Questions

1. Crop classification: by use (food, cash, industrial); by lifespan (annual: maize, cowpea; perennial: cocoa, oil palm); by botanical family (Gramineae: maize, sorghum; Leguminosae: cowpea, groundnut). Five growth stages: germination (seed absorbs water; radicle emerges), seedling establishment (most vulnerable; losses



- reduce stand), vegetative growth (leaf area and root development), reproductive growth (flowering and grain fill; most critical for yield), maturity and senescence (physiological maturity; harvest). Land preparation: primary tillage (ploughing; loosens soil; buries weeds), secondary tillage (harrowing; fine seedbed). Planting: correct depth, spacing, population density, and timing to match rainfall; transplanting used for tomato, pepper, and rice.
2. Fertilisers: organic (compost, manure; slow-release; improves soil structure) and inorganic (urea for N; SSP for P; MOP for K; NPK 15:15:15 compound fertiliser; fast-release; applied at right growth stage and rate). Weed management: critical period is first 3-6 weeks after emergence; methods: hand weeding (most common in smallholder farms), herbicides (atrazine for maize; glyphosate pre-planting), cover crops, crop rotation; important weeds: *Imperata cylindrica*, *Striga hermonthica*, *Chromolaena odorata*. IPM: combines cultural control (resistant varieties, rotation, sanitation), biological control (natural enemies, Bt), and selective chemical control; keeps pests below economic damage threshold; reduces pesticide costs and environmental damage.
  3. Major crops: cereals (maize: all zones; sorghum: north; millet: Sahel/Sudan; rice: fadama); legumes (cowpea: all zones; protein 23-25%; nitrogen fixation; groundnut: north; soybean: Guinea savanna). Root crops (cassava: world largest producer; garri, fufu, starch; yam: yam belt; culturally important). Oil crops (oil palm: palm oil + palm kernel oil; forest zone; sesame: major export). Tree/industrial crops (cocoa: fourth global producer; southwest/southeast; cotton: north; sugarcane: Numan, Bacita). Post-harvest losses: 20-40% perishables; 10-20% grains; causes: mechanical damage, heat/moisture, insects, rodents. Storage: traditional (cribs, mud silos, pit storage); modern (metallic silos, cold rooms). Processing: milling, garri-making, palm oil extraction, fermentation (dawadawa). Marketing challenges: poor roads, distress selling, limited market information, multiple middlemen reducing farm-gate price.

### Answers to Pilot Questions [Series 3]

#### Part 3.1



1. By use: food crops (maize, cassava, yam, rice); cash/export crops (cocoa, groundnut, rubber, sesame); industrial crops (cotton, sugarcane, tobacco). By lifespan: annual (maize, cowpea, tomato); perennial (cocoa, oil palm, rubber). By botanical family: Gramineae (maize, sorghum, millet, rice); Leguminosae (cowpea, groundnut, soybean).
2. Annual crops complete their entire life cycle within one growing season; examples: maize, cowpea, tomato, groundnut. Perennial crops live and produce for many years without replanting; examples: cocoa, oil palm, rubber, cashew.
3. Five stages: (1) Germination: seed absorbs water; radicle then plumule emerge. (2) Seedling establishment: young plant establishes and begins independent photosynthesis; the most vulnerable stage. (3) Vegetative growth: rapid increase in leaf area, stem height, and root depth. (4) Reproductive growth: flowering, pollination, and seed or fruit development; the most critical stage for final yield. (5) Maturity and senescence: crop reaches physiological maturity; leaves die; ready for harvest.
4. Primary tillage is the first deep soil cultivation (ploughing) that loosens compacted soil, buries weeds and crop residues, and improves drainage. Secondary tillage consists of lighter follow-up operations (harrowing, ridging) that break clods, level the surface, and create a fine, firm seedbed for planting.
5. Plant population density determines the competition among crop plants for light, water, and nutrients. Too many plants per hectare causes competition, lodging, and reduced yield per plant; too few plants leaves land under-utilised. Each crop has an optimum plant population (e.g. maize: 40,000-60,000 plants/ha) that maximises total yield per hectare.

### Part 3.2

1. Organic fertilisers: derived from plant or animal material; release nutrients slowly; improve soil structure; examples: compost, farmyard manure. Inorganic fertilisers: chemically manufactured; concentrated; nutrients available quickly; examples: urea (46% N), single superphosphate (SSP; 18% P<sub>2</sub>O<sub>5</sub>).



2. The critical period of weed competition is the first 3-6 weeks after crop emergence. Weeds that grow unchecked during this period compete most effectively with the young crop for light, water, and nutrients, causing the greatest yield reductions. After this period the crop canopy closes, shading and suppressing weed growth naturally.
3. Four important weeds: (1) *Imperata cylindrica* (spear grass): serious in the forest zone; perennial grass with deep rhizomes. (2) *Striga hermonthica* (witch weed): parasitic on roots of sorghum and millet in the northern savanna. (3) *Chromolaena odorata* (Siam weed): invasive shrub in the forest zone; aggressive coloniser of farmland. (4) *Cyperus rotundus* (nutgrass): widespread sedge in all zones; difficult to control due to underground tubers.
4. Four methods: (1) Hand weeding with a hoe (most common in smallholder farms). (2) Herbicide application (pre-emergence: atrazine in maize; post-emergence: glyphosate before planting). (3) Cover cropping (leguminous cover crops shade out weeds). (4) Crop rotation (changes weed-crop association and breaks weed build-up cycles).
5. IPM (Integrated Pest Management) is a strategy that combines multiple pest control methods to keep pest populations below the economic damage threshold while minimising pesticide use, cost, and environmental impact. Three methods it combines: (1) Cultural control (resistant varieties, crop rotation, sanitation, early planting). (2) Biological control (natural enemies such as predators and parasitoids; *Bacillus thuringiensis* for stem borers). (3) Selective chemical control (applying pesticides only when pest populations exceed the economic threshold, targeting specific pests).

### Part 3.3

1. Four cereal crops: (1) Maize (*Zea mays*): grown in all agro-ecological zones, especially the Guinea savanna and forest zones. (2) Sorghum (*Sorghum bicolor*): the Sudan and Guinea savanna of the north. (3) Pearl millet (*Pennisetum glaucum*): the Sahel and Sudan savanna of the far north. (4) Rice (*Oryza sativa*): fadama lands, inland valleys, and swamp areas nationwide.





2. Beyond food, legumes improve soil fertility through biological nitrogen fixation: Rhizobium bacteria live in root nodules of leguminous plants and convert atmospheric nitrogen gas (N<sub>2</sub>) into ammonia that the plant and subsequent crops can use. Including a legume in a crop rotation reduces the need for expensive nitrogen fertiliser for the following crop. Cowpea and groundnut are widely used as rotation crops in Nigerian farming systems for this reason.
3. Cassava (*Manihot esculenta*): grown in all zones; starchy root; processed into garri, fufu, tapioca, and starch; Nigeria is the world's largest producer; has both sweet and bitter types. Yam (*Dioscorea rotundata*): culturally the most important food crop; produced mainly in the Guinea savanna yam belt; consumed boiled, pounded, or roasted; not easily mechanised (requires staking and mounding); more perishable and more expensive than cassava.
4. Two products from oil palm fruit: (1) Palm oil, extracted from the orange-red fleshy mesocarp (outer fruit wall); used for cooking, soap, and cosmetics. (2) Palm kernel oil, extracted from the hard seed (kernel) inside the nut; used in margarine, soap, and confectionery; the residue (palm kernel cake) is used as animal feed.
5. Three tree or industrial crops: (1) Cocoa (*Theobroma cacao*): seeds fermented, dried, and exported for chocolate and cocoa powder manufacture; Nigeria is the fourth largest global producer. (2) Cotton (*Gossypium hirsutum*): the lint (white fibre) is the raw material for textile spinning and weaving; the seed is processed for cooking oil and animal feed. (3) Rubber (*Hevea brasiliensis*): latex tapped from the bark is processed into natural rubber for tyres, gloves, and industrial products.

#### Part 3.4

1. Post-harvest losses are quantitative and qualitative reductions in agricultural produce that occur between harvest and final consumption. Four causes: (1) mechanical damage (bruising during harvesting, threshing, and transport); (2) heat and moisture causing microbial spoilage (mould, bacteria, yeast); (3) insect pest infestation (weevils and beetles in stored grain); (4) rodent damage (rats and mice consuming and contaminating stored produce).



2. Drying grains to 12-13% moisture content is important because at moisture levels above 14%, mould fungi (especially *Aspergillus* species producing aflatoxins) grow rapidly, grain-boring insects (weevils, grain beetles) become active, and respiration by the grain generates heat that further accelerates spoilage. Grain dried to below 13% moisture can be stored safely for months without significant quality loss, protecting both the farmer's income and consumer health.
3. Traditional methods: (1) Cribs and barns: open-sided wooden or bamboo structures used to store maize on the cob; allow air circulation but offer limited protection from insects and rodents. (2) Mud silos: hermetically sealed clay storage structures used for sorghum and millet in northern Nigeria; effective if properly sealed and maintained. Modern methods: (1) Metallic silos: airtight corrugated metal containers; grain can be fumigated with phosphine; protect from insects and rodents; suitable for large quantities. (2) Cold storage: refrigerated rooms for fruits, vegetables, and processed perishables; maintains low temperatures that slow down spoilage.
4. Agro-processing converts raw agricultural produce into more stable and valuable food products. Three cassava products: (1) Garri: grated, dewatered, and roasted granules; the most widely consumed cassava product in Nigeria. (2) Fufu (akpu): fermented cassava paste, pounded and moulded; consumed in southern Nigeria. (3) Cassava starch: extracted by wet-milling; used in food, textile, and pharmaceutical industries.
5. Four marketing challenges: (1) Poor rural roads increase transport costs, cause delays, and lead to spoilage of perishables before reaching urban markets. (2) Lack of timely market information prevents farmers from knowing where and when to sell at the best price, leading to distress selling immediately after harvest. (3) Limited storage infrastructure forces farmers to sell at harvest-time glut prices rather than waiting for prices to rise. (4) Multiple middlemen in the marketing chain each add a margin, reducing the share of the final consumer price that the farmer receives.



## References and Attributions [Series 3]

### Textual References (Books and External Sources)

- Olayide, S. O., & Heady, E. O. (1982). Introduction to agricultural production economics. University Press, 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.
- IAR (Institute for Agricultural Research). (2019). Improved varieties of cereals and legumes for northern Nigeria. IAR, Zaria.

### Figures, Plates, Tables, and Boxes

- Figure 3.1: Crop classification and growth stages Attribution: AI generated. Suggested OER search string: "crop classification annual perennial food crops cash crops Nigeria crop growth stages germination vegetative reproductive maturity OER".
- Figure 3.2: Crop management practices Attribution: AI generated. Suggested OER search string: "fertiliser NPK Nigeria weed management critical period IPM integrated pest management crop protection OER".
- Figure 3.3: Major crops of Nigeria Attribution: AI generated. Suggested OER search string: "major crops Nigeria cocoa groundnut cassava yam oil palm sorghum maize cotton sesame production map OER".
- Figure 3.4: Post-harvest management and marketing chain Attribution: AI generated. Suggested OER search string: "post-harvest losses Nigeria storage cassava garri grain marketing chain smallholder farmer consumer OER".



## Series 4: Animal Farming Principles

- **Part 4.1: Introduction to Livestock Production**
  - Sub Part 4.1.1: Importance of livestock farming
  - Sub Part 4.1.2: Classification of farm animals
  - Sub Part 4.1.3: Livestock breeds in Nigeria
- **Part 4.2: Principles of Animal Nutrition**
  - Sub Part 4.2.1: Nutrients and their functions
  - Sub Part 4.2.2: Livestock feeds and feed formulation
  - Sub Part 4.2.3: Feeding systems and pasture management
- **Part 4.3: Animal Health and Disease Management**
  - Sub Part 4.3.1: Common livestock diseases in Nigeria
  - Sub Part 4.3.2: Prevention and control of livestock diseases
  - Sub Part 4.3.3: Veterinary services and animal welfare
- **Part 4.4: Livestock Products and Management Systems**
  - Sub Part 4.4.1: Major livestock products
  - Sub Part 4.4.2: Livestock management systems
  - Sub Part 4.4.3: Record keeping and enterprise economics

### Introduction

Animal farming is the second major branch of agriculture after crop production. In Nigeria, livestock provides protein (meat, milk, eggs, fish), draught power for land preparation and transportation, manure for soil fertility, hides and skins for leather industries, and income for



rural households. Understanding how to keep animals healthy, well-fed, and productive is therefore essential knowledge for every agricultural student.

This Series covers the importance and classification of farm animals, the breeds available in Nigeria, the principles of animal nutrition and feeding, the major diseases and their prevention, and the main livestock products, management systems, and record-keeping practices. These principles apply across all species of farm animals kept in Nigeria.

### **Series Learning Outcomes**

Upon completing this Series, you should be able to:

- **SLO 4.1** describe the importance of livestock farming and classify farm animals by various criteria (Linked to Part 4.1),
- **SLO 4.2** describe the major nutrients required by livestock and explain livestock feeding systems and pasture management (Linked to Part 4.2),
- **SLO 4.3** describe common livestock diseases in Nigeria and explain their prevention and control (Linked to Part 4.3), and
- **SLO 4.4** describe the major livestock products, management systems, and enterprise record keeping (Linked to Part 4.4).

## **4.1 Introduction to Livestock Production**

### **4.1.1 Importance of livestock farming**

Livestock farming plays a critical role in Nigerian agriculture and rural livelihoods. Farm animals provide: food and nutrition (meat, milk, and eggs are the main sources of high-quality animal protein in the human diet; fish provides about 40% of dietary protein in Nigeria); income (livestock can be sold at any time and serves as a savings bank and insurance for farm families); draught power (cattle, donkeys, and horses pull ploughs and carts in northern Nigeria, reducing the need for expensive tractors); organic manure (dung and urine improve soil fertility and



reduce the need for inorganic fertilisers); and raw materials for industry (hides and skins for leather, bone for glue and meal, feathers for cushions and decorative items).

Livestock also has cultural and social significance in Nigeria: cattle are a store of wealth and a symbol of prestige among the Fulani; goats and chickens are used in traditional ceremonies, bride price, and celebrations; poultry is the most widely kept livestock in Nigerian households. At the national level, the livestock sub-sector contributes approximately 5-6% of Nigeria's GDP and provides employment for millions of pastoralists, agropastoralists, and commercial farmers. Increasing livestock productivity is therefore a key element of Nigeria's strategy to improve food security and rural incomes.

Fill in the blank: In Nigeria, fish provides about \_\_\_\_\_ % of dietary protein; livestock also supplies meat, milk, and eggs and provides draught power, organic manure, hides, and skins.

#### **4.1.2 Classification of farm animals**

Farm animals are classified in several ways. By digestive system: ruminants (cattle, sheep, goat, buffalo, camel; have a four-chambered stomach: rumen, reticulum, omasum, abomasum; can digest fibrous plant material through microbial fermentation in the rumen); pseudo-ruminants or modified ruminants (camels and llamas; three-chambered stomach); monogastrics (pigs, poultry, rabbits, horses; simple single-chambered stomach; cannot digest large amounts of fibre; require more concentrated, digestible feeds). By use: meat animals (beef cattle, pigs, sheep, goat, poultry); dairy animals (dairy cattle, goats); draught animals (donkeys, horses, oxen); dual-purpose animals (local cattle breeds used for both beef and draught).

By habitat: terrestrial animals (kept on land: cattle, goats, sheep, pigs, poultry); aquatic animals (fish, shrimps, crabs, turtles; farmed in ponds, rivers, and sea). By size: large animals (cattle, horses, camels); small ruminants (goats, sheep); small animals (pigs, rabbits, poultry). By reproductive cycle: seasonal breeders (sheep and goats breed mainly in short-day seasons); year-round breeders (cattle, pigs, poultry). Understanding classification helps in planning housing, nutrition, health management, and marketing strategies appropriate to each species.



Fill in the blank: \_\_\_\_\_ are farm animals with a four-chambered stomach that allows microbial fermentation of fibrous plant material; examples in Nigeria include cattle, sheep, and goats.

#### 4.1.3 Livestock breeds in Nigeria

Nigeria has both indigenous (local) breeds and exotic (imported) breeds of livestock. Indigenous breeds: White Fulani cattle (Bunaji; most numerous; dual-purpose milk and beef; adapted to Nigerian savanna conditions); Red Sokoto (Maradi) goat (the most important goat breed; produces high-quality leather, the famous "Morocco leather"); Yankasa sheep (most numerous sheep breed; northern Nigeria; white body with black patches; small ruminant of the Sudan/Guinea savanna); Nigerian Local Chicken (also called village or backyard chicken; small, hardy, disease-resistant, poor layer; reared by virtually every rural household). These local breeds are well-adapted to harsh tropical conditions, heat, disease, and low-quality feed, but have lower productivity than exotic breeds.

Exotic breeds: Friesian (Holstein-Friesian) cattle (the world's highest milk-producing dairy breed; introduced to Nigeria but requires intensive management and high-quality feed; used in peri-urban dairy farms); Boer goat (South African breed; fast-growing; high meat yield; introduced for crossbreeding programmes); Ross 308 and Arbor Acres broiler chickens and Hy-Line and Lohmann Brown layer chickens (commercial poultry breeds; high growth rate and egg production but require high-quality feed and good housing). Crossbreeding local breeds with exotic breeds is widely practised in Nigeria to combine the adaptability of local breeds with the higher productivity of exotic breeds.

Fill in the blank: The White \_\_\_\_\_ (Bunaji) is the most numerous indigenous cattle breed in Nigeria; it is dual-purpose (milk and beef), well-adapted to the Nigerian savanna, and tolerant of heat and local disease conditions.





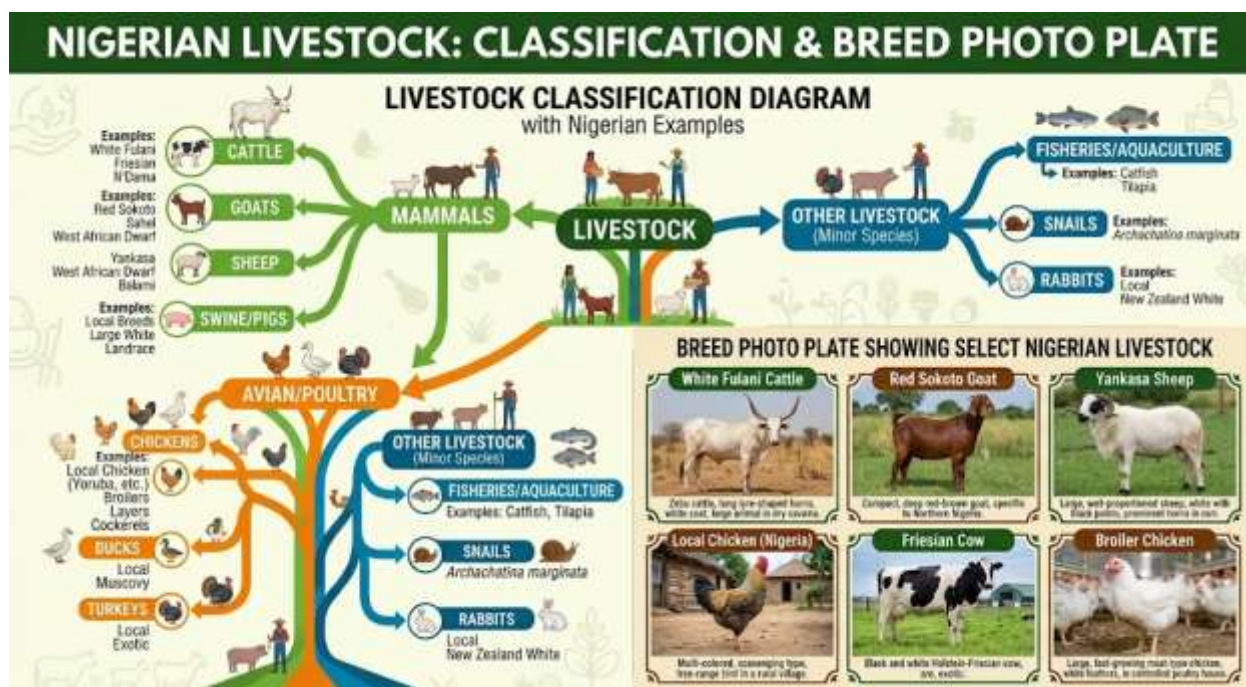


Figure 4.1: Classification of farm animals and Nigerian livestock breeds

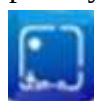
#### Pilot questions 4.1

11. State five reasons why livestock farming is important in Nigeria.
12. Distinguish between ruminants and monogastrics with two examples each.
13. Name four Nigerian indigenous livestock breeds and state the main product of each.
14. Explain the advantage of crossbreeding local and exotic livestock breeds.
15. State two cultural or social roles of livestock in Nigerian communities.

## 4.2 Principles of Animal Nutrition

### 4.2.1 Nutrients and their functions

Nutrients are chemical substances in feed that animals use for energy, growth, reproduction, and maintenance of body functions. The six classes of nutrients required by livestock are: (1) Water: the most critical nutrient; animals can survive longer without feed than without water; required for digestion, temperature regulation, and all metabolic reactions; dairy cows need 50-100 litres per day. (2) Carbohydrates: the main energy source in livestock diets; include sugars, starch (in



grains), and fibre (cellulose and hemicellulose in forages); ruminants can digest fibre through microbial action in the rumen; monogastrics cannot digest large amounts of fibre. (3) Proteins: provide amino acids for muscle, enzyme, hormone, and milk protein synthesis; sources: soybean meal, groundnut cake, fishmeal, blood meal.

(4) Fats and oils: concentrated energy source (2.25 times the energy of carbohydrates); source of fat-soluble vitamins A, D, E, and K; necessary for reproductive hormones; excess fat in the diet can cause digestive upset. (5) Vitamins: organic compounds required in small amounts for metabolic regulation; fat-soluble vitamins (A, D, E, K) are stored in body fat; water-soluble vitamins (B-complex, C) are not stored and must be supplied daily; deficiencies cause specific diseases (vitamin A deficiency: night blindness; rickets from vitamin D deficiency). (6) Minerals: inorganic elements; macro-minerals (calcium, phosphorus, sodium, magnesium, potassium, sulphur) and micro-minerals/trace elements (iron, zinc, copper, manganese, selenium, iodine, cobalt); calcium and phosphorus are most commonly deficient in Nigerian livestock diets, causing weak bones and poor milk production.

Fill in the blank: \_\_\_\_\_ is the most critical nutrient for livestock; animals can survive longer without feed than without it; dairy cows require 50-100 litres per day for normal milk production and metabolic function.

#### **4.2.2 Livestock feeds and feed formulation**

Livestock feeds are broadly divided into two categories. Roughages (forages): bulky, high-fibre feeds with relatively low energy density; include fresh grasses (*Panicum maximum*/Guinea grass, *Andropogon gayanus*/Gamba grass, *Pennisetum purpureum*/Napier grass), legume forages (*Stylosanthes*, *Centrosema*, Lablab), hay (dried grass or legume), silage (fermented green forage), and crop residues (straw, stovers, groundnut haulms). Roughages are the main feed for ruminants and are cheap and abundant in Nigeria after the rainy season. Concentrates: feeds with high nutrient density and low fibre content; include energy sources (maize grain, sorghum grain, cassava chips, wheat offal, rice bran) and protein sources (soybean meal, groundnut cake, fishmeal, blood meal, cotton seed cake); concentrates are more expensive but needed to supplement roughages and to meet the higher nutrient demands of high-producing animals.



Feed formulation is the process of combining different feed ingredients in the correct proportions to meet the nutritional requirements of a specific class of animal at a given stage of production. In Nigeria, the Pearson square method is widely used to formulate simple two-ingredient rations meeting a target crude protein level. A complete poultry ration for layers typically contains: maize (50-60%), wheat offal (5-10%), soybean meal (15-20%), groundnut cake (5-10%), fishmeal (3-5%), bone meal or limestone (3-5% for calcium), vitamin-mineral premix (0.25-0.5%), and salt (0.3%). Correctly formulated feed reduces cost while maintaining animal health and productivity.

Fill in the blank: \_\_\_\_\_ are high-fibre, bulky livestock feeds that include grasses, legume forages, hay, silage, and crop residues; they are the main diet of ruminants and are cheaply available in Nigeria after the rainy season.

#### **4.2.3 Feeding systems and pasture management**

Livestock feeding systems range from extensive to intensive. Extensive system (range or pastoral grazing): animals roam freely over large areas of natural rangeland to find their own feed; low input cost; suitable for the large Fulani cattle herds of northern Nigeria; risk of overgrazing and land degradation; animals travel long distances and may enter conflicts with crop farmers. Semi-intensive system: animals are housed at night and grazed or tethered on controlled pastures or crop residues during the day; supplementary concentrates provided; more productive than extensive; most common system for smallholder cattle, goats, and sheep in Nigeria. Intensive (zero-grazing or cut-and-carry) system: animals are permanently housed; all feed is cut and brought to them; maximum control over nutrition; suitable for high-producing dairy cows, commercial poultry, and pigs; high input cost but high productivity.

Pasture management involves establishing, improving, and maintaining grasslands to provide consistent, high-quality forage for grazing animals. Key practices: establishing improved grass varieties (Guinea grass, Napier grass, Gamba grass) that yield more and stay green longer than native grasses; overseeding with forage legumes (*Stylosanthes*, *Centrosema*, *Lablab*) to increase protein content; rotational grazing (dividing pasture into paddocks and resting each for 3-6 weeks to allow regrowth; prevents overgrazing); controlled stocking rate (matching animal



numbers to the carrying capacity of the pasture to prevent degradation); and hay and silage making (conserving excess wet-season forage for use in the dry season when grass quality and quantity decline sharply).

Fill in the blank: \_\_\_\_\_ grazing divides the pasture into paddocks and rests each section for 3-6 weeks to allow regrowth; it prevents overgrazing and maintains pasture productivity throughout the year.

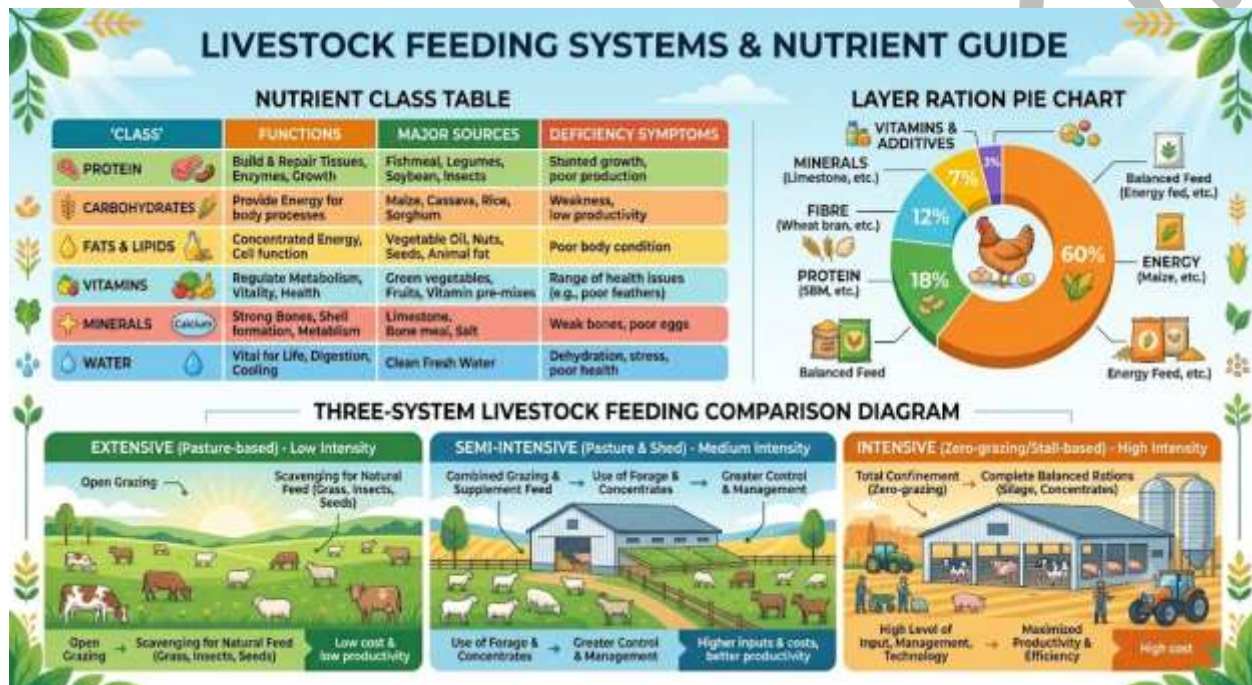


Figure 4.2: Animal nutrition and feeding systems

Pilot questions 4.2

16. Name the six nutrient classes required by livestock and state one function of each.
17. Distinguish between roughages and concentrates with two examples each.
18. Explain feed formulation and state why it is important.
19. Distinguish between extensive, semi-intensive, and intensive livestock feeding systems.
20. Explain rotational grazing and state two benefits.





## 4.3 Animal Health and Disease Management

### 4.3.1 Common livestock diseases in Nigeria

Livestock diseases reduce animal productivity, increase mortality, and represent one of the greatest constraints to animal farming in Nigeria. Major cattle diseases: Rinderpest (now officially eradicated globally but historically devastated Nigerian cattle herds); Foot and Mouth Disease (FMD): highly contagious viral disease causing vesicles on the mouth and feet; Contagious Bovine Pleuropneumonia (CBPP): bacterial lung disease; Trypanosomiasis (sleeping sickness): caused by Trypanosoma species transmitted by tsetse flies; restricts cattle keeping to tsetse-free areas of Nigeria; Tick-borne diseases (East Coast Fever, Babesiosis, Anaplasmosis): caused by parasites transmitted by Amblyomma and Boophilus ticks. Major small ruminant diseases: Peste des Petits Ruminants (PPR; "goat plague"): the most devastating disease of goats and sheep in Nigeria.

Major poultry diseases: Newcastle Disease (ND): the most economically important poultry disease in Nigeria; caused by Newcastle Disease Virus (NDV); spreads rapidly; causes high mortality in unvaccinated flocks; can devastate an entire flock within days. Fowl Pox: viral disease causing skin lesions; preventable by vaccination. Gumboro Disease (Infectious Bursal Disease, IBD): attacks the bursa of Fabricius in young chicks; destroys immunity; common in commercial poultry. Coccidiosis: caused by Eimeria species; a protozoan intestinal parasite; causes bloody diarrhoea and high mortality in young birds; most common disease in floor-raised broilers. Major pig diseases: African Swine Fever (ASF): highly lethal viral disease with no vaccine or treatment; causes catastrophic mortality.

Fill in the blank: Newcastle \_\_\_\_\_ is the most economically important poultry disease in Nigeria; it is caused by a virus, spreads rapidly among unvaccinated flocks, and can kill an entire flock within days.

### 4.3.2 Prevention and control of livestock diseases

Disease prevention is more cost-effective than treatment. Key preventive measures: vaccination (the most effective tool against viral diseases; national vaccination campaigns against Newcastle



Disease, FMD, PPR, and CBPP are conducted by state veterinary departments and the National Veterinary Research Institute, NVRI, Vom); good sanitation and hygiene (regular cleaning and disinfection of pens, water troughs, and equipment; removal of dead animals; control of rodents and insects that spread disease); quarantine (isolating newly purchased animals for 2-4 weeks before mixing with the existing herd to prevent introduction of new diseases); proper nutrition (well-nourished animals have stronger immunity and are more resistant to disease); and vector control (reducing tsetse fly populations through insecticide-treated livestock and land clearing reduces trypanosomiasis; tick control through acaricide dipping or spraying reduces tick-borne diseases).

When disease occurs, treatment must be prompt and correct. Common treatments: antibiotics (for bacterial diseases such as CBPP and Salmonellosis; penicillin, oxytetracycline, streptomycin); anthelmintics (dewormers for internal parasites such as roundworms, tapeworms, lungworms; e.g. ivermectin, albendazole); acaricides (tick killers; applied by dipping or spraying; e.g. amitraz, cypermethrin); trypanocides (drugs to treat trypanosomiasis; e.g. diminazene aceturate/Berenil); and antiprotozoals (for coccidiosis in poultry; e.g. amprolium, toltrazuril). Sick animals should be isolated promptly, and the farm veterinarian or veterinary officer consulted before administering treatment.

Fill in the blank: \_\_\_\_\_ is the most effective preventive measure against viral livestock diseases; national campaigns for Newcastle Disease, FMD, PPR, and CBPP vaccines are coordinated by state veterinary departments and the NVRI in Nigeria.

#### **4.3.3 Veterinary services and animal welfare**

Veterinary services are essential for maintaining healthy and productive livestock. In Nigeria, veterinary services are provided by: federal and state government veterinary departments (conducting disease surveillance, vaccination campaigns, and meat inspection); the National Veterinary Research Institute (NVRI, Vom, Plateau State; produces vaccines for major livestock diseases including Newcastle Disease and Rinderpest); Schools of Veterinary Medicine (University of Ibadan, Ahmadu Bello University, University of Maiduguri; training veterinarians and para-veterinary staff); and private veterinary practitioners (providing clinical services to



commercial farmers). Access to veterinary services in rural areas is limited: Nigeria has approximately one veterinarian per 30,000 livestock units, far below international standards.

Animal welfare refers to the physical and psychological well-being of farm animals. The internationally accepted "Five Freedoms" of animal welfare are: freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury, or disease; freedom to express normal behaviour; and freedom from fear and distress. Poor animal welfare reduces productivity: stressed animals grow slowly, produce less milk and eggs, and are more susceptible to disease. In Nigerian commercial farming, particular attention is given to proper stocking density, ventilation, water supply, and humane handling and slaughter practices. Improving animal welfare is both an ethical responsibility and a commercial advantage, especially for producers targeting export markets.

Fill in the blank: The National Veterinary Research Institute (NVRI) located in \_\_\_\_\_ , Plateau State, produces vaccines for major Nigerian livestock diseases including Newcastle Disease and was instrumental in the eradication of Rinderpest.



Figure 4.3: Major livestock diseases and prevention measures





### Pilot questions 4.3

16. Name four important livestock diseases in Nigeria and state the species each affects.
17. Explain why Newcastle Disease is the most economically important poultry disease in Nigeria.
18. State five measures for preventing livestock diseases.
19. Explain what trypanosomiasis is and how it affects cattle farming in Nigeria.
20. State the Five Freedoms of animal welfare.

## 4.4 Livestock Products and Management Systems

### 4.4.1 Major livestock products

Livestock produce a wide range of products that are important for food, industry, and income. Meat: produced from cattle (beef), goats (chevon), sheep (mutton), pigs (pork), poultry (chicken, turkey, duck), and rabbits; Nigeria's per capita meat consumption is below the recommended level; meeting rising demand requires increased production and reduced post-slaughter losses. Milk: dairy cattle (White Fulani, Friesian cross) and dairy goats produce milk; processed into fresh milk, yoghurt, cheese, and butter; Nigeria imports large quantities of milk powder due to insufficient domestic production; peri-urban dairy farming is growing rapidly. Eggs: commercial layer hens produce 250-300 eggs per year; eggs are an affordable source of animal protein; Nigeria's egg production has grown significantly with the expansion of commercial poultry farming.

Hides and skins: cattle hides and goat skins (especially Red Sokoto goat skins) are processed into leather for shoes, bags, belts, and upholstery; Nigeria was once a major exporter of hides and skins but quality has declined due to poor slaughter and processing practices. Wool and fibre: West African Dwarf sheep produce coarse wool used locally; Angora rabbits produce fine fibre. Draught power: cattle and donkeys provide traction for ploughing, planting, weeding, and transportation in northern Nigeria; one pair of oxen can plough approximately 0.5 ha per day. Manure: cattle, goat, and poultry manure are valuable organic fertilisers that improve soil



structure, water retention, and nutrient content; poultry manure is the richest in nitrogen and is used on vegetable farms.

Fill in the blank: Red Sokoto goat skins are processed into \_\_\_\_\_ leather; Nigeria was once a major exporter of this high-quality leather product used in shoes, bags, and upholstery.

#### 4.4.2 Livestock management systems

Livestock management systems in Nigeria range from traditional to modern commercial operations. Traditional (nomadic pastoralism): practiced mainly by Fulani herdsmen in northern Nigeria and the middle belt; large cattle herds migrate seasonally following water and pasture; low productivity; frequent farmer-herder conflicts over farmland; accounts for the majority of Nigeria's cattle population. Semi-intensive (agropastoral) system: animals are kept around the homestead and grazed on adjacent land or tethered on crop residues; commonly used for goats, sheep, and village poultry; moderately productive; most common system in the Nigerian countryside. Intensive (commercial) system: animals are permanently housed in purpose-built structures; feed, water, health, and environment are fully controlled; used in commercial poultry farms, piggeries, and peri-urban dairy units; high productivity but high capital and operating costs.

Key management practices applicable across all livestock systems: housing (provides shelter from rain, sun, predators, and thieves; must be well-ventilated to prevent respiratory disease buildup of ammonia; stocking density must not be exceeded); water supply (clean water at all times; contaminated water spreads disease; automatic nipple drinkers in poultry and pigs); identification (ear tags, tattooing, branding for cattle; allows individual performance recording); breeding management (selection of superior sires; controlled mating or artificial insemination to improve breed quality); and routine health management (deworming schedule; vaccination calendar; regular body condition scoring; culling of unproductive animals). Good management minimises losses and maximises the return on investment in livestock.

Fill in the blank: \_\_\_\_\_ pastoralism is the traditional livestock management system practised by the Fulani of northern Nigeria, in which large cattle herds migrate seasonally to follow water and pasture availability.



#### 4.4.3 Record keeping and enterprise economics

Record keeping is the systematic collection and storage of data about the performance of a livestock enterprise. Essential records for a livestock farm include: production records (daily milk yield per cow; eggs collected per day; weight gain of animals at regular intervals; litter size and birth weight in pigs and goats); health records (vaccination dates; disease outbreaks; treatments given; mortality records); feed records (quantity of feed purchased and consumed; feed cost per kg of product produced); financial records (income from sales of animals and products; expenditure on feed, drugs, labour, equipment; profit and loss calculation); and breeding records (mating dates; calving/kidding/lambing dates; sire used; progeny performance).

Enterprise economics evaluates the financial performance of the livestock business. Key economic concepts: fixed costs (costs that do not change with output level; e.g. buildings, equipment, land rent); variable costs (costs that change with output; e.g. feed, drugs, labour, chicks); total revenue (price per unit multiplied by quantity sold); gross margin (total revenue minus variable costs; the most commonly used measure of profitability in smallholder livestock enterprises); net profit (total revenue minus total costs); break-even analysis (the output level at which total revenue equals total costs; below this the enterprise makes a loss). Regular record keeping allows the farmer to identify problems early, make informed management decisions, justify loans from banks, and plan for expansion of the enterprise.

Fill in the blank: \_\_\_\_\_ margin is calculated as total revenue minus variable costs; it is the most commonly used measure of profitability in smallholder livestock enterprises in Nigeria.



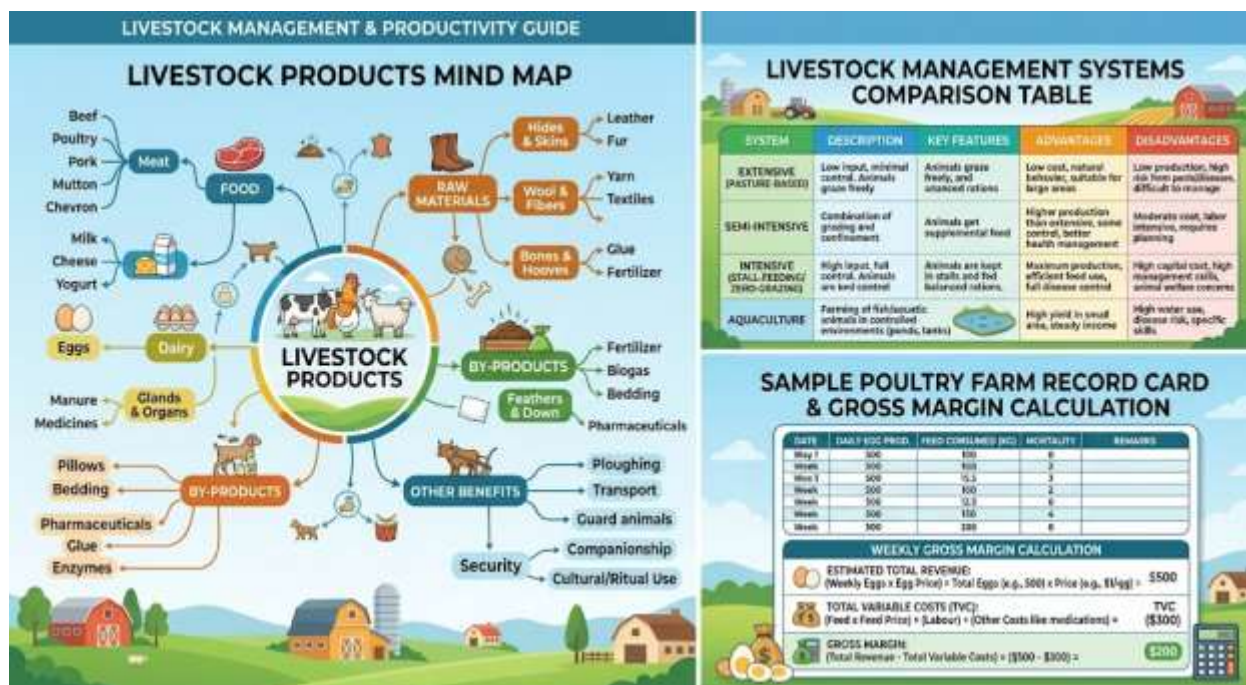


Figure 4.4: Livestock products, management systems, and record keeping

Pilot questions 4.4

16. Name six products obtained from farm animals in Nigeria.
17. Distinguish between nomadic, semi-intensive, and intensive livestock management systems.
18. State five types of records that should be kept on a livestock farm.
19. Define gross margin and explain why it is a useful measure of livestock enterprise profitability.
20. Explain three key management practices important across all livestock systems.



## Series Summary

This Series covered the importance, classification, feeding, health, and management of farm animals. Livestock provides meat, milk, eggs, fish, income, draught power, manure, hides, skins, and cultural value. Farm animals may be classified by digestive system, use, size, or habitat. Ruminants include cattle, sheep, and goats, while monogastrics include pigs, poultry, and rabbits. Important Nigerian breeds include White Fulani cattle, Red Sokoto goats, Yankasa sheep, and Nigerian Local Chickens, while exotic breeds such as Friesian cattle, Boer goats, Ross 308 broilers, and Hy-Line layers are valued for higher productivity. Crossbreeding combines the adaptability of local breeds with the performance of exotic breeds. The six major nutrient classes are water, carbohydrates, proteins, fats, vitamins, and minerals. Roughages such as grasses, hay, silage, and crop residues form the main feed for ruminants, while concentrates such as maize, soybean meal, groundnut cake, and fishmeal supply additional energy and protein. Feed formulation methods such as the Pearson square help achieve the correct nutrient balance at lower cost.

Livestock may be managed under extensive, semi-intensive, or intensive systems. Good pasture management includes improved grasses, forage legumes, rotational grazing, and hay or silage production for the dry season. Major diseases include Newcastle disease, foot-and-mouth disease, PPR, CBPP, trypanosomiasis, coccidiosis, and African swine fever. Prevention depends mainly on vaccination, hygiene, quarantine, good nutrition, and vector control, while treatment may involve antibiotics, anthelmintics, acaricides, trypanocides, and antiprotozoal drugs. Veterinary support is provided by institutions such as NVRI, state services, universities, and private practitioners. Animal welfare is guided by the Five Freedoms, while proper records should cover production, health, feed, finance, and breeding. Enterprise performance is assessed through fixed costs, variable costs, gross margin, net profit, and break-even analysis. By completing this Series, students should achieve SLOs 4.1–4.4.

## Glossary of Terms

- **Acaricide:** a chemical that kills ticks and other acarines; applied by dipping or spraying to control tick-borne diseases in livestock.



- **Anthelmintic:** a drug that kills internal parasites (worms) in livestock; examples include ivermectin and albendazole.
- **Concentrate:** a livestock feed with high nutrient density and low fibre content; includes energy feeds (maize, cassava) and protein feeds (soybean meal, groundnut cake, fishmeal).
- **Crossbreeding:** mating animals of two different breeds to produce offspring that combine the adaptability of the local breed with the higher productivity of the exotic breed.
- **Draught power:** the use of animals (cattle, donkeys, horses) to pull ploughs, carts, and other implements; reduces the need for expensive tractors.
- **Feed formulation:** the process of combining different feed ingredients in correct proportions to meet the nutritional requirements of a specific animal at a given stage of production.
- **Five Freedoms:** internationally accepted principles of animal welfare: freedom from hunger and thirst; from discomfort; from pain, injury, or disease; to express normal behaviour; and from fear and distress.
- **Gross margin:** total revenue minus variable costs; the most commonly used measure of profitability in smallholder livestock enterprises.
- **Monogastric:** an animal with a simple single-chambered stomach; examples include pigs, poultry, and rabbits; cannot efficiently digest large amounts of dietary fibre.
- **Newcastle Disease:** the most economically important viral poultry disease in Nigeria; spreads rapidly and causes high mortality in unvaccinated flocks; preventable by vaccination.
- **NVRI (National Veterinary Research Institute):** located in Vom, Plateau State; produces vaccines for major Nigerian livestock diseases including Newcastle Disease and Rinderpest.



- **Roughage (forage):** a high-fibre, bulky livestock feed including grasses, hay, silage, and crop residues; the staple diet of ruminants.
- **Rotational grazing:** a system that divides pasture into paddocks grazed in rotation, allowing each section to rest for 3-6 weeks to recover before being grazed again.
- **Ruminant:** an animal with a four-chambered stomach (rumen, reticulum, omasum, abomasum) that allows microbial fermentation of fibrous plant material; examples: cattle, sheep, goats.
- **Trypanosomiasis:** a disease of cattle (and humans) caused by Trypanosoma protozoa transmitted by tsetse flies; causes progressive anaemia and wasting; restricts cattle keeping in tsetse-infested areas.
- **White Fulani (Bunaji) cattle:** the most numerous indigenous cattle breed in Nigeria; dual-purpose (milk and beef); well-adapted to the Nigerian savanna; tolerant of heat and local diseases.
- **Zero-grazing (cut-and-carry):** an intensive livestock system in which animals are permanently housed and all feed is cut and brought to them; maximises control over nutrition and productivity.





## Concept Check Questions [Series 4]

### Objective Questions

11. In Nigeria, fish provides about \_\_\_\_\_ % of dietary protein; livestock also supplies meat, milk, and eggs and provides draught power, manure, and hides and skins. (Linked to SLO 4.1)
12. \_\_\_\_\_ are farm animals with a four-chambered stomach; they can digest fibrous plant material through microbial fermentation; examples include cattle, sheep, and goats. (Linked to SLO 4.1)
13. \_\_\_\_\_ is the most critical nutrient for livestock; animals can survive longer without feed than without this substance. (Linked to SLO 4.2)
14. Newcastle \_\_\_\_\_ is the most economically important poultry disease in Nigeria; it is caused by a virus and can kill an entire flock of unvaccinated birds within days. (Linked to SLO 4.3)
15. \_\_\_\_\_ margin is total revenue minus variable costs; it is the most commonly used profitability measure for smallholder livestock enterprises. (Linked to SLO 4.4)

### Short-Answer Questions

16. State four reasons why livestock farming is important in Nigeria. (Linked to SLO 4.1)
17. Name the six nutrient classes and state one function of each. (Linked to SLO 4.2)
18. Distinguish between roughages and concentrates with two examples each. (Linked to SLO 4.2)
19. State five measures for preventing livestock diseases. (Linked to SLO 4.3)
20. Name three types of records that should be kept on a livestock farm. (Linked to SLO 4.4)

### Long-Answer Questions



17. Describe the importance of livestock farming in Nigeria; classify farm animals; and describe three Nigerian livestock breeds. (Linked to SLO 4.1)
18. Describe the six nutrient classes, the difference between roughages and concentrates, and three livestock feeding systems. (Linked to SLO 4.2)
19. Describe four major livestock diseases, five prevention measures, and five key livestock products and management systems in Nigeria. (Linked to SLOs 4.3, 4.4)



## Answers to Concept Check Questions [Series 4]

### Objective Questions

1. 40.
2. Ruminants.
3. Water.
4. Disease.
5. Gross.

### Short-Answer Questions

1. Food/protein (meat, milk, eggs), income (sale of animals and products), draught power (ploughing and transport), organic manure (soil fertility improvement).
2. Water (metabolic reactions); carbohydrates (energy); proteins (muscle and tissue growth); fats (concentrated energy and fat-soluble vitamins); vitamins (metabolic regulation); minerals (bone, enzyme, and hormone functions).
3. Roughages: high-fibre, bulky feeds; examples: Guinea grass, groundnut haulms. Concentrates: high nutrient density, low fibre; examples: maize grain, soybean meal.
4. Vaccination, sanitation and hygiene, quarantine of new animals, proper nutrition, vector control (ticks, tsetse flies).
5. Production records, health records, financial records.

### Long-Answer Questions

1. Importance: food (meat, milk, eggs; fish provides 40% dietary protein); income; draught power; manure; hides/skins; cultural value; contributes ~5-6% of GDP. Classification: by digestive system (ruminants: cattle, sheep, goat; monogastrics: pigs, poultry, rabbits); by use (meat, dairy, draught, dual-purpose); by size (large, small ruminants, small animals). Three Nigerian breeds: White Fulani cattle (most numerous; dual-purpose; savanna-adapted); Red Sokoto goat (Morocco leather; northeast); Yankasa sheep (most numerous sheep; north; Sudan/Guinea savanna).



- Exotic breeds (Friesian dairy, Ross 308 broiler) crossbred with local breeds to combine adaptability with productivity.
2. Six nutrients: water (most critical; 50-100 L/day for dairy cows); carbohydrates (main energy source; starch in grains; fibre in forages); proteins (amino acids for growth, muscle, milk; soybean meal, groundnut cake, fishmeal); fats (concentrated energy; fat-soluble vitamins A,D,E,K); vitamins (metabolic regulation; A: night blindness if deficient; D: rickets); minerals (calcium and phosphorus most deficient in Nigeria; bone and milk production). Roughages: bulky, high-fibre; Guinea grass, hay, groundnut haulms; ruminant staple. Concentrates: high nutrient density; maize grain, soybean meal; supplement roughages; required for high-producing animals. Feeding systems: extensive (nomadic grazing; low cost; overgrazing risk); semi-intensive (tethered/housed at night; supplemented; most common smallholder); intensive/zero-grazing (permanently housed; all feed provided; high productivity and cost).
  3. Four diseases: Newcastle Disease (poultry; viral; rapid high mortality; vaccination prevents); FMD (cattle; viral; vesicles on mouth and feet; vaccination); PPR/goat plague (goats/sheep; viral; fever, diarrhoea, pneumonia; vaccination); Trypanosomiasis (cattle; Trypanosoma protozoa; tsetse-transmitted; anaemia, wasting; vector control and trypanocides). Five prevention measures: vaccination (most effective against viral diseases); sanitation and hygiene (clean pens, water, equipment); quarantine (isolate new animals 2-4 weeks); proper nutrition (well-nourished animals resist disease); vector control (acaricide dipping for ticks; tsetse fly control). Five livestock products: meat (beef, chevon, pork, poultry); milk (fresh, yoghurt, cheese); eggs (affordable animal protein); hides/skins (Red Sokoto leather); manure (organic fertiliser). Management systems: nomadic (Fulani; large herds migrate seasonally); semi-intensive (tethered/grazed; housed at night; most smallholders); intensive/commercial (permanently housed; high productivity; commercial poultry and pig farms).

### Answers to Pilot Questions [Series 4]

#### Part 4.1



1. Five reasons: (1) food and nutrition (meat, milk, eggs, fish); (2) income (animals sold when cash is needed; savings bank for rural families); (3) draught power (oxen and donkeys pull ploughs and carts in northern Nigeria); (4) organic manure (dung improves soil fertility and reduces fertiliser cost); (5) raw materials for industry (hides and skins for leather; bone for meal and glue).
2. Ruminants: have a four-chambered stomach (rumen, reticulum, omasum, abomasum); can digest fibrous plant material through microbial fermentation; examples: cattle, sheep, goats. Monogastrics: have a simple single-chambered stomach; cannot efficiently digest large amounts of fibre; require more concentrated, digestible feed; examples: pigs, poultry.
3. Four indigenous breeds and main products: (1) White Fulani cattle (Bunaji): beef and milk; the most numerous cattle breed. (2) Red Sokoto (Maradi) goat: high-quality Morocco leather from its skin; also meat and milk. (3) Yankasa sheep: meat and wool; most numerous sheep breed in the north. (4) Nigerian Local Chicken: meat and eggs; kept by virtually every rural household.
4. Crossbreeding combines the disease resistance, heat tolerance, and adaptability of local breeds with the higher milk, meat, or egg production capacity of exotic breeds. For example, crossing White Fulani cattle with Friesian produces offspring that yield more milk than pure White Fulani while still tolerating the Nigerian climate better than pure Friesian.
5. Two cultural or social roles: (1) Cattle are a store of wealth and a symbol of prestige and social status among Fulani and other cattle-keeping communities; a man's standing is measured by herd size. (2) Goats and chickens are used in traditional ceremonies, religious rituals, bride-price payments, and community celebrations across Nigerian ethnic groups.

#### Part 4.2

1. Six nutrient classes and functions: (1) Water: required for all metabolic reactions and temperature regulation. (2) Carbohydrates: the main source of energy in livestock diets. (3) Proteins: supply amino acids for muscle, milk, and enzyme synthesis. (4)



Fats: concentrated energy source and carrier of fat-soluble vitamins A, D, E, K. (5)

Vitamins: regulate specific metabolic processes; deficiencies cause diseases (rickets, night blindness). (6) Minerals: calcium and phosphorus for bone formation and milk production; trace minerals for enzyme function.

2. Roughages are bulky, high-fibre livestock feeds with relatively low energy density; they form the main diet of ruminants which can digest fibre through microbial fermentation in the rumen; examples: Guinea grass, groundnut haulms (stover). Concentrates are feeds with high nutrient density and low fibre; they supplement roughages to meet the higher demands of productive animals; examples: maize grain (energy concentrate) and soybean meal (protein concentrate).
3. Feed formulation is the process of combining feed ingredients in the correct proportions to meet the nutritional requirements of a specific class of animal at a given stage of production. It is important because: a correctly formulated ration ensures the animal receives all required nutrients in the right balance, preventing deficiency diseases, maximising production performance, and minimising feed wastage and cost.
4. Extensive (nomadic): animals roam freely over large natural rangeland; very low input cost; risk of overgrazing, conflict with farmers, and variable feed quality. Semi-intensive: animals grazed or tethered during the day and housed at night; supplementary feed provided; moderate productivity; most common in Nigerian smallholder farming. Intensive (zero-grazing): animals permanently housed; all feed cut and brought to them; full nutritional control; highest productivity; highest capital and operating cost; used in commercial poultry, pigs, and dairy farms.
5. Rotational grazing divides the total pasture area into several paddocks; animals graze one paddock at a time while the others rest and regrow; the herd is moved to the next paddock after 1-2 weeks. Two benefits: (1) prevents overgrazing by allowing each paddock to recover its grass biomass before being grazed again; (2) breaks the life cycle of internal parasites (larvae deposited in dung are less likely to reinfect animals if the paddock rests for several weeks).



### Part 4.3

1. Four diseases: (1) Newcastle Disease: affects poultry; caused by Newcastle Disease Virus; highly contagious; causes high mortality. (2) Foot and Mouth Disease (FMD): affects cattle and other cloven-hoofed animals; caused by FMD virus; painful vesicles on mouth and feet; severe production loss. (3) Peste des Petits Ruminants (PPR): affects goats and sheep; caused by PPR virus; fever, diarrhoea, respiratory distress; can kill most of a flock. (4) Trypanosomiasis: affects cattle (and humans); caused by Trypanosoma protozoa; transmitted by tsetse flies; progressive anaemia and wasting.
2. Newcastle Disease is the most economically important poultry disease in Nigeria because: it is caused by a highly contagious virus that spreads rapidly through a flock by direct contact, contaminated feed and water, air, and equipment; it can kill 80-100% of unvaccinated birds within 3-5 days; outbreaks occur frequently because many village poultry are unvaccinated; and it affects the most widely kept livestock species, causing catastrophic losses to both commercial farmers and rural households that depend on poultry for income and protein.
3. Five prevention measures: (1) Vaccination: the most effective protection against viral diseases; national campaigns for Newcastle Disease, FMD, PPR, and CBPP are essential. (2) Sanitation and hygiene: regular cleaning and disinfection of pens, water troughs, and equipment removes pathogens. (3) Quarantine: all newly purchased animals isolated for 2-4 weeks before mixing with the existing herd. (4) Proper nutrition: well-fed animals have stronger immune systems and recover faster if they become infected. (5) Vector control: tick control by acaricide dipping or spraying reduces tick-borne diseases; tsetse fly control reduces trypanosomiasis.
4. Trypanosomiasis (sleeping sickness of animals) is caused by protozoan parasites of the genus Trypanosoma (*T. vivax*, *T. congolense*, *T. brucei*) transmitted through the bite of infected tsetse flies (*Glossina* species). The disease causes progressive anaemia, loss of body condition, poor reproductive performance, reduced milk yield, and eventually death in severely affected cattle. It restricts cattle farming to tsetse-free areas of Nigeria (mainly the drier north where tsetse flies are absent); the humid forest and derived savanna zones (tsetse fly belt) have low cattle densities due to trypanosomiasis risk.





5. The Five Freedoms of animal welfare: (1) Freedom from hunger and thirst (access to fresh water and a diet maintaining health). (2) Freedom from discomfort (appropriate housing and environment). (3) Freedom from pain, injury, or disease (prevention or rapid treatment of illness). (4) Freedom to express normal behaviour (sufficient space and facilities; appropriate company of the animal's own kind). (5) Freedom from fear and distress (conditions and treatment that avoid mental suffering).

#### Part 4.4

1. Six products: (1) Meat (beef from cattle; chevon from goats; mutton from sheep; pork from pigs; chicken from poultry). (2) Milk (from cattle and goats; processed into yoghurt, cheese, butter). (3) Eggs (from poultry; commercial layers produce 250-300 eggs per year). (4) Hides and skins (cattle hides and Red Sokoto goat skins processed into Morocco leather). (5) Draught power (cattle and donkeys for ploughing, planting, and transportation in the north). (6) Manure (dung and urine from cattle, goats, and poultry used as organic fertiliser).
2. Nomadic (extensive) system: large Fulani cattle herds migrate seasonally across long distances to follow water and pasture; no permanent housing; very low input cost; low productivity per animal; risk of overgrazing and farmer-herder conflict. Semi-intensive system: animals kept near the homestead and grazed or tethered on controlled pasture or crop residues during the day; housed at night; supplemented with crop by-products; most common smallholder system; moderately productive. Intensive (commercial) system: animals permanently housed in purpose-built structures; feed, water, health, and environment fully managed; high productivity; high capital and operating cost; used for commercial poultry, pigs, and peri-urban dairy cattle.
3. Five types of records: (1) Production records: daily milk yield per cow; eggs collected; weight gain at regular intervals. (2) Health records: vaccination dates; disease outbreaks and treatments given; mortality numbers. (3) Feed records: quantity of feed purchased and consumed; feed cost per kg of product. (4) Financial records: income from sales; expenditure on feed, drugs, labour; profit and loss account. (5)



Breeding records: mating dates; calving/kidding/lambing dates; sire identification; progeny growth and performance.

4. Gross margin is calculated as total revenue minus variable costs (feed, drugs, labour, chicks, fuel). It is useful because: it tells the farmer how much money is left from sales after paying for inputs directly related to production; it can be calculated quickly without detailed accounting; it allows comparison between different livestock enterprises or between years to identify whether the enterprise is improving or declining; and banks often use gross margin calculations when evaluating loan applications from livestock farmers.
5. Three key management practices: (1) Housing and stocking density: proper housing protects animals from weather, predators, and thieves; ventilation prevents ammonia buildup and respiratory disease; correct stocking density prevents stress, competition, and disease transmission. (2) Water supply: clean, fresh water must be available at all times; water contaminated with pathogens or algae spreads disease rapidly; automatic drinkers ensure consistent supply in commercial units. (3) Routine health management: a scheduled vaccination programme, regular deworming with anthelmintics, periodic acaricide treatment, and body condition scoring allow health problems to be detected and addressed before they become costly disease outbreaks.



## References and Attributions [Series 4]

### Textual References (Books and External Sources)

- Olayide, S. O., & Heady, E. O. (1982). Introduction to agricultural production economics. University Press, Ibadan.
- FAO (Food and Agriculture Organization of the United Nations). (2025). Guidelines for sustainable agriculture. FAO.
- NAPRI (National Animal Production Research Institute). (2020). Annual report. NAPRI, Shika, Zaria.
- NVRI (National Veterinary Research Institute). (2019). Animal disease surveillance report. NVRI, Vom.

### Figures, Plates, Tables, and Boxes

- Figure 4.1: Classification of farm animals and Nigerian livestock breeds Attribution: AI generated. Suggested OER search string: "livestock classification ruminants monogastrics Nigerian breeds White Fulani cattle Red Sokoto goat Yankasa sheep local chicken OER".
- Figure 4.2: Animal nutrition and feeding systems Attribution: AI generated. Suggested OER search string: "livestock nutrition six nutrients water carbohydrate protein fat vitamin mineral poultry ration feeding systems extensive intensive pasture management Nigeria OER".
- Figure 4.3: Major livestock diseases and prevention measures Attribution: AI generated. Suggested OER search string: "livestock diseases Nigeria Newcastle disease FMD PPR trypanosomiasis coccidiosis vaccination prevention veterinary OER".
- Figure 4.4: Livestock products, management systems, and record keeping Attribution: AI generated. Suggested OER search string: "livestock products meat milk eggs hides skins manure draught power management systems nomadic intensive record keeping gross margin Nigeria OER".



## Series 5: Forestry, Fisheries and Wildlife

- **Part 5.1: Forestry in Nigeria**
  - Sub Part 5.1.1: Importance and types of forests
  - Sub Part 5.1.2: Forest products and their uses
  - Sub Part 5.1.3: Deforestation and forest conservation
- **Part 5.2: Fisheries and Aquaculture**
  - Sub Part 5.2.1: Importance and types of fisheries
  - Sub Part 5.2.2: Fish production and aquaculture
  - Sub Part 5.2.3: Challenges and management of fisheries
- **Part 5.3: Wildlife and Conservation**
  - Sub Part 5.3.1: Importance of wildlife
  - Sub Part 5.3.2: Threats to wildlife in Nigeria
  - Sub Part 5.3.3: Wildlife conservation and management
- **Part 5.4: Integration of Forestry, Fisheries, and Wildlife in Agriculture**
  - Sub Part 5.4.1: Role of trees in farming systems
  - Sub Part 5.4.2: Integrated natural resource management
  - Sub Part 5.4.3: Policy and institutional framework

### Introduction

Forestry, fisheries, and wildlife are vital components of Nigeria's natural resource base that complement crop production and livestock farming. Forests regulate climate, protect watersheds, supply timber and non-timber products, and support biodiversity. Fisheries provide the single



largest source of animal protein in the Nigerian diet, while wildlife contributes to ecosystem health, tourism, and cultural heritage.

This final Series examines the importance, products, threats, and management of Nigeria's forests, fisheries, and wildlife, and explores how these resources can be integrated sustainably into agricultural systems. Completing this Series equips students to appreciate natural resource management and its relationship to food security and rural livelihoods.

### **Series Learning Outcomes**

Upon completing this Series, you should be able to:

- **SLO 5.1** describe the types and importance of forests in Nigeria and explain their products, deforestation, and conservation (Linked to Part 5.1),
- **SLO 5.2** describe the importance of fisheries, explain aquaculture production, and identify challenges in fisheries management (Linked to Part 5.2),
- **SLO 5.3** describe the importance of wildlife in Nigeria, explain threats it faces, and describe conservation measures (Linked to Part 5.3), and
- **SLO 5.4** explain the role of trees in farming systems and describe the policy framework for natural resource management in Nigeria (Linked to Part 5.4).

## **5.1 Forestry in Nigeria**

### **5.1.1 Importance and types of forests**

Forests are large areas dominated by trees and associated plant and animal communities. In Nigeria they are classified into: tropical rainforest (south-west and south-east; species: Iroko, Mahogany, Obeche, Opepe); Guinea savanna woodland (middle belt; Isoberlinia, Daniellia, Khaya); Sudan and Sahel savanna scrub (north; Acacia, Balanites, Faidherbia albida); mangrove forest (coastal Niger Delta; Rhizophora, Avicennia; critical fish nursery habitat); and plantation forests (Gmelina arborea, teak, Pinus).

Forests perform essential ecological services: watershed protection (tree roots hold soil and regulate water flow into streams and rivers, protecting downstream farming communities from



floods and droughts); carbon sequestration (forests absorb and store atmospheric CO<sub>2</sub>, mitigating climate change); climate regulation (forests generate rainfall through evapotranspiration; deforested areas receive less rainfall); soil protection (canopy and litter reduce raindrop impact and erosion); and biodiversity conservation (forests shelter thousands of plant and animal species including wild crop relatives).

Fill in the blank: Tropical \_\_\_\_\_ forest in south-western and south-eastern Nigeria is the most biologically diverse forest type and contains valuable timber species such as Iroko, Mahogany, and Obeche.

### 5.1.2 Forest products and their uses

Forests supply two broad categories of products. Timber (wood products): sawlogs converted into sawn timber for construction and furniture (Iroko, Mahogany); poles and posts for fencing and building; fuelwood and charcoal (the main cooking energy source for the majority of Nigerians; about 70% of total energy consumption is biomass); and wood pulp for paper and cardboard manufacture. These timber products are economically important but over-harvesting without replanting is accelerating forest loss.

Non-timber forest products (NTFPs) are often more economically valuable to rural communities than timber itself. Important NTFPs in Nigeria include: *Parkia biglobosa* (locust bean) seeds processed into dawadawa seasoning; *Vitellaria paradoxa* (shea tree) nuts yielding shea butter used in food and cosmetics; rattan and bamboo for furniture and construction; medicinal plants used in traditional medicine; wild fruits, mushrooms, and honey from wild beehives. NTFP collection provides income and nutrition for millions of rural women and children, especially during the agricultural off-season.

Fill in the blank: Non-timber forest \_\_\_\_\_ (NTFPs) such as locust bean seeds, shea butter, rattan, medicinal plants, and honey provide income and nutrition for millions of rural Nigerians, especially women and children.



### 5.1.3 Deforestation and forest conservation

Deforestation is the permanent removal of forest cover and conversion to other land uses.

Nigeria has one of the highest deforestation rates in the world, losing an estimated 350,000-400,000 hectares annually. The main causes are: agricultural expansion (smallholder clearing for new farmland is the leading cause); charcoal and fuelwood demand (very high biomass energy use strips trees from forests and farmlands); commercial logging (selective timber extraction without replanting depletes high-value species); and urban expansion and infrastructure development (roads, buildings, and power lines convert forest to non-forest land).

Forest conservation strategies in Nigeria include: forest reserves (over 1,000 reserves covering approximately 9.6 million hectares, where agriculture is prohibited and timber extraction is regulated); reforestation and afforestation (government programmes planting Gmelina and teak on degraded land; the Great Green Wall project combating desertification in northern states); community-based forest management (giving local communities benefit-sharing rights reduces illegal clearing); and the National Forest Policy 2006 which guides sustainable forest management at the federal level.

Fill in the blank: Nigeria loses an estimated 350,000-400,000 \_\_\_\_\_ of forest per year; the main causes are agricultural expansion, charcoal and fuelwood demand, commercial logging, and urbanisation.







directly and indirectly (fishermen, processors, traders, boat builders, net makers) and contributes approximately 4% of GDP. Nigeria is a net fish importer, spending over 1 billion US dollars annually on imports; expanding domestic aquaculture is therefore a national food security priority.

Types of fisheries in Nigeria: marine fisheries (Atlantic Ocean including the 200 nautical mile Exclusive Economic Zone; species: croaker, bonga, mackerel, grouper, shrimp; major fishing communities in Lagos, Bonny, Brass, and Calabar); artisanal inland fisheries (small-scale fishing in rivers, lakes, and reservoirs using canoes, traps, cast nets, and hook-and-line; major water bodies: Rivers Niger and Benue, Lake Chad, Kainji and Jebba Reservoirs; most widespread type by number of participants); and industrial marine fisheries (larger mechanised trawlers and purse seiners operating offshore).

Fill in the blank: Fish supplies approximately \_\_\_\_\_ % of total animal protein in Nigeria; the country spends over 1 billion US dollars annually on fish imports, making expanded aquaculture a national food security priority.

### **5.2.2 Fish production and aquaculture**

Aquaculture is the controlled cultivation of fish and other aquatic organisms in ponds, cages, tanks, or raceways. Catfish (*Clarias gariepinus*) is the dominant species cultured in Nigeria because of its high growth rate, tolerance of low oxygen levels, acceptance of artificial pelleted feed, ease of reproduction in captivity, and strong consumer demand. Tilapia (*Oreochromis niloticus*) is the second most cultured species; it is fast-growing, herbivorous (cheaper to feed), and well-accepted in the market. The National Institute for Freshwater Fisheries Research (NIFFR, New Bussa, Niger State) provides technical support and improved fingerlings to fish farmers.

Aquaculture production systems in Nigeria: earthen ponds (most common; 100-500 m<sup>2</sup>; excavated and filled with water; stocked with fingerlings; fed floating pellets; harvested by draining after 4-6 months; low capital cost); concrete tanks (urban and peri-urban; easier to manage; used for intensive catfish production); cage culture (floating cages in Kainji and Jebba Reservoirs; tilapia and catfish); and recirculating aquaculture systems (RAS; closed-loop indoor;



very high stocking density; expensive but highly productive). Fish feed represents 60-70% of catfish production cost.

Fill in the blank: \_\_\_\_\_ (Clarias gariepinus) is the dominant aquaculture species in Nigeria because of its fast growth, tolerance of low oxygen, ease of reproduction, and strong market demand.

### 5.2.3 Challenges and management of fisheries

Nigeria's fisheries face serious challenges: overfishing (destructive gear such as dynamite, fine-mesh nets, and poisons is depleting inland fish stocks); water pollution (oil spills in the Niger Delta, industrial effluent, agricultural runoff, and domestic sewage degrade aquatic habitats and kill fish); climate change (erratic rainfall, reduced river flow, and rising temperatures affect fish breeding cycles and reduce catches in inland water bodies); and inadequate cold chain infrastructure (lack of ice plants, cold storage, and refrigerated transport causes high post-harvest losses and limits marketing reach).

Fisheries management measures: closed seasons (prohibiting fishing during the breeding period of key species to allow stock replenishment; Lake Chad, Kainji Reservoir); gear regulations (banning dynamite, poison, and nets below the minimum legal mesh size to protect juvenile fish); fish stocking (releasing fingerlings produced in government hatcheries into lakes and reservoirs to replenish depleted stocks); and aquaculture development (expanding fish pond and cage culture through NIFFR technical support and CBN aquaculture financing schemes). The Federal Department of Fisheries (FDF) oversees regulation and development.

Fill in the blank: Closed \_\_\_\_\_ prohibit fishing during the breeding period of key species to allow stock recovery; they are practised on major Nigerian water bodies including Lake Chad and Kainji Reservoir.



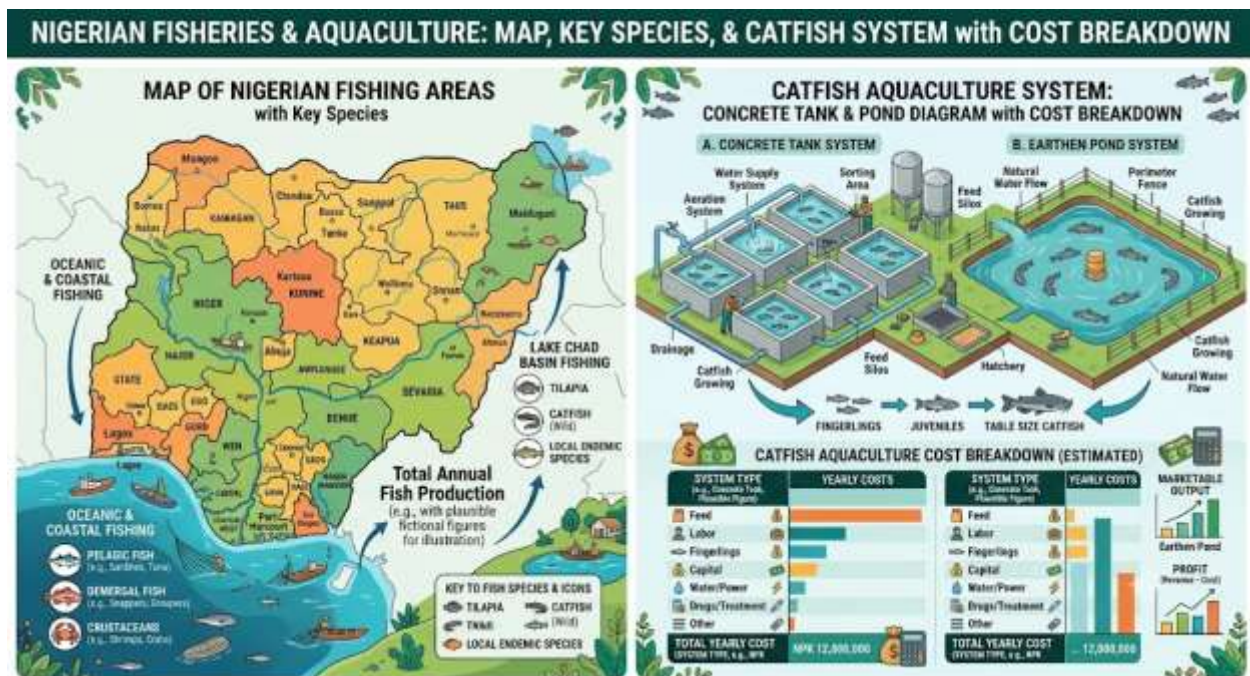


Figure 5.2: Fisheries and aquaculture in Nigeria

### Pilot questions 5.2

21. State four reasons why fisheries are important in Nigeria.
22. Distinguish between marine fisheries and artisanal inland fisheries in Nigeria.
23. Explain why catfish is the most important aquaculture species in Nigeria.
24. Describe two fish production systems used in Nigerian aquaculture.
25. State four challenges facing Nigeria's fisheries and one management measure for each.

## 5.3 Wildlife and Conservation

### 5.3.1 Importance of wildlife

Wildlife refers to all wild animals, birds, reptiles, amphibians, insects, and plants living in their natural habitats without direct human management. Wildlife is important for several reasons: ecological functions (predators regulate prey populations; insects pollinate crops; decomposers recycle nutrients; seed dispersers spread tree species across landscapes); food and nutrition (bushmeat from wild animals is an important source of animal protein for rural communities in





the forest zone where domestic livestock and fish may be scarce); and genetic resources (wild relatives of crop and livestock species carry genes for disease resistance and drought tolerance useful for breeding improved varieties).

Economic value: ecotourism (Yankari National Park in Bauchi, Cross River National Park, and Gashaka Gumti National Park in Taraba and Adamawa States are major wildlife tourism destinations generating foreign exchange and local community income); medicinal value (wild animal and plant parts are used extensively in traditional medicine and contribute to pharmaceutical research); and cultural and heritage value (many Nigerian communities have animal totems and sacred species; the elephant and eagle are national symbols of strength and freedom). These values provide the economic justification for investing in wildlife conservation.

Fill in the blank: Wildlife-based tourism (\_\_\_\_\_) at national parks such as Yankari in Bauchi State generates foreign exchange and local income; it is one of the most important economic arguments for wildlife conservation.

### **5.3.2 Threats to wildlife in Nigeria**

Nigeria's wildlife has declined dramatically due to several overlapping threats. Habitat loss and fragmentation is the most critical threat: agricultural expansion, logging, urban growth, and road construction have destroyed and divided natural habitats; Nigeria has lost over 90% of its original forest cover since 1900, isolating wildlife populations and preventing gene flow. Poaching and unsustainable hunting: elephants are killed for ivory; pangolins are heavily trafficked for scales and meat (among the world's most trafficked mammals); great apes in Cross River State are critically endangered due to hunting and trade.

Human-wildlife conflict occurs as shrinking habitat forces wild animals onto farmland in search of food; elephants and hippopotami raid crops in Kwara, Ogun, and Plateau States, causing economic loss; farmers retaliate by killing the animals, further reducing wildlife populations. Additional threats include: bush burning (widespread dry-season burning for hunting, pasture, and land clearing destroys nesting habitat and kills small mammals, reptiles, and insects); water pollution from oil spills in the Niger Delta devastates coastal and mangrove wildlife; and invasive exotic plants displace native species and alter habitats.



Fill in the blank: Habitat \_\_\_\_\_ and fragmentation is the most critical threat to Nigerian wildlife; agricultural expansion, logging, and urbanisation have destroyed over 90% of Nigeria's original forest cover since 1900.

### 5.3.3 Wildlife conservation and management

Nigeria has established a network of protected areas to conserve its wildlife. Seven national parks are managed by the National Park Service (NPS): Yankari (Bauchi), Kainji Lake (Niger and Kwara), Cross River (Cross River), Gashaka Gumti (Taraba and Adamawa), Chad Basin (Borno and Yobe), Old Oyo (Oyo), and Kamuku (Kaduna); together covering approximately 2.2 million hectares. State governments manage additional game reserves where hunting is regulated, and strict nature reserves are closed to all human use except scientific research.

Other conservation strategies include: wildlife laws and regulations (Endangered Species Act 1985 controls trade in protected species; Nigeria is a CITES signatory; penalties for poaching); ex situ conservation (captive breeding programmes in zoos such as University of Ibadan Zoo and Jos Wildlife Park; gene banks for wild plant genetic resources); community conservation (REDD+ programmes pay communities for preserving forests and wildlife; benefit-sharing from ecotourism and controlled bushmeat harvesting); and public education and awareness campaigns in schools and communities. The Convention on Biological Diversity (CBD) and CITES provide the international framework for Nigerian wildlife law.

Fill in the blank: Nigeria has seven national \_\_\_\_\_ managed by the National Park Service; Yankari (Bauchi) and Gashaka Gumti (Taraba and Adamawa) are among the most important for wildlife conservation and ecotourism.





Figure 5.3: Wildlife and protected areas in Nigeria

Pilot questions 5.3

21. State five reasons why wildlife is important in Nigeria.
22. Describe four major threats to wildlife in Nigeria.
23. Name four national parks in Nigeria and state one species protected in each.
24. Explain two ex situ and two in situ conservation strategies.
25. Explain what human-wildlife conflict is and how it can be reduced.

## 5.4 Integration of Forestry, Fisheries, and Wildlife in Agriculture

### 5.4.1 Role of trees in farming systems

Trees integrated into farming systems provide multiple benefits. They improve microclimate by providing shade that reduces soil surface temperature, evaporation, and heat stress on crops and animals; they also reduce wind speed, lowering crop lodging and soil erosion from wind.

Leguminous trees (*Leucaena leucocephala*, *Gliricidia sepium*, *Faidherbia albida*) fix atmospheric





nitrogen through root nodule bacteria, enriching the soil for associated food crops and reducing the need for purchased nitrogen fertiliser. *Faidherbia albida* is particularly valued in the Sahel because it sheds leaves in the wet season (when crops are growing) and leafs out in the dry season, allowing compatible cultivation of annual crops underneath.

On-farm trees also supply fruit, seeds, fodder, medicinal materials, fuelwood, and timber to the farm household, diversifying income and reducing dependence on purchased inputs. Parkland agroforestry systems, traditional in the West African Guinea savanna, maintain economically valuable trees such as *Parkia biglobosa* (locust bean), *Vitellaria paradoxa* (shea tree), and *Adansonia digitata* (baobab) among annual food crops; these are among the most biodiverse and productive land use systems in tropical Africa. On-farm trees also serve as habitat stepping stones for pollinators and beneficial insects that support crop production.

Fill in the blank: *Faidherbia* \_\_\_\_\_ is a leguminous Sahel tree valued in farming systems because it sheds leaves in the wet season (allowing crops to grow freely underneath) and leafs out in the dry season; it also fixes atmospheric nitrogen.

#### **5.4.2 Integrated natural resource management**

Integrated natural resource management (INRM) simultaneously manages land, water, forest, wildlife, and fisheries resources to achieve productivity, sustainability, and equitable benefit-sharing goals. It recognises that forests, farms, water bodies, and wildlife are parts of one interconnected landscape system that must be managed together rather than in isolation. For example, deforestation in a watershed reduces stream flow and irrigation water for downstream farmers; overgrazing removes stream bank vegetation causing siltation of rivers and reservoirs, reducing fish production; excessive pesticide use on farms pollutes streams and kills aquatic insects and fish that provide biological pest control.

Key INRM practices in Nigeria: watershed management (protecting forest cover in river catchments to regulate stream flow and maintain dry-season water for irrigation and livestock); integrated crop-livestock-tree systems (manure from livestock enriches soil for crops and trees; trees provide shade and fodder for livestock); integrated fish-crop systems (nutrient-rich pond water irrigates vegetable gardens; crop residues serve as fish feed); and community land use



planning (communities map land into agricultural zones, protected areas, and shared grazing and forest areas, reducing resource conflict and ensuring each zone is managed appropriately).

Fill in the blank: Integrated natural resource \_\_\_\_\_ (INRM) simultaneously manages land, water, forest, wildlife, and fisheries as parts of one interconnected landscape system to achieve productivity, sustainability, and equity goals.

#### **5.4.3 Policy and institutional framework**

Effective management of Nigeria's forests, fisheries, and wildlife requires strong policy and institutions. Key national policies and legislation include: National Forest Policy (2006): guidelines for sustainable forest management and NTFP development; National Fisheries and Aquaculture Policy (2015): targets for domestic fish production and aquaculture expansion; Endangered Species Act (1985): controls trade in protected wildlife species; NESREA Act (2007): regulates water quality important for fisheries and aquatic wildlife; and the National Agricultural Promotion Policy 2016-2020 (Green Alternative): includes forestry and fisheries development targets.

Key institutions: Federal Ministry of Agriculture and Rural Development (FMARD; oversees crops, livestock, fisheries, and aquaculture); Federal Ministry of Environment (FMEnv; oversees forestry, wildlife, and environmental regulation); National Park Service (NPS; manages seven national parks); Federal Department of Forestry (FDF; manages forest reserves and reforestation); Federal Department of Fisheries (regulates inland and marine fisheries); National Institute for Freshwater Fisheries Research (NIFFR, New Bussa; freshwater fisheries research and fingerling production); Forestry Research Institute of Nigeria (FRIN, Ibadan; forest research and tree seed supply); and the Nigerian Conservation Foundation (NCF; the leading biodiversity conservation NGO in Nigeria).

Fill in the blank: The Forestry Research Institute of Nigeria (FRIN), located in \_\_\_\_\_ , conducts forest research, supplies improved tree seeds, and provides technical advisory services for reforestation and sustainable forest management.



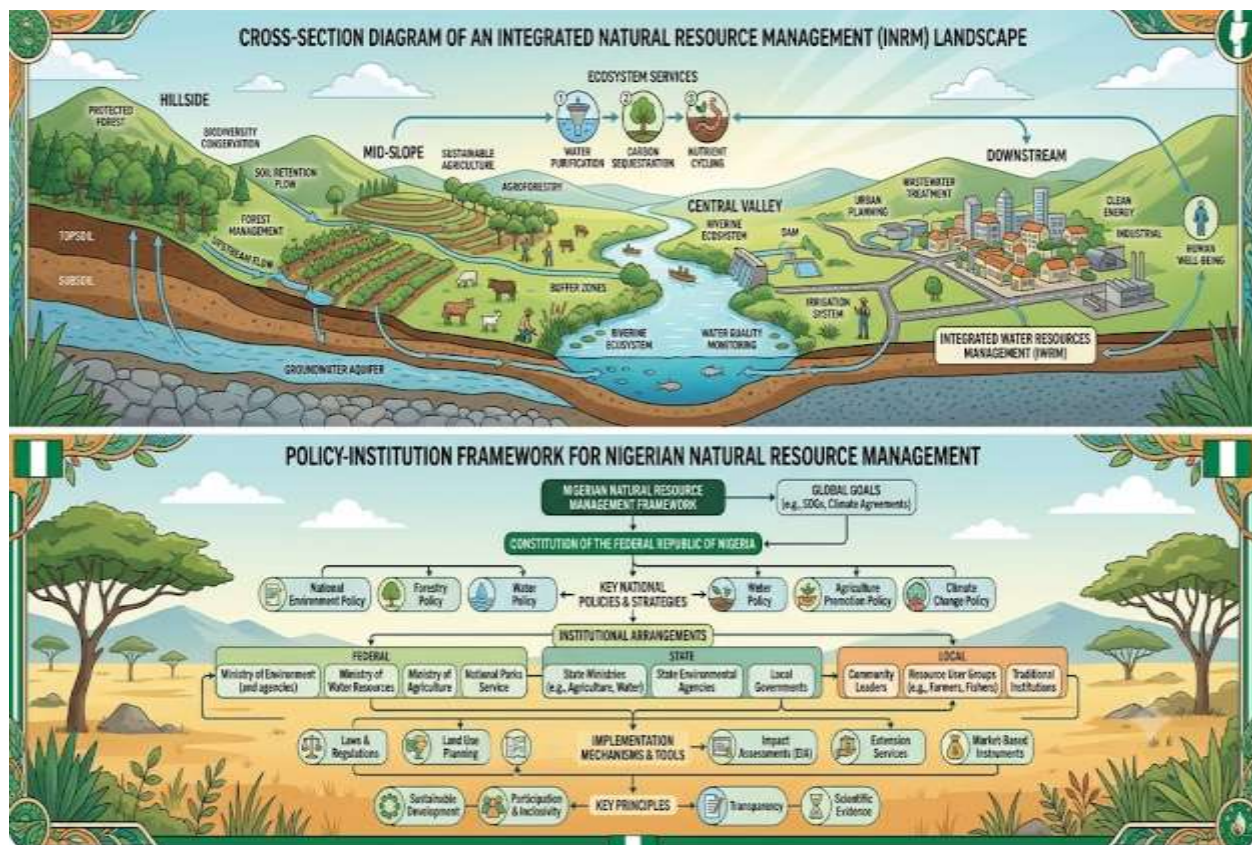


Figure 5.4: INRM landscape and institutional framework

Pilot questions 5.4

21. State four benefits of trees integrated into Nigerian farming systems.
22. Explain what INRM is and give one example of how forestry and fisheries are linked.
23. Explain why watershed management is important for Nigerian agriculture.
24. Name four institutions managing natural resources in Nigeria and state the role of each.
25. Name two international agreements relevant to Nigeria's wildlife and forest conservation.



## Series Summary

This Series covered forestry, fisheries, and wildlife resources in Nigeria. Major forest types include tropical rainforest in the south, Guinea savanna woodland in the Middle Belt, Sudan and Sahel scrub in the north, mangrove forests along the coast, and plantation forests containing species such as *Gmelina* and teak. Forests provide watershed protection, carbon storage, climate regulation, soil conservation, biodiversity, timber, fuelwood, charcoal, and non-timber products such as dawadawa, shea butter, rattan, medicinal plants, and honey. Deforestation is driven mainly by agricultural expansion, fuelwood demand, logging, and urbanisation, while conservation measures include forest reserves, reforestation, community management, and the National Forest Policy. Fisheries include marine, inland artisanal, and industrial systems, while aquaculture focuses mainly on catfish and tilapia production in earthen ponds, concrete tanks, cages, and recirculating systems. Major challenges include overfishing, pollution, climate change, and weak cold-chain facilities, while management involves closed seasons, gear regulations, fish stocking, and aquaculture development.

Wildlife supports ecosystem balance, food supply, genetic resources, tourism, medicine, and cultural heritage. Important conservation areas include Yankari, Cross River, and Gashaka Gumti, but wildlife is threatened by habitat loss, poaching, bush burning, oil pollution, and human-wildlife conflict. Conservation measures include national parks, the Endangered Species Act, CITES, zoos, gene banks, community conservation, REDD+, and public education. Trees also support farming through nitrogen fixation, shade, wind protection, fodder, fruit, timber, and pollinator habitat, especially in parkland agroforestry systems involving *Parkia*, *Vitellaria*, and baobab. Integrated natural resource management treats crops, livestock, trees, fish, soil, and water as parts of one landscape system and promotes watershed protection, community land-use planning, and integrated farming. Major institutions include FMARD, FMEnv, NPS, FDF, NIFFR, FRIN, and NCF, supported by national and international policies such as the National Forest Policy, Fisheries Policy, Endangered Species Act, CITES, CBD, and REDD+. By completing this Series, students should achieve SLOs 5.1–5.4 and all AGE 101 course outcomes.



## Glossary of Terms

- **Aquaculture:** controlled cultivation of fish and aquatic organisms in ponds, cages, or tanks; key strategy for closing Nigeria's fish supply gap.
- **Bushmeat:** meat of wild animals from forests; an important rural protein source in the Nigerian forest zone.
- **CITES:** Convention on International Trade in Endangered Species; regulates international wildlife trade; Nigeria is a signatory.
- **Closed season:** period during which fishing is prohibited to allow fish stocks to recover during breeding.
- **Deforestation:** permanent removal of forest cover; Nigeria loses approximately 350,000-400,000 ha annually.
- **Earthen pond:** the most common Nigerian aquaculture system; a pond excavated in the ground, stocked with fingerlings, fed, and harvested.
- **Ecotourism:** responsible tourism to natural areas that conserves the environment and benefits local communities.
- **Faidherbia albida:** a leguminous Sahel tree that sheds leaves in the wet season and leafs out in the dry season; fixes nitrogen; compatible with crop cultivation underneath.
- **FRIN:** Forestry Research Institute of Nigeria, Ibadan; conducts forest research and supplies tree seeds for reforestation.
- **Human-wildlife conflict:** conflict arising when wild animals damage crops or attack livestock as their natural habitat shrinks.
- **INRM:** Integrated Natural Resource Management; simultaneous management of land, water, forest, wildlife, and fisheries as one landscape system.
- **Mangrove forest:** coastal forest dominated by Rhizophora and Avicennia in the Niger Delta; critical nursery habitat for fish and shrimps.



- **NCF:** Nigerian Conservation Foundation; leading non-governmental biodiversity conservation organisation in Nigeria.
- **NIFFR:** National Institute for Freshwater Fisheries Research, New Bussa; researches inland fisheries and aquaculture; produces fingerlings.
- **NTFP:** non-timber forest product; any forest product other than timber, e.g. locust bean seeds, shea butter, rattan, honey, medicinal plants.
- **Parkland agroforestry:** traditional West African system that maintains economically valuable trees (*Parkia biglobosa*, *Vitellaria paradoxa*) among annual food crops.
- **Poaching:** illegal hunting or trapping of wildlife; threatens elephants (ivory), pangolins (scales), and great apes in Nigeria.
- **Watershed:** area of land draining rainfall into a common river or lake; protecting its vegetation regulates stream flow and water quality downstream.





## Concept Check Questions [Series 5]

### Objective Questions

1. Tropical \_\_\_\_\_ forest in southern Nigeria is the most biologically diverse forest type and contains timber species such as Iroko and Mahogany. (Linked to SLO 5.1)
2. Non-timber forest \_\_\_\_\_ (NTFPs) such as locust bean seeds, shea butter, and medicinal plants provide income and nutrition for millions of rural Nigerians. (Linked to SLO 5.1)
3. Fish supplies approximately \_\_\_\_\_ % of total animal protein in Nigeria; the country spends over 1 billion US dollars annually on fish imports. (Linked to SLO 5.2)
4. \_\_\_\_\_ (Clarias gariepinus) is the dominant aquaculture species in Nigeria; it is fast-growing, tolerates low oxygen, and has strong market demand. (Linked to SLO 5.2)
5. Nigeria has seven national \_\_\_\_\_ managed by the National Park Service; Yankari in Bauchi State is one of the most important for wildlife conservation. (Linked to SLO 5.3)

### Short-Answer Questions

1. State five ecological services provided by forests. (Linked to SLO 5.1)
2. State four causes of deforestation in Nigeria. (Linked to SLO 5.1)
3. State four threats to wildlife in Nigeria. (Linked to SLO 5.3)
4. State four benefits of integrating trees into Nigerian farming systems. (Linked to SLO 5.4)
5. Name three institutions managing natural resources in Nigeria and state the role of each. (Linked to SLO 5.4)

### Long-Answer Questions





1. Describe the types, ecological services, products, deforestation causes, and conservation measures for Nigeria's forests. (Linked to SLO 5.1)
2. Describe the importance of fisheries, the main aquaculture species and systems, and four challenges and their management. (Linked to SLO 5.2)
3. Describe the importance of wildlife, four threats, and four conservation measures; explain the role of trees in farming and the INRM approach. (Linked to SLOs 5.3, 5.4)

### Answers to Concept Check Questions [Series 5]

#### Objective Questions

1. Rainforest.
2. Products.
3. 40.
4. Catfish.
5. Parks.

#### Short-Answer Questions

1. Watershed protection, carbon sequestration, climate regulation, soil protection from erosion, biodiversity conservation.
2. Agricultural expansion, charcoal and fuelwood demand, commercial logging, urban expansion and infrastructure development.
3. Habitat loss and fragmentation, poaching and illegal hunting, human-wildlife conflict, bush burning.
4. Nitrogen fixation (Leucaena, Gliricidia, Faidherbia), shade and wind reduction, supply of fruit/fuelwood/timber, pollinator habitat.
5. NPS (manages seven national parks), NIFFR (freshwater fisheries research and fingerlings), FRIN (forest research and tree seeds).



## Long-Answer Questions

1. Forest types: tropical rainforest (south; Iroko, Mahogany); Guinea savanna woodland (middle belt); Sudan/Sahel scrub (north; Acacia); mangrove (coastal; Rhizophora); plantation forests (Gmelina, teak). Ecological services: watershed protection, carbon sequestration, climate regulation, soil protection, biodiversity conservation. Products: timber (sawlogs, poles, charcoal, fuelwood) and NTFPs (locust bean/dawadawa, shea butter, rattan, medicinal plants, honey). Deforestation: 350,000-400,000 ha/year; causes: agricultural expansion, fuelwood/charcoal demand, commercial logging, urbanisation. Conservation: forest reserves (9.6 million ha), reforestation (Gmelina, teak, Great Green Wall), community-based management, National Forest Policy 2006.
2. Importance: fish supplies ~40% of animal protein; employs ~10 million Nigerians; contributes ~4% of GDP; Nigeria imports >\$1 billion fish/year. Aquaculture species: catfish (Clarias; fast growth, hardy, accepts feed; dominant); tilapia (herbivorous; fast-growing). Production systems: earthen ponds (most common; 4-6 months to harvest; low cost); concrete tanks (urban; easier management). Challenges and management: overfishing (gear regulations; closed seasons); pollution (NESREA enforcement); climate change (fish stocking; adaptive management); poor cold chain (investment in ice plants and refrigerated transport).
3. Wildlife importance: ecological functions (predators, pollinators, decomposers, seed dispersers), bushmeat protein, genetic resources, ecotourism (Yankari, Cross River, Gashaka Gumti NPs), medicinal value, cultural heritage. Four threats: habitat loss (>90% forest gone; most critical), poaching (elephants/ivory; pangolins; great apes), human-wildlife conflict (crop raids; farmer retaliation), bush burning (destroys nesting habitat; kills small animals). Four conservation measures: national parks (seven parks; NPS), wildlife laws (Endangered Species Act 1985; CITES), ex situ conservation (zoos, gene banks), community conservation (REDD+; ecotourism benefit-sharing). Trees in farming: nitrogen fixation (Leucaena, Gliricidia, Faidherbia albida), microclimate improvement, diversified farm income (fruit, fodder, timber), pollinator habitat; parkland agroforestry (Parkia, Vitellaria, baobab). INRM: manages land, water, forest, wildlife, fisheries as one system; watershed management protects



stream flow for irrigation and fisheries; integrated crop-livestock-tree-fish resource flows reduce external inputs and waste.

## Answers to Pilot Questions [Series 5]

### Part 5.1

1. Four types and locations: (1) Tropical rainforest: south-west and south-east Nigeria; most species-rich; Iroko, Mahogany, Obeche. (2) Guinea savanna woodland: middle belt; mixed trees and grasses; Isoberlinia, Daniellia. (3) Sudan/Sahel scrub woodland: northern Nigeria; sparse trees; Acacia, Balanites. (4) Mangrove forest: coastal Niger Delta; Rhizophora and Avicennia; critical fish nursery habitat.
2. Five ecological services: (1) Watershed protection (tree roots hold soil and regulate stream flow). (2) Carbon sequestration (forests absorb and store atmospheric CO<sub>2</sub>). (3) Climate regulation (forests generate rainfall; deforested areas receive less rain). (4) Soil protection (canopy and litter reduce raindrop impact and surface erosion). (5) Biodiversity conservation (forests shelter thousands of species including wild crop relatives).
3. Timber products: derived from wood; examples: sawn timber (Iroko, Mahogany) for construction, and charcoal/fuelwood for domestic cooking energy. NTFPs: all forest products other than timber; examples: locust bean (*Parkia biglobosa*) seeds processed into dawadawa seasoning, and shea butter from *Vitellaria paradoxa* nuts used in food and cosmetics.
4. Four causes: (1) Agricultural expansion (smallholder clearing for new farmland is the leading cause). (2) Charcoal and fuelwood demand (70% of Nigerian energy consumption is biomass; millions of trees felled annually). (3) Commercial logging (selective timber extraction without replanting depletes high-value species). (4) Urban expansion and infrastructure (roads, buildings, and power lines convert forest to non-forest land).
5. Three conservation measures: (1) Forest reserves (over 1,000 reserves covering ~9.6 million ha; agriculture is prohibited and timber extraction is regulated). (2) Reforestation and afforestation (Gmelina and teak plantations on degraded land;



Great Green Wall project in northern states combating desertification). (3) Community-based forest management (local communities given management rights and benefit-sharing from adjacent forests; gives them economic incentive to protect rather than clear the forest).

## Part 5.2

1. Four reasons: (1) Protein supply (fish provides ~40% of total animal protein; the most affordable animal protein for low-income households). (2) Employment (~10 million Nigerians work in fisheries as fishermen, processors, traders, and boat builders). (3) Rural livelihoods (artisanal fishing is the primary livelihood of coastal and riparian communities). (4) Economic contribution (~4% of GDP; expanded aquaculture can reduce the annual >\$1 billion fish import bill).
2. Marine fisheries: carried out in the Atlantic Ocean and the 200 nautical mile Exclusive Economic Zone; species include croaker, bonga, mackerel, and shrimp; major fishing communities in Lagos, Bonny, Brass, and Calabar; uses motorised vessels. Artisanal inland fisheries: small-scale fishing in rivers (Niger, Benue), lakes (Lake Chad), and reservoirs (Kainji, Jebba) using canoes, traps, cast nets, and hook-and-line; the most widespread type by number of participants; vital for rural livelihoods in northern and middle belt Nigeria.
3. Catfish (*Clarias gariepinus*) dominates because: (1) it grows rapidly, reaching 1-1.5 kg within 4-6 months under good management; (2) it tolerates low dissolved oxygen levels, allowing high stocking densities; (3) it accepts pelleted artificial feed readily; (4) it reproduces easily in captivity using hormonal induction; and (5) it has strong, consistent consumer demand and commands premium prices in Nigerian markets.
4. Two systems: (1) Earthen ponds: a pond of 100-500 m<sup>2</sup> excavated in the ground; filled with water; stocked with catfish or tilapia fingerlings at 5-10 fish/m<sup>2</sup>; fish are fed floating pellets; pond is drained and harvested after 4-6 months; lowest capital cost; most common in rural and peri-urban areas. (2) Concrete tanks: rectangular or circular tanks built from blocks and cement; easier to clean and manage than earthen



ponds; used mainly in urban areas for intensive catfish production; higher capital cost.

5. Four challenges and measures: (1) Overfishing (destructive gear depletes stocks): ban dynamite, poison, and undersized mesh nets; enforce closed seasons. (2) Water pollution (oil spills and effluent destroy habitat): NESREA enforcement and site clean-up. (3) Climate change (reduced river flow affects fish distribution): fish stocking and adaptive fishing effort management. (4) Poor cold chain (fish spoils without refrigeration): invest in ice plants, cold rooms, and refrigerated vehicles at major landing sites.

### Part 5.3

1. Five reasons: (1) Ecological functions (predators regulate prey; insects pollinate crops; decomposers recycle nutrients; seed dispersers spread trees). (2) Bushmeat protein (vital protein source in forest-zone communities where domestic protein is scarce). (3) Genetic resources (wild relatives of crops and livestock carry disease resistance and drought tolerance genes). (4) Ecotourism income (national parks generate foreign exchange and community income). (5) Cultural and heritage value (animal totems, national symbols, and sacred species are important to Nigerian communities).
2. Four threats: (1) Habitat loss and fragmentation (most critical; >90% of Nigeria's original forest lost to agricultural expansion, logging, and urbanisation since 1900; isolates wildlife populations). (2) Poaching (elephants killed for ivory; pangolins trafficked for scales and meat; great apes in Cross River critically endangered). (3) Human-wildlife conflict (elephants and hippos raid farms in Kwara, Ogun, and Plateau States; farmers retaliate by killing animals). (4) Bush burning (widespread dry-season burning for hunting and land clearing destroys nesting habitats and kills small animals).
3. Four parks and key species: (1) Yankari (Bauchi): African elephant, hippopotamus, waterbuck, and baboon. (2) Cross River (Cross River): Cross River gorilla (critically endangered), drill monkey, and forest elephant. (3) Gashaka Gumti (Taraba and



- Adamawa): chimpanzee, lion, and African wild dog. (4) Kainji Lake (Niger and Kwara): waterbuck, roan antelope, kob, and Nile crocodile.
4. Two ex situ: (1) Captive breeding in zoos (Ibadan and Jos Wildlife Park maintain chimpanzees, crocodiles, and other endangered species to prevent extinction when wild populations are critically small). (2) Gene banks (seed banks preserve wild plant genetic resources for future crop breeding). Two in situ: (1) Protected areas (national parks and game reserves protect wildlife in natural habitats; core zones closed to human use). (2) Community conservation (REDD+ payments for forest/wildlife preservation; benefit-sharing from ecotourism and controlled bushmeat quotas).
  5. Human-wildlife conflict occurs when wild animals enter farmland to eat crops or attack livestock as their habitat shrinks, causing economic loss; farmers retaliate by killing the animals in response. Reduction measures: (1) buffer zones of natural habitat between protected areas and farmland reduce animal movement onto farms; (2) community compensation schemes pay farmers for verified wildlife damage, reducing the incentive to kill animals; (3) physical barriers such as beehive fences effectively deter elephants from entering farmland.

#### Part 5.4

1. Four benefits: (1) Nitrogen fixation (*Leucaena*, *Gliricidia*, *Faidherbia albida* fix atmospheric nitrogen through root nodule bacteria, reducing purchased fertiliser costs). (2) Microclimate improvement (tree canopy reduces soil temperature, evaporation, and wind speed, protecting crops and animals). (3) Supply of additional products (fruit, seeds, fodder, fuelwood, and timber diversify income and reduce external input costs). (4) Biodiversity conservation (on-farm trees provide habitat for pollinators and beneficial insects that support crop pollination and biological pest control).
2. INRM simultaneously manages land, water, forest, wildlife, and fisheries as one interconnected landscape system rather than as separate sectors. Example: deforestation in a river catchment removes vegetation that regulates water flow; rainfall runs off rapidly causing floods that destroy fish spawning habitat; in the dry



- season, reduced base flow concentrates fish and promotes overfishing; therefore, maintaining forest cover in a watershed directly protects the downstream inland fishery and irrigation water supply.
3. Watershed management is important because the vegetation cover of a watershed controls downstream water quantity and quality. When watersheds are deforested: rainfall runs off bare soil rapidly causing floods followed by dry-season low flows; erosion deposits sediment into reservoirs, reducing irrigation water storage; pesticide and fertiliser runoff contaminates rivers and kills fish. Protecting watershed vegetation through forest reserves and reforestation safeguards irrigation water for crop farmers and fish stocks for fishermen downstream.
  4. Four institutions and roles: (1) National Park Service (NPS): manages and protects the seven national parks; enforces wildlife laws; promotes ecotourism. (2) NIFFR (New Bussa): conducts freshwater fisheries and aquaculture research; produces improved catfish and tilapia fingerlings; trains fish farmers. (3) FRIN (Ibadan): conducts forest research; supplies improved tree seeds for reforestation; advises on silviculture and NTFP management. (4) Federal Department of Fisheries (FDF): regulates marine and inland fisheries; enforces gear and closed season rules; coordinates reservoir fish stocking.
  5. Two international agreements: (1) CITES (Convention on International Trade in Endangered Species): controls trade in over 35,000 species; Nigeria is a signatory; prohibits commercial trade in elephants (ivory), pangolins, and Cross River gorillas; implemented through the Endangered Species Act 1985. (2) Convention on Biological Diversity (CBD): commits member countries to conserving biodiversity, using it sustainably, and sharing benefits fairly; Nigeria has a National Biodiversity Strategy and Action Plan (NBSAP); REDD+ provides financial incentives linked to CBD for communities that preserve forests and wildlife.





### Textual References (Books and External Sources)

- FAO (Food and Agriculture Organization of the United Nations). (2025). Guidelines for sustainable agriculture. FAO.
- FRIN (Forestry Research Institute of Nigeria). (2019). Annual research report. FRIN, Ibadan.
- NIFFR (National Institute for Freshwater Fisheries Research). (2020). Annual report. NIFFR, New Bussa.
- NCF (Nigerian Conservation Foundation). (2018). State of Nigeria's biodiversity. NCF, Lagos.

### Figures, Plates, Tables, and Boxes

- Figure 5.1: Forest types and deforestation in Nigeria Attribution: AI generated. Suggested OER search string: "Nigeria forest types rainforest mangrove savanna woodland deforestation conservation reforestation OER".
- Figure 5.2: Fisheries and aquaculture in Nigeria Attribution: AI generated. Suggested OER search string: "Nigeria fisheries aquaculture catfish earthen pond tilapia Lake Chad Kainji artisanal marine OER".
- Figure 5.3: Wildlife and protected areas in Nigeria Attribution: AI generated. Suggested OER search string: "Nigeria national parks Yankari Gashaka Gumti Cross River wildlife conservation CITES OER".
- Figure 5.4: INRM landscape and institutional framework Attribution: AI generated. Suggested OER search string: "integrated natural resource management Nigeria watershed farming fisheries FMARD FRIN NIFFR OER".

