FRM 211
FORESTRY AND WILDLIFE MANAGEMENT

NATIONAL OPEN UNIVERSITY OF NIGERIA

COURSE GUIDE

FRM 211
FORESTRY AND WILDLIFE MANAGEMENT

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Introduction

Forestry is the practice and art of managing forest lands and other natural resources associated with forest lands such as trees, other plants, wildlife, soil, water, air and the climate for human benefit. In the past, our people have managed the forest for conservation and utilization purposes through rules and taboos. The setting up of sacred forest is for the purpose of conserving useful herbs, fruits and tree species, which are used for building and making canoe.

People were prohibited from clearing forest along the streams and surrounding lakes to prevent siltation and sedimentation and to allow the water bodies retain its dept. Trees were planted within compounds to ameliorate the air, prevent soil erosion and serve as wind-brakes. The art of conserving the forest for sustainable yield and harvesting the forest resources in such a manner that it will continue to regenerate itself is an inborn knowledge with our local people before now.

The course "Principles of Forestry" is a general course in forest resources management that deals with all aspect of forestry. Now that only small fractions of the original forest exist, we are faced with the problem of getting enough timber species for our building, furniture and other constructions involving wood.

In this course we shall learn how to produce seedlings of the major important tree species we cannot get in their natural environment any longer and nurture them to replanting stage. We shall also learn how to afforest the land to enable us get timber and other wood resources we can no longer get from the natural forest. Finally, the last stage of this course will talk about how we can harvest (fell) and transport the harvested timber and other wood species.

The Course

The course guide tells you briefly what to expect from reading this material. Studying forestry is like studying the changes in our natural environment. This is because if a large portion of forest is destroyed through fire or as a result of overexploitation or due to unsustainable manner of harvesting, the following changes take place; soil erosion, flooding, silting and sedimentation of streams and rivers, destruction of habitats for wildlife, which is the main source of protein to the local communities. Water and air pollution with its attendant climate changes is all due to poor management of forest and other forest resources.

Important forest trees are classified according to the various vegetation zones of the country and are further classified according to the families

these important forest trees belong. This is to further inform the reader that as you are moving from the southern to northern part of this country, the morphology of the various plant species changes. These changes are noticed in their crown cover and the length of their bole and thickness of slash.

Course Aims

The aim of this course is to introduce to the student the importance of forest and inculcate in them the attitude of conservation and sustainable harvesting of forest resources.

Course Objectives

In addition to the aims above, this course is set to achieve some objectives. After going through this course, you should be able to:

Define the concept of renewable natural resources and the manner to harvest the resources that it can regenerate for further use.

Recognize that forest trees, wildlife and herbs are renewable natural resources, which deserve conservation and sustainable utilized.

Classify the important forest trees and their distribution in different vegetation zones of the country.

Define silvicultural practices in the seed germination and nurturing to the stage of transferring to planting sites.

Explain clearly the techniques in felling and transportation of log from forest site to mills.

Working through the Course

This course requires you to spend some of your time to read and understand. The content is condensed and requires you to spend great time to study. I will advice that you avail yourself the opportunity of attending tutorial sessions where you will have the chance of comparing knowledge with your peers.

Course Material

You will be provided with the following materials:

- Course Guide
- Study Unit.

In addition, the course comes with a list of recommended textbooks which though not compulsory for you to buy, but indeed are necessary to supplement the course materials.

Study Units

The study units contained in this course are as follows:

Module 1

Unit 1 Renewable Natural Resources
Unit 2 Forest as Renewable Natural Resources
Unit 3 Classification, Morphology and Distribution of Important Forest Trees
Unit 4 Forests and Game Reserves in Nigeria
Unit 5 Silviculture: Seedling Production

Module 2

Unit 1 Treatment
Unit 2 Seed Germination
Unit 3 Seed Management
Unit 4 Protective Afforestation
Unit 5 Logging and Transportation

Module 3

Unit 1 Principles of Wildlife Management
Unit 2 Animal Behaviour
Unit 3 Wildlife Damage Problems
Unit 4 Wildlife Conservation
Unit 5 Methods of Wildlife Conservation

Textbooks and References

Danids, T. W. Helms, J.A. and Baker, F.S. (1979). *Principles of Silviculture*. McGraw. Hill, Inc.

Evans, J. (1992). *Plantation Forestry in the Tropics*. (2nd Edition). New York: Oxford Uni. Press.

Matthews, J. (1994). *Silvicultural System*. New York: Oxford University Press.

Usman, S.S. Savanna. (2007). Makurdi: Maxson Press.

Whitmore, T.C. *Tropical Rainforest*. New York: .Oxford University Press. Inc.

Assessment

There are two components of assessment for the course. The Tutor-Marked Assignment (TMA) and the end of course examination.

Tutor-Marked Assignment

This is the continuous assessment component of the course. It will accounts for 30% of the total score. You will be given 4 TMAs to answer. Three of these must be answered before you are allowed to sit for the end of course examination. The TMA's would be given to you by your facilitator and returned after you have done the assignment

End of Semester Examination

This examination concludes the assessment for the course. It constitutes 70% of the whole course. You will be informed of the time for the examination.

Summary

This course is intended to provide you with some basic knowledge of forestry by the time you complete studying this course, you will be able to answer the following type of questions.

- What are renewable natural resources?
- What are the importance of forest to man.
- Briefly review the potentials derived from the forest.
- Describe the five storey of the rain forest.
- Classify five important forest trees on the bases of family and species.
- List five each of the following items
  Game reserves
  Forest reserves
  National Parks
- Define seed dormancy and describe briefly two causes of seed dormancy

- Describe how temperature, day length and water affect seed germination.
- Describe the basic steps in felling a tree.

I wish you success in this course
I hope you enjoy the course
Best wishes

MAIN COURSE

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MODULE 1

UNIT 1 RENEWABLE NATURAL RESOURCES

CONTENTS

1.0 INTRODUCTION

The main purposes for which forests are cleared are agriculture, wood production, industrial layout and human settlement. The conversion of natural forest to pasture is widespread in the tropics, where there is a long tradition of cattle husbandry. Once roads were built, the larger trees were felled and pastoralists completed the destruction. Along with the trees, most of the wild animals in the forest have become endangered or extinct.

Mining activities has immensely contributed to the destruction of the forest. These are observed on the Jos, Enugu Coal mine, oil exploration and to a larger extent, dam construction.

Felling wood for industrial production (industrial timber, fuel wood) pulp and paper production has impacted greatly to unsustainable utilization of the forest. Setting up of new human settlement involves cutting down of large hectares of forest land. These are hardly replaced

by plantation. Such new cities we have in Nigeria is Abuja and the ever expanding towns like Lagos, Ibadan, Kaduna and Kano. There is widespread concern about the present day human interference with the forests. The consequences are also diverse. They fall into three main groups; effect on climate, biodiversity, and human societies.

Tropical rain forests and the Savanna which seemed limitless in the past are becoming increasingly fragmented. Conservation movement has begun to force a broader vision; a return to a former wider view of both the tropical rain forest and the Savanna, by exerting democratic pressure on aid agencies NGOs and National Agencies to start a change of attitude of the people towards the forest.

2.0OBJECTIVES

At the end of this unit you should be able to:

- define what renewable natural resources are
- describe the importance of forest to the environment
- list the causes of climate changes and its effect on the environment.

3.0 MAIN CONTENT

3.1 What are Renewable Natural Resources

Renewable natural resources are the living biological resources which can reproduce or regenerate itself after harvesting. Good examples are the forest wildlife and fishes. All renewable natural resources can continue to reproduce and regenerate their population as long as environmental conditions remain favourable and an adequate seed source or breeding stock is maintained. They can all be harvested without diminishing their supply provided that harvesting does not exceed their reproduction or growth rate. It does, the resources will be depleted and if it continuously exceeds the rate of replacement or growth, the resource ceases to be renewable and the species involved are reduced to the point of extinction. Over exploitation of our natural resources such as timber from the forest, wildlife from our resources and fishes from our lakes has now led to shortages of these resources in our natural forest. We shall now discuss briefly, the importance of forest and its impact on our environment.

3.1 The Importance of Forest to the Environment

a. It is the habitat where wild animals live and feed.
b. It serves to conserve our water supply.

c. It is used for recreation, such as camping, fishing and hunting.
d. It helps to prevent our environment from desertification and erosion by wind and water.
e. It is a home for herbs used as food and medicine.
f. Its helps to replenish lost nutrients from the soil.
g. It is a home for trees which provides:

- timber for construction
- pulp for paper making
- wood for energy
- sticks for staking agricultural crops
- poles for electrical wires

h. It provides vegetable for consumption e.g *Pterocarpus spp*.
i. It provides fruits for food and condiments e.g *Irvirgia gabonensis* and *Prosopis africana*
j. Provides extractives for use as drugs, tannin for curing, leather and exudates for gum production.

3.2 Impact of Forest on the Environment

The constituents of a good environment are soil, water, air and climate

Soil

Plants grow on the soil from where they derive nutrient and support and in-turn stabilize the soil. Surface run-off under forest covers is prevented so that the forest is not degraded. If vegetation cover is removed, the soil is exposed to direct impact of wind and rain drops. This can break up the fragile soil and the fertile top soil gets washed away in the fast surface run-off, resulting in erosion. The litter of dried and decaying leaves also forms the carpet to protect the soil from being washed off.

Water

Under forest cover, watershed is protected, under ground water flow is regulated and sedimentation of reservoir and siltation of streams and lakes are prevented. When the leaves of the tree drop rainwater falls on the leaf litters, giving it time to seep under ground.

Air

Photosynthetic activities of the plants in the forest purify the air through the release of oxygen. Through transpiration, water vapour is constantly released to the surrounding air of the tree crown. As the wind blows pass

the foliage of the tree, it carries the moisture, which provides pleasant cooling effect to the environment.

Climate

One issue on which forest destruction focuses is the changes that might occur to local, regional, or global climate. Although the increasing loss of forest covers is a global problem; African countries significantly contribute to this problem. For instance, the % land area of Nigeria under forest had dropped by 5% by 1996 from 37% of 1976; a period of 20 years. Deforestation is taking place at 3.5% per annum. Ironically, desert land now covers about 35% of the country land mass and it is advancing at the rate 0.7km per annum on the average. Specifically, the desert belt has moved from latitude 12 ^{o}30'N (ie Kebbi, Kano, and Maiduguri) to 10 ^{0}30'N (New Bussa, Jos and Shelleng) (UNSN, Nigeria 2001). UNSN=United Nation System in Nigeria. The Savanna interface which is between the desert and forest belt is now along Oyo, Osun, Kogi, Enugu, Ebonyi and Benue State; an area which use to be in the thick of rain forest.

Government estimates suggests that about N11.25 billion are needed to halt the desertification process; which is fuelled by:

- overgrazing
- excessive logging
- bush clearing and burning
- non-stop fuel wood harvesting
- wetland drainage

3.3 Global Evidence of Climate Change

The global mean surface temperature for 2002 was expected to be approximately 0.5 ^{0}C, above the 1961-1990 annual mean value (WMO; 2000: World Meteorological Organization). The rise in global average surface temperature since 1910 now exceed 0.6 ^{0}C

i. Regional Temperature and Rain Fall Patterns

El Nino condition returned to the tropical Pacific in 2002. Characteristic sea surface and sea level pressure patterns became well established. Land and sea surface became warmer. Climate anomalies across Western and Southwest Pacific moved from drier condition, before may 2002 to wetter than normal. For instance, Tanzania and Kenya reported heavy rainfall in January to March of 2002. Heavy rainfall was also reported in Uganda in October- November of the same year. However, Ethiopia experienced general failure of rains from June-September of

2002. Sweden experienced the warmest weather in September of 2002 since the experience of 1860. Central Europe experienced the worst flooding ever, with many deaths. Germany alone lost over US 9 billion to flooding.

ii. Drought in Many Regions

India recorded the lowest rainfall in the June-September monsoon summer rain of 2002. Most of West African Countries received only 25% of their normal rainfall. The horn of Africa experienced the worst drought in 2002.

3.4 The Reality of Climate Change

- thunderstorms
- lightening
- landslides
- flooding
- drought
- bushfire
- unpredictable rainfall pattern
- sea level rise
- desert encroachment
- loss of forest cover
- lost of biodiversity

3.5 Evidence of Climate Change in Nigeria

i. Increase Surface Air Temperature

Meteorological data on surface air temperature for Kano, Calabar and Lagos shows increase since 1920. Increase of 0.25 ^{0}C for Calabar and Kano and an increase of between 0.25 C to 0.5 C has been reported for Lagos (UNSN 2001) UNSN = United Nation System in Nigeria. *In: Nigeria Common Country Assessment*. This has affected rainfall patterns coupled with extreme weather events.

ii. Sea Level Rise

Greenhouse gas (GHG) emissions also indicated that surface temperature increase in Nigeria has good correlation with GHG emissions. Sea level rise, result to coastal erosion, flooding, salt water intrusion, mangrove degradation and other related socio-economic problems. Estimated land loss due to these seas level rise measures are:

- present 0.2m = 3,400m^2

- Future 1m = 18,400m^2 i.e. in the next 50 to 100 years time.

iii. Reduced Agricultural Productivity

It is in the area of reduced agricultural productivity that human being has had the most severe impact of climate change. Local farmers can no longer predict incidence of rainfall based on past observation. Incidences of drought in many parts of the country decreases water availability to crops leading to severe yield reduction.

iv. Loss of Forest Resources

Nigeria forest area has been on the decrease. It has diminished from about 60 million hectares in 1890 to the current value of about 9.6 million hectares. Current annual loss is about 300,000 hectares per annum. This is fuelled by the increasing loss of forest cover.

4.0 CONCLUSION

Renewable natural resources are those resources when harvested in sustainable manner can continue to reproduce or regenerate itself for further use. Good examples of these resources that we have discussed in this unit are forest trees, shrubs, herbs vegetable and wildlife resources.

5.0 SUMMARY

In this unit we have learnt that:

- Renewable natural resources are mainly forest, wildlife and fish resources.
- The importance of forest to the environment as it stabilizes the soil by preventing surface run-off which may result to gully erosion; protect watershed and prevent our streams and lakes from silting up. It also purifies the air through photosynthesis when oxygen is release to the atmosphere.
- We have also learnt that when forest is not properly managed, it brings about both regional and local climate changes. This is seen in the areas of flooding, drought, desert encroachment, increase in surface temperature and poor agricultural productivity.

6.0 TUTOR-MARKED ASSIGNMENT

1 a. What is renewable natural resources?
b. List 8 importance of forest to the environment.

2. Explain with examples two evidences of climatic changes in Nigeria.

7.0 REFERENCES/FURTHER READINGS

Ezealor A.U. (2002). *Critical Sites for Biodiversity Conservation in Nigeria* (editor) Lagos, Nigeria.

Ogogo A.U. (2004). *Wildlife Management in Nigeria.* Calabar Nigeria: Median Communication.

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UNIT 2 FOREST AS A RENEWABLE NATURAL RESOURCES

CONTENTS

1.0 INTRODUCTION

A forest consists of trees, shrubs, herbs, climbers, creepers and grasses, in association with soil, water and air. Renewable ones are trees, shrubs, herbs, climbers, creepers and grasses. This is because they can regenerate/reproduce after harvesting.

2.0 OBJECTIVES

By the end of this unit, the student should be able to:

- explain why we say forest is renewable natural resources
- explain the depletion of available land under forest reserves and why forest trees and wildlife are diminishing
- identify the vegetation pattern of the country, the amount of rainfall and length of dim season in each vegetation zone
- state the potentials of forest trees, herbs, and wildlife resources to mankind.

3.0 MAIN CONTENT

3.1 Availability of Forest Resources in Nigeria

Nigeria land area is 99 million hectares. Out of this, only 10% is under forest reserve. It is sad to note that the land under forest reserve has been decreasing steadily since 1979. In Ondo state, 107.36km^2 of forest in Ore has been converted to causal land. In Kano State, 70km^2 of forest land has been cleared for a Dam project (Tiga Dam) while in Kogi State

183.89km^2 of forest land in Ajaokuta has been used for the establishment of the steel complex.

Tree species and herbs have been depleted or wiped out completely as a result of indiscriminate state government policies as well as reaction to economic, social and political tensions from the ever increasing urban population.

Deforestation in Nigeria has been estimated at 14000km^2 between 1979 and 1995 (FORMECU, 1990) i.e. 823.5km^2 per annum for the said period. It is probable that the current rate of deforestation will be much higher. Deforestation is caused by illegal felling, farming and other physical developments such as industrial and other infrastructural development. Natives, who have lost their land to government, set fire to forest estate, as a result, wildlife species are being wiped out completely due to modified or lost habitat. Certain tree species are becoming endangered e.g. Iroko and Mahogany which have been exported for many years and were obtained from the natural forest. These groups of trees are difficult to grow in plantations due to pest problems causing canker. The insects attack the growing part of these trees in the early period of growth.

3.1 Distribution of Forest Resources in Nigeria

There are distinctive ecological zones in Nigeria, corresponding to a rapid decline in total annual rainfall and duration of wet season from the south to the north. This result in the moist tropical rainfall, including a sizeable component of freshwater and mangrove swamps in the south.

The rainforest is characterized by a great variety of trees which occur in several layers and abundance of creepers, climbers and herbs. The trees are predominantly evergreen with deciduous trees on the margin. Grasses are virtually absent in the rainforest. The mangrove vegetation is commonly found in the Creeks near the sea, while the rainforest is found mainly at Akwa Ibom, Cross River, Edo and part of Ondo, Ogun, Ekiti, Oyo and Osun States.

Table 1:2 Showing climatic condition of each vegetation zone.

Vegetation zone	Mean annual Rainfall	Duration of Dry season
Sahel	250 -500mm	7-8 months
Sudan	500 -1140mm	5-7 months
Northern Guinea Savanna	1070-1270mm	5-6 months
Southern Guinea Savanna	1140-1520mm	4-5 months
Derived Savanna	1140-1770mm	3-4 months
Forest zone	2780-4000mm	3 months

Further more, the forest declines into Savanna of steady drier nature as they reach into the arid zone beyond latitude 12 ^{0}N. The Sahel Northern Guinea Savanna, Southern Guinea Savanna and Derived Savanna are all grouped under Savanna region; typified by woodland vegetation, in which herb layer is dominated by grass; and with scattered trees. The trees are usually small with twisted boles owing to frequent burning. They have thick bark to enable them withstand fire. The trees are rarely close enough for their crown to touch and usually one layer is formed and consisting of shrubs only.

The Savanna zone covers about 80% of Nigeria land area and is found around Taraba, Adamawa, Kaduna, Kwara, Kogi, Nasarawa and Benue, while the arid north is found around Sokoto, Kebbi, Kano, Katsina, Yobe and Borno States. Sometimes, patches of high forest are found growing near streams and other wet places in the Savanna and are called fringing forest or riparian.

In between these two major zones is the transitional forest zone or the derived Savanna likely to have been degraded from the rainforest. This type of vegetation is commonly found in parts of Anambra, Enugu, parts of Kogi and Benue states.

3.2 Potentials of Forest Resources in Nigeria

The southern forest has the largest potential for timber production. Forest potentials in the northern areas ranges from extensive dry land plantation development to community based forestry, to prevent erosion and stabilize the fragile soil against desert encroachment. In the Savanna and semi-arid areas, livelihood in most places depends on forest for food, vegetable oil, resin, fodder and fuel-wood for domestic energy. Farm residues left on the farm (e.g. maize and rice stocks) after harvest are for the purpose of providing shelter and fodder for livestock as well as protect the soil from wind and water erosion.

The shelterbelt programmes of various forest services of the country are intended primarily to stabilize the loose soil by reducing wind erosion and desert encroachment.

The following are the specific potentials derived from the forest.

i. Fuel Wood

Trees provide the wood resources of the forest. About 80% of the wood produced from the forest in Nigeria is utilized as combustion fuel. Generally wood is the main domestic fuel in developing countries. It is used in cooking meals, heat and lights the house, cure tobacco, smoke

fish, bake bread, used in industrial boilers, for pottery and other craft work. Planting and protecting fuel wood species around the village may go a long way in satisfying the demand for fuel in rural area.

ii. Timber Resources

About 80% of the wood extracted from the forest in developed countries are used industrially. Wood is the basis of raw materials for all the 10 (ten) wood based industries identified by the Raw Materials. Research and Development Council in 1988. The industries include sawmills, plywood and particle board, poles, match, tooth-pick, furniture, veneer, pencil and ruler, flush door and the pulp and paper industry. This has an installed capacity of 8,831, 750cm ^{3}. Nigeria at the same time had 14.9 million hectares of land carrying about 305 million cubic metres of wood. Only 42 million m ^{3} were obtained from plantations while the rest came from the natural forest.

The Savanna zone produces a little amount of utilizable wood from the short bole and small dimensional wood species. The net stock of utilizable wood in Nigeria is estimated at 214 million cubic metres (Mm ^{3}), made up of 172Mm^3 from the forest and 42Mm^3 from plantations. One immediately gets impression of self sufficiency if this figure is composed with the installed capacity.

However, this is not true because the uses to which some of these species can be put are not yet known. Moreover, comparing with a population figure of over a hundred million, at an average consumption rate of 0.15Mm^3 per head per annum.

$$\text{Annual total requirement} = 0.15\text{Mm}^3 \times 100 \text{ million}$$
$$= 15 \text{ million m}^3.$$

With 172 million m^3 of the net stock from the natural forest, of which Savanna contributes a little; then dividing 214 Mm^3 by the annual requirement of 15Mm^3 gives 14. This in essence means that the utilizable natural forest will last for 14 years. This state of affair should be viewed seriously because timber species from the natural forest takes about 35-40 years to mature. To stem this renewable shortage, the country should accelerate the establishment of forest plantations which are more productive than depending on natural forest.

iii. Pulp Wood Production

This is one of the potentials derived from the forest. Nigeria has three functional pulpwood based industries. These are:

i. Nigeria Paper Mill Jebba
ii. Newsprint Manufacturing Company Akwa Ibom
iii. Iwopin Paper Mill in Ogun State.

The Savanna hard wood species are currently used for the production of short fibre pulp in Nigeria paper Mill in Jebba. One particular species *Sterculia setigera* was observed to have varied good pulping properties and grows very well on plantations and it is a fast grower. Bamboo *Bumbusa vulgaris*, the wooden plant commonly found growing in the dry forest and dry Savanna zones of the country is also used for production of long fibre pulp. Bamboo is generally used in India for pulping; the quantity of Bamboo available in the country has not been ascertained.

Its silviculture is being studied at the Forest Research Institute of Nigeria, Ibadan, for large scale production. Pines (long fibre) and Gmelina (short fibre) are the recognised species for pulpwood production in Nigeria. Gmelina is easy to grow and the World Bank has financed several afforestation projects in Nigeria leading to seemingly Gmelina glut. Pines however are difficult to grow, coupled with the problem of seed production which has called for intensive investigation.

3.3 Other Non-Wood Produce

The following are non-wood products obtained from the forest.

i. Fruits

Species used includes pear *Dacripids edulis*, African bread fruit *Treculia africana* and African star apple *Gysophyllum albidium*.

ii. Tarnin

Tarnin extracted from *Acacia* species e.g. *Acacia nilotica* is used in leather tannery, while tarnin extracted from the bark of mangrove trees are used as a substitute in phenol type adhesive.

iii. Gum

Gum is produced by a shruby plant *Acacia senegal*, *Acacia seyel* and *Acacia albida* which occur in the Sahel and Sudan vegetation region of the country. Gum is an important export item in Nigeria, as Nigeria supply 10% of the World demand.

iv. Condiments

The Nigerian housewife continues to obtain her condiments from the forest. Such condiments are *Irvingia gabonensis* (ogbone), *Parkia biglobosa*, *Prosopis africana* and *Tetarplura tetrapetera*. Many others of such condiments exist from one locality to another all over the country.

v. Dye

Extracts from the whole shrub of *Lachocarpus cyanancis* is used for dying clothes e.g Adire and chado.

vi. Fats

Sheabuter, being the most popular is obtained from *Butyrospermum paradoxa*. This is an export produce. Nigeria produces about 10% of the World demand.

vii. Medicine

Herbal medicine stock are abound everywhere in the country.

3.4 Herbs as Renewable Natural Resources

Herbs also produce fruits for food, medicine and wrapping leaves. More important herbs are protein sweetness, which include miracle berry and katenfe. Miracle berry produce miraculin which itself is not a sweetner but makes bitter substances sweet if taken before such substances. Sometime sweeter than sugar. It is very safe for diabetic patient.

Katenfe produces thanmatim which is about 300 times sweeter than table sugar It is a rainforest herb found in Sierra Leone. Other herbs of importance are wrapping leaves *Sarcophyrium brachystachys* for wrapping *Gnetum africana* (Afang- Efik or Okazi-Igbo); and *Piper guinensis* used as condiments.

3.5 Wildlife as a Renewable Natural Resources

Wildlife is an important source of protein in Nigeria constituting about 20% of the mean annual consumption of protein in the southern part of the country. It constitutes 60% of an annual protein consumption in Botswana and 65% in Ghana.

Guinea fowl, the African giant snail and the shaggy rat are some of the wildlife delicacies found in our restaurants. Wildlife and freshwater

fisheries can be developed with little capital to boost protein production within a short time. Management of wildlife has been in game reserves and it is relatively recent. Nigeria has seven National Parks (Lake Chad, Cross River, Old Oyo, Kamuku, Okomu, Gashaka Gumti and Kainji Lake National Park), in addition to several game reserves located in various part of the country. When these reserves are protected from illegal hunting, there will be rapid increase in the number of some of the mammals like, Duikers, water buck, Buffalo, Bush buck and cane rats. The cane rat (grasscutter) which is a popular bush meat has been domesticated, and there is rapid production of this particular wildlife in many farms in the country.

4.0 CONCLUSION

Forest and wildlife are renewable natural resources and their continuous existence and utilization for our benefit will depend on their conservation and sustainable harvesting.

5.0 SUMMARY

- In this unit we have learnt about the available forest land and what is making it to decrease.
- Various vegetation zones and their mean annual rainfall.
- About the potentials of the forest in terms of the production of timber, fuel wood, pulp and other non-wood forest product.
- Wildlife as a sources of protein to the teaming rural dwellers

6.0 TUTOR-MARKED ASSIGNMENT

1 Review some specific potential that could be derived from the forest
2. Briefly explain the distribution of forest resources in the ecological zones of Nigeria
3. State the non wood resources of Nigerian forest

7.0 REFERENCES/FURTHER READINGS

Ezealor, A. U., (2002). *Critical Sites for Biodiversity conservation in Nigeria*.

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UNIT 3 CLASSIFICATION, MORPHOLOGY AND DISTRIBUTION OF IMPORTANT FOREST TREES

CONTENTS

1.0 INTRODUCTION

This unit deals with classification, morphology and distribution of important forest trees. The features of the trees used for this classification are the crown, sometimes referred to as the canopy. The crown is made up of branches, twigs, leaves, flowers, fruits and seeds. The trunk (stem) is another external feature used for classification. The trunk is the portion of the tree used for timber, pole and pulp. The outer covering of the trunk is called the bark. When the bark is cut with a sharp machete to remove a piece of it, the wound left is called slash. In some species the slash appear dry while in other some juice exudes, which could be milky, watery, blood like or even gummy. The colour of the slash and the type of juice it produces is another feature for classification.

2.0 OBJECTIVES

At the end of this unit the student should be able to:

- explain that forest trees can be classified on the basis of vegetation where they are found or based on their families
- indicate that there are five storeys or strata the rain forest, and each storey has a distinctive characteristic

- explain that the absence of grasses in rain forest is due to heavy canopy which prevent the sunlight from penetrating to ground level
- indicate that forest trees are attached to particular vegetation, though some species may occur in the different vegetation but exhibiting different morphology
- identify that the savanna covers about 86% of the country's land area, the canopy are not touching each other
- list the important forest trees that are used for timber in the country.

3.0 MAIN CONTENT

3.1 Types of Vegetation in Nigeria

Forest trees could be classified on the basis of the vegetation types they are found or based on their families and species. The following classification, distribution and morphology is based on vegetation type.

Table 1:3 Vegetation types in relation to the total area in Nigeria.

Vegetation Type	Land area (%)	Land area km^2
Mangrove forest	1	12,783
Freshwater swamp	3	25,563
Tropical Rainforest	10	95,566
Derived Savanna	8	75,786
Guinea Savanna	40	400,158
Sudan Savanna	35	342,156
Sahel	3	31,453

Source: Fed. Dept. Forestry 1994

i. The Mangrove or Salt Water Swamp Forest

This is a coastal vegetation which is often flooded by water from the Atlantic Ocean. There are many Creeks, lagoons, rivers and streams and it occupied about 1% of the Nigerian landmass. Prominent mangrove trees are *Rhizophora racemosa* which could grow to about 30m high. Trees here have well developed props for stability.

ii. Fresh Water Swamp or Raphia Swamp

A notable feature of this forest is the presence of raphia palms *Raphia vinifera* and *Raphia hookeri*. Wine tapped from there *Raphias* are distilled into 'ogogoro'. The stems are sawn into planks for roofing while the leaves and fronds are used for making mat, baskets, roofing and brooms. This forest covers about 3% of the country's land mass.

iii. Tropical Rain forest or Lowland Rain Forest.

The most complex vegetation with the highest number of plant species per unit area. A multistorey structure with most tree growing above 40 metres. The vegetation is dominated by woody trees to the exclusion of grasses. Grasses are shade intolerant, and cease to grow under such tall vegetation with heavy total canopy. Another feature of the rain forest is the presence of lianas, climbers, twiners, stranglers scramblers and epiphytes which makes movement almost impossible. It covers 10% of Nigeria's land mass. The rain forest is very important for the supply of timber for construction and joinery.

Among the valuable species are:
Milicia excelsa (Iroko)
Triplochiton scleroxylon (obeche or white wood)
Lovoa triechilioides (African walnut)
Terminalia superba (white Afana)
Khaya ivoensis (African Mahogany)
Entandrophragma cylindricum (Sapele wood
Sarcocephalus diderrichi (opepe)
Diospyros ebenum (Ebony)
Hallea stipulosa (Abura
Mansonia altissima (mansonia)
Lophira alata (Ekki)

iv. Five Storeys or Strata of the Rain Forest are of Botanical Interest and We are Going to Discuss Them

Storey A: Members of this stratum are the tallest in the vegetation and are referred to as the emergent as they shoot out above the general level of the forest. They are scattered here and there so that their crowns are not in lateral contact. The stems are usually buttressed for extra stability. The stem/bole/trunk is clean of branches except towards the upper canopy. This is why several logs can be cut from one stem and sawn into planks. The leaves are simple. Threes in this stratum include *Milicia excelsa Antiaris africana, Triplochiton scleroxylon Terminalia superba and Ceiba petandra*; and their crowns are umbrella shaped.

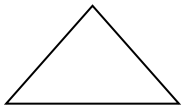
Storey B: Some features of storey A are shown in this stratum; for instance, they have buttress roots and their crowns are restricted to the canopy. But their crowns make lateral contact with each other. They therefore form the upper canopy of the rainforest. Their crowns are roundish and is often referred to as iso-diametic. Examples includes *Sarcocephalus diderrichi, Diospyro ebenum, Hallea stipulosa* and *khaya grandifoliola*

Fig. 1.3 showing different tree crowns.

Storey A crown
Umbrella shape

Storey B Crown
Spherical shape

Storey C: Trees of this storey are not buttressed. They have short boles. Their crowns are deeper and conical in shape and they form the lower canopy of the rainforest. They produce flower and fruit directly on the stem. Examples *are Irvingia gabonensis, Celtis zenkeri and Myrianthus arboreus.*



Storey C Crown
Conical shape

Storey D: This stratum is made up of plants of the size of a walking stick shooting out here and there and making movement in the rainforest almost impossible. Most are saplings of the members of storeys A, B and C, suppressed by the heavy shade strata A, B, and C. They will shoot out where gap is created in the canopy

Storey E: This is the ground flora of the rain forest, though grasses do not occur. Examples of herbs in this stratum are; *Pavetta corymbosa, Colocasia scandens*, orchids and Aroids. The rain forest is being destroyed at an alarming rate. This is due to logging, shifting cultivation, large urban settlement and fire wood gathering are among the factors that have contributed to the destruction of this vegetation.

v. The Derived Savanna

It shows that this forest is derived from something else. It is derived from the tropical rain forest, which we just discussed above. Here, remnants of forest species and the Savanna species co-exist side by side. As a result of the arrival of Savanna species, especially grassy materials, which are highly inflammable in dry season, bush burning has become a major factors in this vegetation. Due to shifting cultivation, excessive logging, excessive grazing and fire wood gathering have decimated the northern part of the rain forest and savanna have extended into the rain forest from Guinea Savanna. The Derived Savanna occupies about 8% of the country's land mass. Some rain forest species such as *Iruingia gabonensis* are found in the derived Savanna, Savanna trees and shrubs

scattered here and there. They include *Daniellia olliveri, Prosopis africana* (Red mortar wood) *Parkia biglobosa* locust bean plant), khaya *senegalensis* (Dry zone Mahogany), Dialium guineense (velvet Tamarind), *Syzygium guineense kerosine* wood), *Lophira lanceolata* (Red iron wood), and *Vitex doniana* (Black plum).

Grasses and grassy materials make a continuous cover of Savanna land. Most of the grasses are perennial and could grow to a height of about 3 metres. They include *Hyparrhenia involucruta Andropogon gayanus Loudetia flavida, pennisetum Punpureum, Panicum unerimum Pe*nnisetum *unisetum* and *Digitaria hirizontalis* and a host of others.

There are several forbs interspersed among the grasses. These are *Tridax procubens Sesbania sudanica, Eupherbia hirta* (the so called Asterna weed), *Ipomoea biloba Mimosa pundica* and so many other species.

vi. The Guinea Savanna

The largest vegetation zone in Nigeria covering about 40% of the surface area. The splitting of the Guinea Savanna into Southern and Northern Guinea Savanna was based primarily on physiognomy or structure and secondarily on taxonomic groupings. Another factor was based on the amount of rainfall on both sides of this vegetation zone. Thickly wooded vegetation and tall grasses reaching up to 2.5 m is noticed. The crown of trees are in lateral contacts here and there, but as one move to the Northern part of Guinea Savanna, the vegetation become less dense and are scattered. Trees in gallery forest and flooded plains (Fadama) have crowns that touch each other laterally. Tree species in the southern guinea Savanna which are of Timber qualities includes *Daniellia oliveri* Other trees of importance will include syzygium guineense, *Prosopis africana*, *Vitellaria paradoxia*, *Parkia biglobosa*, *Lophira lanceolata Vitex doniana* and *khaya senegalensis*. Trees common to the northern guinea Savanna include *Isoberlina doka, Isoberlina tomentosa Vitelleria paradoxia Terminalia avicennoides,* and *Afzelia africna* and a host of others.

Tall perennial grasses are also found in this vegetation zone, but most of the grasses cannot be grazed by livestock and wildlife except only at flushing stages because matured grasses store pectin, cyanide and silica which makes the grasses coarse and unpalatable.

vii. Sudan and Savanna

This vegetation covers about 35% of the surface area of Nigeria. Generally, the number of woody species per area decreases North-wards.
The trees are short with multiple stems arising and underground rootstocks, branching very close to the ground surface. Grasses are short except in fadamas or in gallery forest. Woody trees found here are not of any timber qualities. They include: *Parkia biglobosa*, *Adansonia digitata Acacia albida*, *Vitellaria paradoxia*, *Balantese megyptica* , *Guiera senegacensis* and *Piliostigma reticulatum*

viii. The Sahel Vegetation

The Sahelian vegetation has short woody species, around which are clusters of herbaceous materials which form thickets here and there. The lands between are either bare soils or sand dunes, and as such does not support trees of reasonable boles. Plants have develop several strategies to cope with the high evapotranspiration rate. Such strategies are reduced leaf size, reduction in the number of stomata, sunken stomata with hairs to help conserve water from escaping through the stomata, extensive rooting system to enable the plant absorb all available water, storage of water in the stem, for instance in *Adansonia digitata,* that have hollow stem for storing water and development of multiple epidermis and presence of thick cuticles. The Sahel is restricted to the North-east corner of the country and covers about 3% of the surface land area. The woody species are trees like *Adansonia digitata, Anogeissus leiocarpus, Balanites aegyptica, Acacia hookii, Monotes kerstingii* and *Borassus aethipum*

3.2 Classification, Morphology and Distribution of some Important Forest Trees Based on the Families and Species

3.2.1 Family *Meliaceae*

a. Genus *Kaya*

This is the genus of African mahogany easily recognized by the round and woody bole. The flat seed winged at the edge are also quite diagnostic. The bark is bitter and often cut for medicinal use.

Khaya Ivorensis

This is the well known Lagos Mahogany and it is the species of khaya most exported from Nigeria. It occurs in the most rain forest where it is recognised by its dark bark. It produces first class mahogany. Yoruba

(oganwo), Bini (ogwango); Ibo (Ono). Habitat: Low land rain forest extending from Ivory Coast to Gabon.

Tree could grow to 120 metre high and 5-10 metre girth, with strong buttress roots. Bark scaly, grey or reddish brown and sometimes dark brown. The crown is rather open with the leaves crowded at the ends of the branches. The leaves have between 4-7 pairs of leaflets and flowers between September to December or between February to May.

b. Genus *Entandrophragma*

This is another genus of the family *MELIACEAE*. This genus is represented by four species in Nigeria, all yielding mahogany and the finest of the timber is Sapele wood.

Entandrophragma Cylindricum

This is one of the Nigeria's largest and finest tree; producing the well known Sapele wood. The fine cylindrical bole has only broad buttress, and the slash is always sweetly scented. The fruits are small, and have thin segments which split away from both ends Yoruba (ijebu); Bini (ubilesan)' Ibo (owura).

Habitat: Grows in mostly lowland rain forest, extending from Sierra Leone through West Africa to Congo and Uganda.

The tree grow to a very large size, up to 60m high and 50m girth. These tree are rarely found these days due to over-exploitation. The buttress is broad and dark it is relatively smooth with irregular flaking scales, grey brown to ash in colour. Flowers between November and April and fruits between May to August. The wood is of a first class mahogany, known as Sapele wood, it has a characteristic stripe when quarter-sawn.

3.2.2 Family *Moraceae*

a. Genus *Melicia*

A very small genus represented in Nigeria by Iroko, which is widely known on account of its excellent timber. The flowers are borne in spike-like inflorescence among the leaves, males and females occurring on separate trees.

Melicia excelsa

Hausa (Loko); Yoruba (iroko), Ibo (oji)

Habitat: Found in rain forest and forest outlines in Savanna wood land areas, Wide spread in Tropical Africa from the Ivory Coast to Mozambique.
Tree grows to about 90 metres high and 15 metres in girth. Decidous, bole straight and cylinderical' up to 45 metres or more to the first branch, usually with a short blunt buttresses. The bark is grey to dark brown or blackish, usually fairly rough and flaking off in small scales. Slash thick, fibrous and exuding white latex. Leaves are about 2.3cm long by 1-2cm broad, and rounded at the based. Flowers are produced between December to March; in single spikes in the axils of the young leaves. Male flowers are white while the female is greenish. Fruits appear between February and April, they are green; 1-2cm long by 0-1cm thick. The wood is pale to dark brown, with a fairly open grain.

3.2.3 Family *Rubiaceae*

a. Genus *Nauclea*

This is the best sources of the well known timber called opepe.

i. Nauclea diderrichii

Habitat: High forest extending from Sierra Leone to Uganda and South to the Mozambique. Tree grows to 90 metres high and 10 metres in girth with a round crown. Branches often horizontal and in whorls. Boles is clean up to 30 metres with low buttress or none at all. Bark is pale brown, slash is yellowish-brown, fibrous and moist.

Leaves are about 3-5cm long by 1.3-4cm broad and blunt at the apex. Flowers are produced between May and July, they are yellowish white and crowded in spherical heads.

Fruits in May-June, November-January, are orange coloured and the surface covered with rough edge. The wood is golden yellow, hard and durable.

Yoruba (opepe); Ibo (uburu); Bini(obiakhe).

ii. Mitragyna ciliate

A characteristic tree of fresh water swamp forest mostly in coastal areas. It may be recognised by the large opposite leaves with big stipules and the numerous small heads of flowers and fruits. It yields a useful timber, the leaves are used for wrapping kola nuts. Yoruba (abuba); Bini (eben); Ibo (uburn).

Habitat: Flesh water swamp forest and by streams, extending from Liberia to the Congo. Tree grows up to 40 metres and about 5 metre in girth, rarely large, with straight bole and short thick buttresses. The bark is grey brown, with shallow longitudinal fissures; slash creamy with a smell of sugar cane. The leaves are about 6-10cm long and 5-7cm broad, which are larger in young plants. Flowers (Jan-April) which are club shaped and split open to release the small winged seeds.

3.2.4 Family *Ebenaceae*

a. Genus *Diospyros*

Diospyros mesipiliformis

One of the most widely distributed African trees and in Nigeria, it grows under a wider range of conditions. Hausa (kanyan; kaiwa); Yoruba (kanran, igidudu) Igala (obiudu).

Habitat: This is a species that grow under a wide range of climate and edaphic conditions. It is found in the rain forest towards its northern edge. In the Guinea Savanna zone it occurs in moist valleys as well as in riparian wood land. It is wide spread from Senegal to other parts of West Africa.

Tree grows to 30 metre high by 3-5 metre in girth with a straight bole and rather dense crown. Bole is blackish to dark brown, while slash is black outside and pink inside. Leaves are pale reddish brown up to 3cm long by 1.5cm broad. Flowers (Feb-June) and fruits appear Aug-Oct; yellowish in colour and about 1cm long.

3.2.5 Family *CAESALPINIACEAE*

a. Genus *Daniellia*

i. Daniellia oliveri

This Savanna tree is particularly abundant in the Southern Guinea and Derived Savanna zone of Nigeria. Hausa (maje, kadaura), Yourba (iya); Ibo (ozabwa).

Habitat: The moist Savanna area extending from Senegal to the Sudan and South to Angola Tree grow to about 20-40 metre high and 5 metre in girth; sometimes larger leaves; about 2-6cm long and swollen at the base. Flowers (Dec-Feb) and fruits (Jan-March). Wood is whitish.

ii. *Atzelia Africana*

This is another species in the family *caesalpinaceae* which is wide spread in the Savanna with a broad open crown and massive branches, most easily recognized by the conspicuous hard blackish fruits.
Habitat: Found in Savanna, fringing forest and the drier part of the forest region, extending from Senegal to the Sudan and South of the Congo and Tanzania. Tree could grow to 30 metres high with a girth of about 3 metres, with a widely spreading crown and irregular branches. Bole rarely exceeding 20 metres with dark pale grey to brown bark.

Flowers (Feb-April, June) which are conspicuous and strongly scented. The wood is hard and trough, and heavy, coarsely grained with light streaks. Hausa (kawo); ibo (akpalata); Yoruba (apa).

3.2.6 Family *VERBENACEAE*

a. Genus *Gmelina*

This is the Asian and Austrian tree species that have been introduced into Nigeria

Gmelina arborea (Gmelina).

This is the commonly cultivated species in Nigeria which are fast growing tree, easily recognized by the leaves, flowers and fruits. Mostly cultivated in plantation and the tree could grow to about 30 metres high and 4 metres in girth. Bole, tapering with slight buttress and slash very thick. The wood is yellowish white, soft and light.

Another genus in the family is the *Tectona*, popularly known as teak. The species *Tectona grandis* are mostly cultivated in large hectares in plantation in most part of the country. Teak could grow to 30 metres high and about 4-5 metres in girth. Wood is dark golden, moderately hard and strongly scented; and could be very durable.

4.0CONCLUSION

Forest trees can be classified on the basis of the vegetation where they are found and also based on their families where they belong. They could also be classified on the basis of their morphology:- crown cover, trunk and slash colour.

5.0SUMMARY

In this unit, we have learnt:

- That there are seven vegetation zone in Nigeria and that the savanna forms about 86% of the country's land area.
- About the five storeys of the rain forest and why there are no grasses in the vegetation.
- The canopies of the savanna vegetation do not touch in most cases and the ground is covered by tall grasses.
- About the various important forest trees that are used for timber

6.0 TUTOR-MARKED ASSIGNMENT

1. Write briefly on the five storeys of the Rain forest, giving two examples of important tree species found in this forest.
2. Write short notes on the following:

i. sahel savanna
ii. Sudan Savanna
iii. Tropical rainforest
iv. Guinea Savanna

7.0REFERENCES/FURTHER READINGS

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UNIT 4 FOREST AND GAME RESERVES IN NIGERIA

CONTENTS

1.0 INTRODUCTION

Nigeria is blessed with very rich biological diversity. As a result of the wide variety in physical environment, climate and vegetation zones, the Country is endowed with a great variety of ecosystems and habitats and a number of unique species that are found only in Nigeria and nowhere else. However, the Country has always had a relatively high population with a corresponding high demand for agricultural land. By the end of the nineteenth century, the pressures on natural areas arising from bush fallow cultivation and other factors were becoming noticeable and protective measures were considered necessary.

The protection of habitats and species has long been part and parcel of the traditions and practices of various cultures in Nigeria. In the past, some communities conserved forests within their settlements purposely for hunting expeditions while others established sacred groves for the worship of their tradition deities.

In other cases, individual plants or animals species valued for a particular purpose such as medicine, shade or food were preserved through taboo. Similarlarly, there were effective and elaborate traditional systems for the rational exploitation of fish and other natural resources.

This chapter traces the history of organized conservation in Nigeria. It outlines the evolution of the protected areas system and examines issues cross-cutting related institutional framework and policy and legislation

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- identify the distribution of forest reserves in the six geotropical zones of the country.
- write briefly on game reserves and National Parks in the country and their function in conserving biodiversity of the nation.

3.0 MAIN CONTENT

3.1 Forest Reserves

Organized conservation in Nigeria started in the field of forestry. A governor of the Colony and Protectorate of Lagos, Sir Alfred Maloney, indicated the first interest in the sector by writing "A sketch of the forestry of West Africa" in 1887. Ten years later, 1897, the Acting Governor of the same Territory, Sir George Denton recommended the formation of a forestry department. The first forest reserve was created in 1899.

In 1902, Mr. H.N. Thompson was appointed the Conservator of Forests. He pursued the policy such that from a modest figure of 97,125 hectares representing 0.01% of the total area of Nigeria in 1900 to 7,332,31 hectares in 1950, representing 8% of the total area of Nigeria. The creation of forest reserves slowed down after independence and stopped around 1980 at about 11% of the total land area (Onochie, 1984).

Organized forestry was practiced earlier in the two Southern territories of Colony and Protectorate of Lagos and the Niger Coast Protectorate. Organized forestry was not practiced in the North until the promulgation of unified forestry Ordinance of 1916. Subsequent to the amalgamation of Nigeria in 1914, Mr. H.N. Thompson became Director of Forestry to the whole country in 1916.

The table below shows the area of reserved forest and the percentage of reserve forest to the total land area according to the current geopolitical zones of the Country

Table 1.4 Distributions of Forest Reserves in Nigeria by Geopolitical Zone (Onochie, 1984)

	Geo-political zones	Total land Areas (sq.km)	Area of Reserves Forest (sq.km)	% of land Area Reserved as Forest
1	North-West	205,096.03	31,190.19	15.21%
2	North East	278,148.03	18215.36	6.55%
3	North Central	234,754.96	24,084.95	10.26%
4	South West	77,656.44	12,958.77	16.69%
5	South East	28,612.55	446.31	1.63%
6	South South	83.784.50	13,075.94	15.61%
	Nigeria	90,055.61	99,991.92	10.992%

Note that south East has the smallest areas of reserved forest. This is most probably due to extreme high population density in the zone. At this point, it is necessary to list the names of some forest reserves in Nigeria. They are as follows:

Olokemeji forest reserves
Gambari forest reserves
Omo forest reserves
Akure/Ofosu forest reserves
Idanre forest reserves
Ifon/Owo forest reserves
Eba forest reserves
Ofogbo forest reserves
Obiaruku forest reserves
Ngel-Nyaki forest reserves
Afi River Forest Reserve
IlTA forest reserves, Ibadan
Kagoro-Nindam forest reserves
Donga River Basin forest reserves
Upper Orashi forest reserves
Biseni forest reserves
Akassa forest reserves

3.2 Game Reserves

Historical Background

A colonial officer, Col. A.H. Haywood surveyed the wildlife resources of West Africa in 1932 and recommended the creation of game reserves in the Savanna areas of Northern Nigeria. This was not implemented until after two decades when the Northern Region Minister of Trade and Industries went on a visit to Sudan in 1956, where he was impressed by the abundance of wildlife in game reserves. In January 1957 a colonial forestry officer Mr. N. Coulthard, and Alhaji Jibrin Jia (MON)

demarcated and established the first Game Reserve in Nigeria in Yankari in present day Bauchi State. Borgu Game Reserve was created in 1962. Both Yankari and Borgu were formerly forest Reserves. The upgrading of forest reserves to game reserves followed in rapid succession. By 1967 there were ten game reserves in Nigeria which increased to twenty-three in 1975, and thirty-five in 1980. Afi Mountain Reserve in Cross River State was created in 2000. Game Reserve are currently estimated to cover a land area of about 25,356.39km^2, which is about 2.7% of Nigeria land area (NARESCON 1992). Many of the Game Reserves have been converted to National Parks.

Game Reserves are areas set aside by the State governments for the protection of wildlife. Included here are wildlife Parks, Bird sanctuaries and strict Nature Reserves. Hunting is usually prohibited, but could be allowed under permit at times. Poaching is, however, widespread despite State edicts prohibiting illegal hunting in reserves.

Most reserves are poorly managed due to inadequate funding, staffing, lack of equipment and poor remuneration of staff. Game reserves are fewer in the southern states of Nigeria due to high human population densities. The following are some of the existing game reserves.

Falgore Game Reserves
Akpaka Game Reserves
Lame-burra Game Reserves
Kwaiambana Game Reserves
Dagidda Game Reserves
Ibi Game Reserves
Pai River Game Reserves
Ankwe Game Reserves
Wase Game Santurary
Wase Rock Game Reserves
Bakono Game Reserves

3.3 National Parks

At present there are eight National Parks, they all derive their origins from previous Game Reserves. These are:

Kainji Lake National Park
Yankari National Park
Old Oyo National Park
Cross River National Park
Chad Basin National Park
Gashaka Gumti National Park
Okomu National Park
Kamuku National Park

We will now give brief description of each National Park, stating the land area it occupy, the vegetation type and a few list of animals found in each of them.

3.3.1 Kainji Lake National Park

It has a total land area of 5340.82km^2, and is located in Niger and Kwara States. This park was developed from two game reserves Borgu and Zugurma. Significant animal species include: Buffalo, Roan antelope, Hippopotamus in Oli River, kobs Western hartebeest, lion, Leopard, Olive baboom etc

Ecologically, it is in the Northern Guinea Savanna and has the following distinctive complexes:

Burkea/Detarium woodland
Atzelia/Isoberlinia woodland
Acacia/Anogeissus/Deterium woodland
Isoberlinia tomentosa woodland
The oil River complex and Manyara complex etc

3.3.2 Yankari National Park

Located in Bauchi State and has a total land area of 2244km^2, and lies within the Sudan Savanna vegetation zone. The vegetation type belongs to a complex described as *Burkea africana* woodland. A total of 350 species of flora resources have been identified.

The park has a wide variety of wildlife species. Among them are:

Buffalo whose population was nearly decimate in 1984 due to rinderpest outbreak,
Baboon
Hartebeest
Waterbuck
Hippopotamus
Crocodile
Grimm's duiker
Lion
Roan antelope
Warthog
Elephant etc

There is a spectacular perfusion of bird life particularly in the Gaji Valley. Yankari National Park has reverted to be called Yankari Game Reserves, now managed by Bauchi State Government.

3.3.3 Cross River National Park

Has land area of 4000sqkm and it is located in Cross River state in the rain forest vegetation. The park has two distinct divisions; Okwangwo and Oban Hills. The Okwangwo division is very rich in biological diversity. Six species are new records for Nigeria. These new species are:

Asplenium cornutum
Arthropteris monocarps
Bulbophyllum bequaertii
Bulbophyllum odiccim
Disperis nitida
Habenaria obovata

Four other species of plants in this park are believed to be new to science, they are:

Tridactyle spp
Uapaca spp
Habenaria spp
Afrocalathea flavida

Two other species of plants generating global interest, which are reputed to be effective against AIDS and Prostate cancer are:

Anceistoclads korupensis
Prunus africana

The park is also home to about 78% of the primates species recorded in Nigeria. Notable among these are:

The drills *Papio leucophacus*
Lowland gorillas *Gorilla gorilla*
The chimpanzees *Pan troglodytes*
Forest elephants *Loxodonta africna cyclotis* etc

3.3.4 Gashaka Gumti National Park

The park is located in Adamawa and Taraba States on the famous Mambila Plateau covering 6731km^2; and the largest and most scenic of all the National Parks. The park has several ecological zones ranging from scrub, Sudan and guinea savanna to rain forest or fringing forests to montane. The park is home to a diverse population of rare and endangered animal species. These species are:
Colobus monkeys

Red-river hog
Yellow-backed duikers
Reedbuck chimpanzee
Wild dog
Elephant

3.3.5 Old Oyo National Park

Located in northern Oyo in Oyo State and has an area of 2512km^2. A high forest and dense savanna mosaics woodland characterised the ecosystem. It is very rich in wildlife species, such as:
Buffoon's kob
Buffalo
Grimm's duiker
Bushbuck
Baboons
Read up information about Kamuku National Park in Kaduna State and Okomu National Park in Edo State.

3.3.6 Chad Basin National Park

Located in the northeastern corner of Nigeria across Borno and Yobe State. Has a land area of 2258 km^2 in semi-arid scrub savanna vegetation. It is home to many rare, hardy, but endangered species of animals and plants. Important wildlife found here are:
Giraffe
Ostrich
Red-fronted gazelle
Elephant
Western hartebeest
Spotted hyena
Baboon
Vegetation type includes:
Dump palm
Ba;amtis
Acacia species
Fairdherbia

4.0 CONCLUSION

There are many Game and Forest Reserves in the country. These reserves are not properly managed. Enabling laws and policies should be put in place to enforce people to recognize the importance of these reserves. The National Park needs better funding for proper management.

5.0 SUMMARY

In this unit, we have learnt about.

- The historical background of forest and game reserves development in Nigeria.
- The description of the various forests and game reserves in Nigeria and the National Parks.

6.0 TUTOR-MARKED ASSIGNMENT

1. List four each of games, reserve, forest reserve and National Parks.
2. Briefly describe the main features of Cross River National Park.

7.0 REFERENCES/FURTHER READINGS

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UNIT 5 SILVICULTURE

CONTENTS

1.0 INTRODUCTION

There are various standardized methods for raising young trees for planting in Nigeria such as stump plants and striplings or plants raised in containers of various materials; the common one being polythene pots. The use of any of these methods depends on individual species as one particular method is often better than another. Stump planting is for example the most successful way to establish *Tectona grandis* and *Gmelina arborea* in the high forest belt with over 90% survival. There are other species such as *Triplochiton scleroxylon* and *Terminalia ivorensis* which due to poor or irregular germination are not suited to either stump or stripling methods because of their very low level field establishments rate, less than 85%. For such species seeding or cutting raised in containers are more suitable.

2.0 OBJECTIVES

By the end of this unit, the student should be able to:

- identify the type of seeds to collect so as to produce quality trees
- choose the right time to collect seeds for planting
- describe how to handle and store collected seeds to retain it viability
- explain seed dormancy and causes of dormancy.

3.0 MAIN CONTENT

3.1 Seed Production

Most artificial and natural forest regeneration programmes start with seeds or cuttings. An assured supply of seeds is a pre-requisite to successful tree planting and forest regeneration. The amount of available

seeds determines the amount of plantable stock to be produced in the nursery. The quality and quantity of seeds of the desirable species on the forest floor will determine success or failure of natural regeneration. To produce high quality tree requires high quality seeds which can be obtained from professional collectors or from non-professional local sources.

i. Seed Location

Careful examination of available stands must be made before seed matures to locate areas where fruit production is sufficiently heavy to make collection profitable. In the absence of seed orchards, the genetic purity of trees can best be approached by collecting from pure stands of mother trees which exhibit the desired phenotypically good characteristics such as good form and vigour. Seeds from immature trees which have not yet fully exhibited their phenotypical characteristics and therefore the quality of trees produced from them cannot be predicted with certainty. Attention should also be given to quality of the fruits such as freedom from pest and diseases.

It is undesirable to collect seeds from isolated plants or from single plants or species growing near other plants of related species. Under such conditions, either self-pollination resulting in reduced seed quality or cross pollination with different species may occur or produce variable seedlings that are different from the parent ones. The quality of a seed source can be determined by growing a population of seedlings from it.

ii. Time for Collection

It is the duty of the seed collector to know the best criteria to indicate the optimum time to harvest his seeds so that they accumulate sufficient food resources, can germinate, and are easy to harvest. Some of the criteria used include: moisture content or dryness, colour, specific gravity.

iii. Method of Collection

Tree fruits collection can be divided into direct and indirect methods. Direct methods include climbing, plucking with hand or pole, tree shaking, tree felling or trimming, and stoning or shooting. Indirect methods involve collection of fruits that have either fallen on their own or by other means such as animals.

The method employed in direct fruit collection is determined by the tree height, quantity and location of fruits and the nature of the tree hole. Fallen fruits and seeds can be collected by sweeping and raking them or

spreading a sheet of plastic, tarpaulin or mat under the tree or simply clear and sweep under it to collect fallen fruits.

In most cases seeds are collected by hand picking before fruit begin to fall, open and scatter its seeds. This is very important especially wit small seeds which fall from them while they are still attached to the tree. Felling the tree to collect the fruits is destructive but may be useful where the trees are already earmarked for felling and there is no other better alternative method such as climbing and lopping of branches, putting down branches with hook or rope and weight, shooting down fruits and collecting fallen seeds on the ground or floating in water (for large fruits and seeds).

Collected seeds should be labeled before putting into sacks or suitable containers and transported quickly to places where they can be extracted and cured for storage. The label should contain the name of the species, date of collection, location and nature of the mother tree.

3.2 Seed Handling

i. Seed Extraction and Cleaning

The length of time that freshly picked fruits can remain in sacks without becoming heated, mouldy or deteriorating, depends on the species and weather conditions. The pre-extraction treatment of dry fruits usually involves direct exposure of most of the species to the sun. Both mechanical (machines) and manual methods of seed extraction are available, but in Nigeria, like in most developing Countries, manual methods such as hand splitting or removing, crushing, pounding, beating, soaking, shaking, drying, and fermenting are most common. The particular method adopted depends on the species as well as the facilities available. Good seeds are sorted from impurities by picking, floating, and sieving/winnowing.

ii. Seed Storage

Seed storage is sometimes necessary because they are often collected in greater quantities than immediately required and their time of production may be different from the time required to raise them. They may also need to be transported over long distances from the point of collection to their point of use.

The viability of seed at the end of any storage period is the result of initial viability and the rate at which deterioration takes place. When placed under conditions that slow down respiration and other life

processes without injury to the embryo, (like in sealed containers) some seeds can be stored for many years.

Temperature moisture relationship are of most practical significance in seed storage Seeds that have hard seed coats and are impermeable to water and gases generally have long storage viability. Very low moisture content (4-6%) of the storage environment (such as sealed storage containers) is necessary for long storage. The combination of low moisture content, sealed containers and low temperature provides one of the most desirable seed storage conditions. In areas where facilities are lacking, dry storage method which does not involve temperature control and the seeds are stored under room or air temperature may be used, in cold dry storage the temperature is usually between 30-50% and below zero for long storage. This is carried out in refrigerated rooms with temperature control. Cold moist storage seeds are sealed in containers and mixed with moisture retaining materials which will maintain their moisture contents. The temperature is usually kept above zero (32-50). Common seed storage containers include: jute/fibre bag, tin/can, glass jar/bottle, pot, jerrican (metal/plastic) or drum, sealed plastic and bags. Moisture absorbing materials include: wood ash, dry charcoal, lime, silica gel, pieces of news paper, and rice husks.

3.3 Seed Dormancy

Mature seeds of many species of woody plants will germinate immediately if planted under favourable environmental conditions, but seeds of most species may fail to germinate under favourable environmental conditions and are therefore said to exhibit some degree of dormancy. Seed dormancy has both advantages and disadvantages, it provides for the establishment and survival of a species by remaining in soil for many years before germination. It also restricts seed germination in hot and dry regions to the short, wet period of the year.

In contrast, seed dormancy is often a nuisance to nursery operators who wish to have large quantities of seeds germinate promptly in order to produce large and uniform crops of seedlings. The causes of seed dormancy and methods of breaking it are therefore of both physiological and practical importance.

The failure of viable seeds to germinate may be due to external factors such as lack of favourable moisture, temperature and oxygen conditions and internal factors within the embryo such as dormancy and influence of the enclosing seed parts on the embryo which may mechanically inhibit water uptake, restrict gaseous exchange or resist embryo expansion. It may also be due to chemical inhibition by specific

substances in some parts of the seed or fruit or may be the combination of two or more of the above.

A viable seed which is unable to germinate under appropriate germination conditions is said to be **dormant.** Dormancy is a state of reduced activity of the plant or plant part in which readily discernable growth does not occur. The causes may be due to external effects of the environment, the internal conditions within the plant part, and inhibiting influence of adjacent parts. There are 3 types of dormancy namely, chemical dormancy, physical dormancy, and embryo dormancy. Chemical dormancy (inhibitors) is caused by growth inhibiting chemical such as conmarin, phenols, caffeine, and cocaine present in the seed. Physical or seed coat dormancy is often due to thick, hard, bony or waxy covering of the seed coat which prevents entrance of water and air into the seed to facilitate germination. Immature embryo dormancy occurs where embryos are only partially developed at time of fruit ripening. This requires a rest period to complete the development process and therefore disappears during storage.

In nature dormancy prevents germination soon after seed maturation during which time the environmental conditions may be unfavorable for survival of the resulting seedlings. It also prevents immature germination and makes seed dispersal, exchange and importation possible. Variability in the degree of dormancy ensures that not all seeds germinate at the same time thus ensuring the survival of the species. However dormancy has made pre-germination testing and treatment of seeds necessary. While seed testing causes delays, germination may be unsatisfactory if pre-germination treatment of the species is not known.

i. Causes of Seed Dormancy

Knowledge of the causes of seed dormancy often makes it possible to intelligently apply appropriate treatments to overcome the dormant condition of individual seed lots. Seed dormancy results from a number of causes including: immaturity of the embryo, metabolic blocks within the embryo, mechanical resistance of seed coat to growth of the embryo, impermeability of seed coats to water and gaseous exchange, a combination of two or more of the causes, and secondary dormancy.

ii. Embryo Dormancy

Sometimes the embryo is immature and requires a period of “after-ripening” (storage under favorable conditions) to reach a certain stage of development before germination occurs. However, the most common type of seed dormancy is one in which morphologically mature embryo are unable to resume growth and germinate. Sometimes the failure of

seeds to germinate is traceable to more than one specific type of dormancy. In some species of Rose, seed germination is prevented by the mechanical restriction of a thick pericarp on embryo expansion, as well as by dormancy resulting from growth inhibitors in the achene.

iii. Hormones and Inhibitors

Presumably all physiological dormancy is controlled by growth regulators. The onset of embryo dormancy is often associated with accumulation of growth inhibitors, and the breaking of dormancy with a shift in balance of growth promoters that overcome the effects of inhibitors.

Various seed germination inhibitors occur in many species of woody plants in all parts of seeds and fruits, including the embryo, nucleolus, testa and pericarp. Abscisic acid (ABA) is perhaps the best known and most inhibitory substance of the inhibitor complex and is prevalent in seeds of peach and apple. In some species, such inhibitor decrease during chilling of seeds, while in others the inhibitor is not removed by chilling but its inhibitory effect may be overcome by an increase in growth promoter such as gibberellins or cytokinins.

iv. Seed Coat Dormancy

A very common cause of dormancy is the impermeability of seed coats to water or oxygen. Seed coat dormancy is especially common in the seeds of leguminosae. Red cedar, Eastern white pine and apple seeds also have seed coat dormancy problems. In apple seeds, the seed coats impede oxygen uptake, thereby making the supply inadequate for the high respiration rate necessary for germination of the embryo to occur. Seed coats of some species are said to be mechanically resistant, preventing the embryo from further development once it becomes fully grown in the seed. However, many of such reported cases are probably caused by other factors such as physiological dormancy of the embryo.

4.0 CONCLUSION

One needs viable seed which are collected at the right time of maturity to raise young trees for planting. Seed dormancy is a hindrance to germination.

5.0 SUMMARY

In this unit we have learnt:

- About the right time to collect seed so that it will retain its viability.
- About storage conditions of seed that will not injure the embryo.
- About seed dormancy, its advantages and disadvantages and the causes of seed dormancy.
- About pre–treatment of seed, to break dormancy and hasten germination.

6.0 TUTOR-MARKED ASSIGNMENT

1. What are the causes of dormancy?
2. Explain briefly how seed coat causes dormancy?
3. Write short notes on seed storage and seed extraction.

7.0 REFERENCES/FURTHER READINGS

Evans, J. (1992). *Plantation Forestry in the Tropics*. (2nd Edition). New York: Oxford Uni. Press.

MODULE 2

UNIT 1 SEED TREATMENT

CONTENTS

1.0 INTRODUCTION

In many species, seed dormancy can be broken by treatments directed towards altering the growth inhibitor – promoter balance and increasing the permeability of seed coats or reducing their mechanical resistance to embryo growth. The efficiency of treatments varies greatly with the degree and kind of dormancy. In some species seed dormancy can be easily broken by any of several treatments, whereas seeds of other species respond only to a single, specific treatment. Seed dormancy of certain species sometimes can not be broken by any of the methods commonly used.

Some species (*Gmelina arborea)* may germinate well if extracted fresh but not uniformly. Yet there are some which germinate poorly and slowly as in the case of *Terminalia ivorensis* while others require specific pre-treatment to germinate. The last group includes the leguminous species which are characterised by impermeable leathery

testa that has to be chipped or abraised in some way and soaked in water before sowing. Pre-treatment used for other species include gibberellic acid for *chlorophora excelsa,* leaching of *Tectona granidis,* alternate soaking drying of *Canariium schewinfurthii* and mere soaking in water of *Desbordesia glaucesceus*. Grating fruit stones of *Gmelina arborea* produces uniform germination larger fruit stones germinate better.

Inherent dormancy or impermeable seed coat to water is the most common causes of dormancy in most tree seeds. While inherent dormancy normally disappears during rest, seed coat dormancy persists. The aim of pre-treatment is to get the largest possible proportion of seeds sown, to germinate in the shortest possible time. The objective is to obtain uniform field planting seedlings with uniform roots and shoots growth which is essential for mechanization, chemical weeding, economic use of resources and mass production.

The most common methods of pre-treatment to hasten germination include scarification, soaking in water, heating or boiling, passing through the gut of animals, and storing.

2.0 OBJECTIVES

At the end of this unit the student should be able to:

- list the pre-treatment required to hasten seed germination
- explain that environmental condition has effect on germination experiment as shown in table 1
- deduce that seed viability test is necessary to ascertain the purity of the seed and its readiness to germinate.

3.0 MAIN CONTENT

3.1 Seed Treatments

3.1.1 Physical Scarification

There are two major constraints to the germination of *Prosopis africana* in the field. First the pods do not dehisce like the papillionaceous ones. It means that after dropping from the tree, the pods do not release the seeds except by some accidental or mechanical force. Even then the seeds do not scatter as in the case of those with explosive mechanism and therefore their dispersal is restricted. The second constraint to germination of this seed is the waxiness and hardness of its seed coat which therefore imbibes water slowly. These difficulties may also partly explain the scarcity and isolated occurrence of this plant in the field.

3.1.2 Chemical Scarification

Acid scarification has been used by a lot of workers to break dormancy in seeds. Somade and Ekeke (in prep) found concentrated sulphuric acid to be very effective in seed coat dormancy in *Terminalia superba.* Adeola and Dada (1985) worked on the germination of *Acacia albida* and *Acacia senegal* and also found that treatment with concentrated sulphuric acid for 10 min. significantly gave better germination percentage of 99% and 57.3% respectively than other treatments. Germination trials carried out by Nwankiti (1982) showed that concentrated sulphuric acid treatment to scarify the seed coat considerably increased the percentage of germination.

Table 1.6: Cumulative mean % daily germination of *Prosopis africana* seeds from the Sudan (Maiduguri) and Guinea Savanna (Makurdi) areas of Nigeria pre-treated by soaking in concentrated sulphuric acid for various time periods.

Time in Acid (Min)	Maiduguri Sample % Germination	Makurdi sample % Germination	Mixed Sample % Germination	Mean % Germination
0	0	10	0	3
5	24	22	9	18
10	74	29	17	40
15	90	35	71	65
20	98	43	88	76
25	98	59	90	82
30	97	78	93	89
35	94	41	73	69
40	90	44	-	67

Water Soaking
Passing though Animals Gut
Heating or Boiling

3.1.3 Treatment with Chemicals

Embryo dormancy of seeds has often been broken by various chemicals such as gibberellic acid and the cytokinins. In species with relatively mild embryo dormancy oxidising agents such as hydrogen peroxide stimulate respiration and accelerate germination. However, hydrogen peroxide has been shown to have practical limitations including germination of some seeds with embryo dormancy.

3.2 Seed Testing

The property of the seed to remain in a state of apparent inactivity (dormant) after separation from its mother renders it the most efficient mechanism for perpetuation and propagation of the parent tree. Under favourable conditions the seed resumes active living evidenced by germination and growth. The process requires that the seed must be viable and must be subjected to favourable environmental conditions of water, temperature and oxygen. Any internal condition which prevents germination even when the environmental conditions are favourable needs to be overcome through pre-germination treatment.

3.2.1 Purity Test

A good quality seed is true to species and variety and has capacity for high germination. It is also free from mixture with other crop seeds, weed seeds and extraneous materials (impurities). Seed test on a small representative sample of the seed determines the purity and germination capacity of the seeds.

The purity or percentage of the pure seed present in the sample is carried out by sorting and expressing it in weight or numbers. The information is important and can be used in determining the rate of sowing to obtain a given stand of seedlings per unit area.

1. $$\text{Purity } \% = \frac{\text{wt of pure seed} \times 100}{\text{wt of pure seed + impurities}}$$

3.2.2 Viability Test

Reduced seed viability may result from several factors such as improper seed development on the tree, injuries during harvest, improper handling procedure during processing, storage, and ageing. Methods of determining viability include visual examination, cutting, floatation, colour, weight, chemical stain test, and germination. Viability can be represented by the germination percentage, which expresses the number of seedlings which can be produced by a given amount of seed. Viability of seeds can therefore be tested by seed sample germination of whole seed or carefully excised embryo.

Tetrazolium test is a biochemical seed testing method in which viability is ascertained by the red colour appearing when the seed is soaked in 2,3, triphenyl tetrazolium, chloride (TTC). Living tissues become red while dead ones remain uncoloured. The TTC is effective in both dormant and non dormant seeds, yield quick results and indicates weakness in seed before germination is actually impaired. However

difficulty may occur in judgment where both stained and unstained area occur in the same seed. The difficulty and time required in preparation for the test may be greater than in the excised embryo test for most seeds. The TTC solution deteriorates with exposure to light and therefore seed has to be soaked in darkness.

2. Viability %= $\frac{\text{No of viable seeds x 100}}{\text{No of seeds examined}}$ or $\frac{\text{wt. of viable seeds x 100}}{\text{wt. of seeds examined}}$

3.2.3 Germination Test

Measurement of germination involves the germination percentage and germination rate. The rate of germination is dependent upon the degree of dormancy still present in the seed and the environmental conditions influencing the seed. Germination therefore takes place over a period of time, and the rate at which it occurs is measured by seed vitality germinated within a specific number conditions of days and is usually estimated by laboratory germination, under optimum conditions, of 4 replications each of about 100 randomly picked seeds and averaging the results.

3. Germination % = $\frac{\text{No of seeds germinated x 100}}{\text{No of seeds sown}}$

The tests help to determine the amount of seed required to plant a given area employing the following formula.

$$\text{Wt (kg) of seed} = \frac{\text{Area to be planted (ha) x stocking per ha.}}{\text{\% purity x \% germination x No. of seeds per kg.}}$$

4.0 CONCLUSION

Seed treatment and purity test are very essential in ensuring that viable seedlings are raised for planting.

5.0 SUMMARY

In this unit we have learnt that:

- Treatment of seed is necessary to hasten germination.
- Percentage of pure seed present in a sample can be used in determining the rate of sowing to obtain a given stand of seedling per unit area.
- The tetrazolium Biochemical test is a better way of ensuring the viability of a seed for germination.

6.0 TUTOR-MARKED ASSIGNMENT

1. List five pre-treatment methods to hasten seed germination and explain fully one of the methods listed.
2. Explain the following:

a. viability test
b. purity test
c. germination test

7.0 REFERENCES/FURTHER READINGS

Evans, J (1992). *Plantation Forestry in the Tropics.* (2nd Edition). New York: Oxford Uni. Press.

UNIT 2 SEED GERMINATION

CONTENTS

1.0 INTRODUCTION

The growth of a tree begins with the germination of its most important propagule, the seed. Seed germination essentially consists of the resumption of growth by the embryo which causes the seed coat to rupture. In the early stages of germination, the embryo is wholly dependent on the food stored either in the cotyledons or in the endosperm. Thus, the growing embryo is sustained by the reserved foods in the seed until leaves and roots develop to supply photosynthethetic and water respectively. The metabolism of germinating seed is both catabolic in the sense that reserve compounds are degraded to provide energy and raw materials for the early growth of the seedlings and anabolic in the sense that it produces proteins and various organelles needed for the metabolism of the seedlings. Major events observed during germination of many species include imbibition of water, degradation of reserve lipids proteins and carbohydrates as well as transport of these compounds to the embryo where cellular components are synthesized.

Many changes are set in motion as germination begins but the exact order of the early changes is not clear and there is considerable overlap, but with few exceptions, absorption of water is a necessary first step. Increase in hydration is associated with cell enlargement and cell division in the growing points as well as release of hormones that stimulate enzyme formation and activity. Although an increase in fresh weight of the seed accompanies inhibition, there is an early loss in dry weight due to oxidation of substrates and some leakage.

2.0 OBJECTIVES

At the end of this unit the student should be able to:

- explain that imbibitions of water by seed triggers of germination resulting to increased cellular respiration to give the required energy
- deduce that resumption of growth by the embryo causes the seed coat to rupture and that the growing embryo depend on the reserved foods in the cotyledon or in the endosperm
- explain how that environmental factors like water, temperature, light and oxygen control germination
- deduce that other environmental factors like day length, wavelength and radiation has effect on germination
- explain the different types of nurseries and accelerating germination and growth of seedlings.

3.0 MAIN CONTENT

3.1 Factors Affecting germination of Seeds

Rapid germination of seeds is very desirable because the shorter the time required the less opportunity there is for injury by insects, fungi, or unfavourable weather conditions or for seeds to be eaten by birds or rodents. Among the most important environmental factors controlling seed germination are water, temperature, light, oxygen and various chemicals.

i. Water

Non dormant seeds must imbibe water before they resume the physiological processes involved in germination. For example, seed respiration increase greatly with an increase in hydration above some critical level. The absolute amounts of water required to initiate germination are relatively small, usually not more than 2 to 3 times the weight of the seed.

ii. Temperature

After seed dormancy is broken by low temperatures, much higher temperatures are needed to induce rapid germination. Non dormant seeds can also germinate at low temperatures but much longer times are required. Seeds of many species will germinate equally well over a rather wide temperature range. Seeds of lodgpole pine germinated at about the same rate at 20 ^{0}C as at 30 ^{0}C and germination of kack pine seed does not vary appreciably at 15 ^{0}C, 21 ^{0}C or 27^{0}C under continuous

light. However, at temperatures below or above 27 ^{0}C, *Azadiracta indica* germinates poorly. Other seeds require special germination conditions such as alternating temperature for *Terminalia ivorensis.*

iii. Radiation

Most seeds appear to be insensitive to light and germinate as well in the dark as in the light. However, seeds of some species require light for germination. Bothwick et al (1954) obtained a detailed action spectum for the breaking of dormancy in the Grand Rapids cultivar of lettuce. It revealed that the major activitty is at 660m. Nwankiti (1982) in his experiment on seed germination and flower colour inheritance in *Talinum triangulare* emphasized that germination trials, carried out on its seed showed that they require light for germination. The promotive action of light on germination operates by increasing the growth potential of the embryo.

iv. Day Length

For seeds of the majority of light – sensitive species of woody plants the most rapid and greatest total germiation occur in daily light periods of 8 to 12 hour. Interrupting the dark period with a short light flash or increasing temperature usually has the same effect as extending the duration of exposure of light.Eucalyptus seeds germinated well in 8 hour days and those of birch in 20 hour days. Seed of Doughlas fir, however, germinated in continuous light or 16 hr days, but not 8 hr days.

v. Wavelength

Germination of seeds of a number of species of herbaceous and woody plants are sensitive to wavelength. The germination responses to wavelength controlled by the red and infra-red phytochrome pigment system. Red light promotes germination and infra-red light inhibits it. The red-light requirement for promoting germination often varies with temperature or duration of water uptake. Toole et al., (1961), noted for example, that germination of virginia pine seeds occurred faster for seeds promoted with red light after a 20 day period of imbibition of water at 5 ^{0}C, than in seeds given a 1-day period of imbibition.

vi. Oxygen

As stimulation of respiration is an essential early phase if seed germination, it is not surprising that oxygen supply affects germination. Seeds usually require higher oxygen concentrations for germination than seedlings require for subsequent growth. Removal of seed coats, followed by exposure of the de-coated seeds to high oxygen

concentration, accelerates respiration even more Oxygen plays a primary role as the electron acceptor in respiration. Soaking of seeds for a few hours hasten germination, but prolonged soaking induces injury and loss in viability of many seeds, presumably because of the reduced concentration and availability of dissolved oxygen in comparison with that of the water. Soaking seeds of several upland species for 3 to 5 days did not decrease germination, but soaking for 10 days reduced germination considerably and soaking for 30 days killed the seeds.

vii. Effects of Seedbed

Because of wide differences in physical characteristics, temperatures, and availability of water and mineral nutrients establishment of plants varies greatly in different natural seedbeds. Mineral soil is a good seedbed because of its high infiltration capacity, adequate aeration, and close contact between soil particles and seeds. Decayed wood also is an excellent natural seedbed for seeds of forest trees, probably because of its capacity for water retention.

viii. Effect of Chemicals

Several applied chemicals, including insecticides, fungicides, herbicides, and fertilizers sometimes check plant establishment by direct suppression of seed germination, toxicity to young seedlings, or both. Other herbicides at compariable dosages, that is N-1-naphthylphthalamic acid (naptatam), 2-chlorallyl dietyl dithiocarbamate (CDEC), S-ethl dipropythiocarbmate EPTC), N, N-daillyl – 2-chloraecetamide (CDAA), 2,4 – dichlorophenozylacetic acid (2,4-D) variously inhibited both seed germination and really seedling growth. Both 2,4 – D and CDAA greatly suppressed seed germination. Seed germination and growth of young seedlings are inhibited not only by applied chemicals but also by a variety of naturally-occurring compounds in plants that are released to the soil. Naturally occurring compounds that have inhibitory effects on the seed germination and growth of neighboring plants include phenolic acids, coumarins and quinones, terpense, essential oil, alkaloids and organic cyanides.

ix. Effect of Seed Size

Linhares (1980) reported that heavy seeds of wheat exhibited greater vigour than lighter ones. The explanation was that larger seeds had large food reserves for the growing seedlings. However, increase in seed size led to diminishing returns in seedlings size, explaining that seedlings from small seeds assimilated much more carbon per unit weight that seedlings from large seeds. Thus although other Environmental factors

may obscure the effects of size, it is one of the most important factors that influence seed and seedling characteristic.

x. Effect of Sowing

Sowing methods can be divided into two namely: broadcast sowing and drill sowing, but seed sowing time varies with the species, the plant seedling size and the time to attain this size. In broadcast sowing the seeds are distributed uniformly over the seed bed or germination bed, while in drill sowing they are arranged in parallel uniformly spaced bands that run length or breadth of the beds and spaced as narrowly as possible. Broadcast sowing has the advantage of permitting the production of a greater number of plants per unit area of germination bed and quicker formation of a dense soil cover as well as rapid suppression. The transplanting operation is however more difficult in broadcast sown beds.

Large seeds are particularly suitable for drill or row sowing method. The drills are made by hand, using small hoes or by machine, leaving farrows of predetermined depth on recently pulverised seed beds for seeds to be sown manually or mechanically. Another technique is sowing directly into individual plant containers which will ultimately be planted with seedlings. It eliminates the need for germination beds, pricking out operation and the associated problems.

3.2 Nursery Practices

In most cases it is unsuitable to sow tree seeds direct in the plantation because they are small in size, their viability is uncertain, and they are under the influence of dormancy. Trees whose seeds are scarce and expensive, and those whose seedlings have slow initial growth rate, as well as predominance of harsh environmental conditions have made the use of nurseries essential. Seedlings or transplants have to be raised in a nursery which has the facilities to protect and care for seeds and young seedlings unit they are strong enough to withstand the more harsh and difficult field conditions and later transferred to plantation.

The nursery is a seedbed specially prepared to provide a moist, weed free, fertile soil of good tilth, free from pathogens, free from predatory insects, and free from weed seeds, while ensuring the presence of mychorrhiza and nodule bacteria where necessary. The aim of a nursery is to obtain the highest quality seedling in the minimum period of time.

The choice of site for nurseries which can be grouped into temporary or shifting, and permanent or central nurseries is dictated by the availability of an accessible good land located on a suitable topography

close to the planting sites, free from pollution, pests and diseases, and with adequate water and labour supply.

Temporary nurseries, as the name implies, are used for a few years only, to grow seedling for planting in a limited area. They are relatively small in size and have the advantages of being cheaper to establish while proximity to the planting site reduces the cost of transportation, handling risk, and the time interval between lifting the seedling and planting them on the field.

Permanent or central nurseries are usually large and more intensively managed. They are used for raising seedling for many years on the same site that is different from the planting site. Centralization of their location, labour, management and use of resources yield higher economic benefits in the long run. However, seedlings have to be transported over longer distances at higher cost and risks. Fertility of the nursery also has to be maintained while ensuring that pests and diseases do not build up.

3.3 Germination Media

The most common types of beds used in Nigeria for seedling production include; germination bed, transplant bed and standing on bed. Seedlings are usually raised on germination beds and pricked onto transplant beds which can be containers (pots) placed on standing-on beds. Germination and transplant beds made to provide suitable conditions for germination and seedling growth by ensuring that adequate moisture and air supplies are available to the seedlings.

In temporary nurseries, the site is cleared and the ground thoroughly filled and raised into beds or left flat. The same applies to permanent nurseries except that the beds tend to be more permanent and replacement of soil from outside each season becomes necessary. Where containerised seedlings are raised, standing-on beds are made for stacking potted plants. Standing-on beds are constructed to restrict root penetration so as to eliminate or minimize root pruning.

For potted seedlings, the type and size of pots used depend on the size of plant required and the length of time the plant is required to stay in the nursery. Plants staying for a short time period of 2-3 months only required small size pots of about 13x8x005cm. Those that need to stay 4-6 months require pots of about 26x7x005cm while those staying a year or more may do better in 46x36x005cm pots.

The quality of the potting media will determine the rate of seedling growth. For good growth, the ideal potting mixture should contain

adequate nutrition and be of good physical structure to allow free draining when irrigated but still be able to retain adequate water for growth. It should also have cheap and easily available ingredients. The potting mixture ingredients are mixed thoroughly and sufficient water added during the process to make it just wet. The pots are well filled with potting mixture to avoid bending of the pots and creating too much air spaces.

The most common ingredients in Nigeria include top-soil, sand, manure fertilizer, mycorrhiza, and insecticide. The top soil contains some humus which aids water retention and some plant nutrients. The humus acts as a long term fertilizer supply and also improves water retention and other physical properties of the soil. The sand affords aeration and drainage while fertilizer is the source of immediately available fertilizer ensuring there is fertilizer to reactivate the potting media. The insecticide guarantees safety of the pots and seedlings from pests and diseases.

The presence of mychorrhiza fungi increases the surface area of absorbing roots and induces profuse branching of active short roots. It also actively participates in nutrient absorption and deters root infection by soil pathogens. Some tree species such as pines cannot grow successfully in the field for a long time if their roots are not associate with appropriate mychorrhiza fungi. It is possible to raise healthy seedlings without mychorrhiza in the nursey but these may later die in the field or grow very poorly. Mychorrhiza development on the roots of *Pinus elliotii* seedlings could be just as important as seedling grade in determining survival.

Poor performance of seedlings was observed on pots with sand or clay alone. With increasing addition and therefore concentration of sand in clay soil, progressive improvement in potting mixture quality and therefore seedling yield were noticed. The yield advantages reached their maximum (0.94g/plant) where the potting mixture was made of equal quantities of surface clay and sub-surface sand. At this maximum yield point, the mixture contained 58% sand, 4% silt and 38% clay while the pH was 7.18. Lower or higher mixture combinations gave lower seedling yield. Treatments that contained both sand, clay and manure also showed lower seedling yield than those observed on pots with only sand and clay combinations.

4.0 CONCLUSION

The most important environmental factors controlling seed germination are water, temperature, light, oxygen and various other chemicals.

5.0 SUMMARY

In this unit we have learnt the following:

- that the seed imbibe water to stimulate the activities of the embryo to resume germination.
- that environmental factors controlling germination are water, light, temperature, oxygen and other chemicals.
- that there are two methods of sowing seeds, these are broadcast and drill sowing.
- there are two types of nurseries; the temporary and permanent nurseries, and the main aim of setting up a nursery is to obtain the highest in quality seeding short period of time.
- that the most common germination media used in Nigeria include the top soil, sand, manure, mycorrhiza and insecticide.

6.0 TUTOR-MARKED ASSIGNMENT

1. Write on the two different types of nurseries and the advantages associated with each.
2. List 4 environmental factors necessary for germination.
3. What are the effect of germination media in accelerating germination and growth of seedlings?

7.0 REFERENCES/FURTHER READINGS

Evans, J. (1992). *Plantation Forestry in the Tropics*. (2nd Edition). New York: Oxford Uni. Press.

UNIT 3 SEEDLINGS MANAGEMENT PRACTICES

CONTENTS

1.0 INTRODUCTION

The aim of pricking out and transplanting is to give the seedlings a wider and more even space so that each one can develop without competition from its neighbors. Pricking out of seedlings should be done early and very gently to avoid root-hair and shoot damage. There is need to check the development of tap roots and to stimulate the formation of fibrous roots near the ground surface. In dry areas transplanting may be done to avoid root damage and to minimize planting shock.

2.0 OBJECTIVES

At the end of this unit the student should be able to:

- identify major seedling management practices
- suggest when to transplant seedling on the field
- outline planting pattern and planting methods.

3.0 MAIN CONTENT

3.1 Seedlings Management Practices

i. Shading and Mulching

Tree species differ in their requirement of shade to germinate. Shade bearing species require heavy shade to reduce temperature and keep the soil moist and fresh. Light demanding species like *Tectona grandis* and *Gmelina arborea* do not necessarily need shade to germinate. Shading is

provided for small seedlings sown in boxes or trays in the Savannah zone but not usually for pricked out seedlings or seedling raised by direct sowing into containers.

Mulching or spreading insulating substances over the surface of the soil can be used in place of shading. It regulates soil temperature and conserves soil moisture by reducing evaporation through lowering of the soil temperature and by increasing the absorptive capacity in the upper layers of the soil. It also controls weeds and reduces erosion by encouraging infiltration and decreasing surface run off.

ii. Irrigation

Water is vital to seed germination and seedling growth. The seed or seedling environment must be kept adequately moist through irrigation where natural watering conditions are not adequate. The frequency and amount of irrigation depend on the climatic conditions in the nursery the rate at which water is absorbed by the roots and the water holding capacity of the soil in the root zone.

Scanty irrigation encourages deep root development while excess (flooding) reduce drought resistant and cause seedlings stagnation as a result of insufficient aeration. A balance between excess and scare irrigation will produce the optimum seedling.

Three nursery irrigation methods are currently in use. They include surface, sub-surface and sprinkler irrigation systems. In surface irrigation or flooding, the water is distributed either by flooding the entire surface or restricting the water to some type of furrow. In sub-surface irrigation, the water flows under ground as a controlled water table over an impervious substratum and provides moisture to the seedlings by upward capillary movement. It involves creating and maintaining an artificial water table where soil is permeable enough to allow lateral and vertical water movement. In fadama areas and around the Lake Chad such water tables exist naturally. Both manual and mechanical sprinkler irrigation involve artificial simulation of natural rainfall on the seedlings

iii. Weeding

Weeds compete with seedlings for moisture, mineral nutrients, space and light. If left unchecked they may stunt and even kill the plant. Movement of soil (tillage) during weeding also improves infiltration, aeration of the roots, absorption of water and reduces run-off and minimizes soil erosion.

iv. Fertilizer Application

Chamshama and Hall (1984) observed that a simple way to promote growth and yield of trees in plantations is to produce and use strong healthy planting stock. This can be achieved through the use of fertilizers to improve soil fertility and consequently promote strong healthy seedling growth.

On the entisole of north-eastern Nigeria results of experiments suggested the ideal fertilizer rates to be 30-90kg/ha, 30-60kg P/ha and 60-90 kg K/ha for rapid growth and high yield of mahogany seedlings. Single application of N or P produced maximum tree yield at the rate of 30kg N or P/ha while single K did so at 60 kg K/ha. Where N and P were applied together, 60 kg N/ha and 60 kg P/ha gave maximum tree yield. Combined application of N and P produced superior yield on pots with 90 kg N/ha and 30 kg K/ha. The best combination for P and K was 30 kg P/ha and 30kg K/ha, while 60 kg N/ha, and 90 kg K/ha produced the highest mahogany seedling yield where all the three fertilizers were applied.

Rapid seedling growth implies rapid availability of strong, healthy planting stock. It also implies less time spent at the nursery. This is particularly important in these semi-arid areas where resources, such as water for long time (extended) seedling irrigation, are very scare. The application of fertilizers would improve the quantity of seedlings and enhance implementation of afforestation programmes.

v. Pruning

Roots of both bare-rooted and potted seedlings need to be pruned regularly to restrict their extensive development or to change their rooting habit, especially the tap root. Root pruning involves severing the tap-root and the lateral roots as well. The aim is to restrict the tap-root development and to encourage the seedling to develop quickly after planting it. Shoot pruning of seedlings is also practiced as a means of checking the growth of seedlings that tend to grow tall, thin and weak.
Seedlings in beds or rows can have their roots pruned or undercut in situ as an alternative to transplanting. In containerized seedlings, root pruning involves cutting off the roots that have grown through the pots.

3.2 Planting Practices

In the tropics, the occurrence of the wet season usually determines when planting should be done. Evapo-transpiration stress at planting is the main cause of death and is minimized by three practices.

1) Plant seedlings when soil moisture levels returned to field capacity, this is often only after about 100mm of steady rain has fallen and the wet season commenced.
2) Plant on cloudy days.
3) Use well- balanced and conditioned plants which have been well watered just before leaving the nursery.

In arid regions it is safest to use container stock and to plant when there are heavy rains during the period they are most expected. However, this time for tree planting coincides with sowing and planting of food crops by villagers and farmers, a conflict which needs to be recognized and allow for, particularly in social and community forest project.

3.2.1 Laying Out Planting Positions

There are consideration alignment of rows and spacing between trees. Row alignment should fit in with the intended extraction system and be at right angles to the main extraction roads and tracks in a compartment road and tracks mostly follow the contours, rows run up and down slopes.

There are many methods of marking the planting position to ensure regular spacing of trees. It is important that the method is simple, easy to apply, and practicable on the kind of terrain encountered. Extreme precision is not necessary. Clearly visible rows and evenly spaced trees are quite adequate.

3.2.2 Planting Pattern

Two patterns are commonly used, square planting, where distance between trees is the same along and between rows, and rectangular planting where trees are closer in the row than between rows. Rectangular planting patterns may be done to aid machine access, allow food crops to be cultivated between the trees, or where trees are planted in spaced lines in enrichment planting or to avoid complete clearance of vegetative cover for protection reasons. Most tick plantation follows this pattern of planting. The number of trees planted per hectare (stocking), is one of the most important silvicultural decision in plantation establishment. Wider spacing than 5x5m is largely confined to agro forestry. Spacing affects plantation yields, tree sizes and growing cost and revenue. Overall, more widely spaced plantations are probably cheaper to grow. At closer spacing cost were higher due to both greater planting costs and weeding cost because of less opportunity for mechanized weed control.

The effect of spacing on revenues is complex. Spacing directly influences total volume production and tree size, but in summary:

1) Wider spacing reduces total volume production, especially in short rotation, since for a longer period a site is not fully occupied.
2) Wider spacing increases neam tree size.
3) Wider spacing tends to increase stem taper which may reduce the percentage conversion when the log is sawn.
4) In broad leaved stands wider spacing usually results in trees of poorer form, with larger crowns and less strong apical dominance.
5) With wider spacing, there are fewer final crop trees to choose from. Many broad leaves require close spacing to assist upward development and reduce overly spreading crowns such as teak and iroko.

3.2.3 Planting Methods

Bare-rooted plants and stumps can be planted in a hole or slit dug with a spade. Container plants are planted in a small pit. Planting is an important operation and deserves been done carefully, poor practices hastily carried out can lead to high mortality even with robust species like teak. For all planting the following general rules apply:

1) Insert roots into the soil up to the root collar.
2) Avoid damaging roots by breaking, blending or crushing.
3) Firm soil around the roots using ball of the foot.
4) Remove impervious container before planting. However, in termit-infested sites, plastic sleeves are slit but left in place around eucalypt seedlings as a protective barrier.

On day sites the planting position should maximize water retention, e.g. furrow bottom, based of mound or micro- catchments.

5) Stump plant should not be forced into the ground. They should be placed in specially prepared holes and the soil firmed around them as with ordinary plants.

3.3 Protection of Newly Planted Trees

Fire protection is especially important on dry grassy sites since young trees soon die if burning occurs. Provided there is adequate weed control which reduces fire hazards. No other special protection measures are applied to young trees. Fungal infections are uncommon, provided cultivation, weeding and fertilization are satisfactory. Two most serious damage to young seedlings are from animal and insect attack.

Animal damage to small trees from burrowing, transplanting, breaking and rodent gnawing bark can be a serious problem. This is most acute in dry countries with sparse natural vegetation where animals turn to planted trees for food. Goats, Carmel, sheep, and cattle in sahel, Sudan and guinea zones of Africa are perpetual obstacle to afforestation programmes. Protection includes errection of fences and walls and use of Shepards and herdsmen may be the only solution.

Insects can destroy newly established plantations. In many parts of the tropics, especially Africa, termites attacks are the most common problem. A protection against termites is most important for eucalypts, pines and *Gmeline.* Plant extract such as "azadiracttan" from Neem *azadiracta indica*, mulching with foliage of certain species and surrounding newly planted trees with *Euphorbia* have all been found to contain some insecticidal properties.

4.0 CONCLUSION

It is important to understand various management practices for different plant species to ensure maximum survival of seedlings, both while on the seed bed and when planted on the sites.

5.0 SUMMARY

- Mulching regulates soil temperature and conserve soil moisture.
- Irrigation is vital to seed germination and seedlings growth, and there are three nursery irrigation methods. They are surface, sub-surface and sprinkle immigration system.
- Weeding, fertilizer application and prunning are necessary for rapid seedling growth.
- The best time for planting seedling is after a rain fall and on a cloudy day.
- There are two commonly used planting pattern, square planting and rectangular planting.
- Animal damage, insect attack fungal infection and fire are the most common damages that affect young seedlings planted in the yield.

6.0 TUTOR-MARKED ASSIGNMENT

1. List five management practices necessary for seed germination and seedling growth.
2. Write briefly on protective measures needed for newly planted trees.

7.0 REFERENCES/FURTHER READINGS

Evans, J. (1992). *Plantation Forestry in the Tropics*. (2nd Edition). New York: Oxford Uni. Press.

Mathew, J. (1994). Silvicultural *Systems*. New York:. Oxford Uni. Press.

UNIT 4 PROTECTION AFFORESTATION

CONTENTS

1.0 INTRODUCTION

This is an extremely important aspect of forestry, which concerns the role trees and forests play in protecting the environment. The presence of forest cover usually reduces soil erosion, slow wind speeds, trap air borne sand and dust particles, moderates the force of rain and slows the runoff of water, after heavy rain. In addition, the planting and establishment of trees on degraded land and industrial waste, or sand dunes can be the first important step in soil rehabilitation, and land reclamation.

Though these benefits have long been recognized and almost every national forest policy makes reference to them, the protective role of forest has in the past been under estimated. It is the cutting of forest itself which is necessarily the main cause, but the conversion of such forest land into appropriate agricultural systems, especially over grazing, which is the chief cause of worse flooding.

In protective afforestation or any forest reserved and managed for protection, timber production is of secondary importance. The protective role of trees and accompanying vegetation becomes the dominant consideration in all decisions such as what to plant, whether to thin, how to regenerate the forest, whether to allow fire wood collection and livestock grazing.

In the past the use of plantations in protection forestry has been small and limited to shelter belts and farm land, around towns and stabilization of sand dunes. Maintenance of natural forest cover in upper watersheds and mountainous regions has been the main form of protection. Much of the large afforestation programmes on hills is mostly for soil conservation, protection and production of timber.

2.0 OBJECTIVES

At the end of this unit the student should be able to:

- deduce the protective role of trees and accompanying vegetation becomes the dominant consideration in all decisions such as what to plant how to regenerate the forest and whether to allow fire wood collection and livestock grazing.
- verify that much of large afforestation programmes on hills are mostly for soil conservation, protection and production of timber.

3.0 MAIN CONTENT

3.1 Protective Afforestation

3.1.1 The Need for Protective Afforestion in the Tropics

Tropical ecosystems are, on the whole, more fragile than temperate ones and more liable to rapid deterioration when disrupted. Some of the reasons for this and the fact that pressures of population and land-use practices, notably over-grazing and burning, widespread destruction of forest are discussed to show the importance of tree-planting programmes for protection as one component of sustainable land-use.

3.1.2 Lose of Vegetative Cover

One of the reasons for establishing plantation is due to lose of vegetation cover. What is important in terms of protection is where disappearance of vegetation cover has caused major damage to the environment. The con sequences of such loss are more in mountainous and arid land. Clearance of vegetation leads to soil erosion and accelerated runoff of water from mountain slopes and contributes to the irreversible

development of hard iron pans in some soils of the tropics, and to desertification in arid regions.

3.1.3 Soil Erosion

Erosion of soil is a normal geological phenomenon which plays an important role in the formation of natural landscapes. The rate of occurrence varies depending on climate, terrain (especially steepness of slopes), soil structure and the amount of vegetation cover. Wind and water are the agents of erosion. It may occur over extensive areas as surface or sheet erosion, in rills, or as gulliet. Whatever type of erosion occurs, the commonest reason for serious damage is due to rapid loss of vegetation cover. The loss may arise from over-grazing, too frequent burning, clearance for arable farming, excessive gathering of fire wood or livestock along dirt track. The less vegetation covering the soil, the more likely it is eroded, though not all soil erode the same way or to the same degree.

Soil erosion has many effects, here are three main ones:

i. Loss of topsoil for cultivation.
ii. Loss of ground stability on steep slopes and development of landslides.
iii. Siltation of rivers causing premature filling of dams and blockage of irrigation channels downstream, and development of deltas and deposition of sand banks which impair river navigability.

3.1.4 Accelerated Runoff on Watersheds

The seriousness and frequency of damaging floods is increasing. Investigation of the incidence of flooding in the River Niger system shows that flooding has been far worse in the last 25 years than in the previous 60 years. In this case the proportion of forest cover in upper watershed is at its lowest level in historical times. The loss of forest itself need not directly be too damaging, but it is so often followed by poor farming and land-use practices or overgrazing, lacking even rudimentary conservation measures. Rain water that falls in these catchments, particularly during rain season downpours rapidly drains off the more exposed land into streams and rivers which reach peak levels that are very high.

3.1.5 Development of Hard Iron Pans

Development of a very hard “ironstone” layer in the soil or as a surface crust is due to the presence of sesquioxide –commented material which hardens irreversibly on exposure to repeated wetting and drying in a

cycle the general progress of which is towards desiccation, which occur only when vegetation are removed. Combinations of geological, hydrological and climatic factors cause iron-pan development on susceptible terrain features, notably along breaks of slope. About 3 percent of tropical soils are affected, though it is much higher in West African sub-region perhaps nearly 8 percent (FAO/UNESCO World Soil Map). Some apparently "irreversible" hardening of iron pan will succumb to erosion process gradually, and can be counteracted by growing particularly strong rooted species like *Eucalytus grandis* and *Populous deltordct.* Such species can physically disrupt and penetrate an already breaking and crumbling hard iron pan.

3.2 The Protective Role of Tree Cover

Many of the influences of trees and forest on the environment are well understood. The purposeful retention of forest or planting of trees in the tropics are done for five closely related purposes. These are soil stabilization and prevention of erosion

- Watershed management
- Provision of shelter and shades
- Reclamation of sites and
- To arrest desertification

3.2.1 Soil Stabilization and Erosion Control

Tree cover protects the soil and reduces erosion in many of the following ways:

Rainfall interception, wind speed reduction, soil covering and ground vegetation, moisture retention and binding actions of roots.

3.2.2 Rainfall Interception

The crowns of trees which together form the canopy and under storey and ground vegetation layers are a barrier between falling rain and soil surface. This brings about three benefits.

First, the force of rain is spent on a tree's crown and other foliage which may absorb most of the kinetic energy of a raindrop secondly, the water from the rain falling in the crown takes longer to reach the ground as it trickles down the branches and trunk and drips of leaves.

Thirdly, the total quantity of water reaching the ground is reduced because, some moisture evaporates from leaf surfaces. These effects

can greatly moderate rainfall intensity at the ground surface and virtually eliminate raindrop erosion.

3.2.3 Wind Speed Reduction

Both inside a forest and for a short distance to the leeward windspeed, and consequently wind erosion are reduced.

3.2.4 Soil Covering and Ground Vegetation

If left undisturbed the ground beneath trees becomes covered with a layer of debris called forest litter (dead leaves, twigs, branches and grasses). The litter layer along with the ground vegetation is the most important protection for the soil surface

3.2.5 Moisture Retention

As well as protecting the soil from the direct impact of raindrops, the litter and humus layers absorb moisture. This further slows the movement of water into the soil (infiltration rate) and also a small amount will evaporate.

3.2.6 Binding Action of Roots

An examination of soil beneath a forest will reveal a mass of roots near the surface. Under the rain forest there is an uninterrupted mat of fine roots over every square metre of ground. The total quantities of root are very large even in a simple ecosystem.

While trees are alive this root mat is continually renewed; if a tree dies a new one soon replaces it. This living network of roots provides mechanical supports on steep slopes and is the main contribution to slope strength and prevention of landslides. But if forest is cleared and stumps killed, root regeneration stops, the old roots dies and decay, and their binding effect on the soil soon disappears.

Nearly all studies confirm this favorable effect of forest cover on erosion, provided litter and undergrowth are present, and that is why ground cover is so important in water catchments areas to reduce the sediment loading of streams and rivers that flow from them.

3.3 Watershed Management

Trees and ground cover greatly reduce soil erosion. In watershed management this is not only important for preventing loss of fertile topsoil but means that water, draining from a forested or well-grassed

catchments will be largely free of sediment. The destructive effect of erosion is not only loss of soil from the eroding land itself, but its transport and subsequent deposition else where. Sediment deposited in reservoirs and irrigation channels is widespread and costly consequence of deforestation in many tropical countries.

The second effect of forest cover in catchment areas is that water draining from a largely forested catchment is usually cleaner than one where land is mostly used for grazing or arable farming, which may include the additional pollution from fertilizers, pesticides, human and animal wastes. Many forest operations e.g. ground preparation, planting, control burning, forest grazing, felling and road construction cause disturbance and exposure of soil. This is one of the reasons why timber production is of secondary importance to that of leaving trees and ground cover intact, and why chemicals such as pesticides and insecticides are avoided.

Thirdly, more recently recognized effect is the role tree play in "filtering" or cleaning polluted air, leading to slightly elevated, aluminum levels and acidity in streams flowing from forested areas on poorly buffered soils. In general, any undesirable effect of forest management on water quality can be much reduced by leaving buffer zone of undisturbed vegetation next to all water courses in catchments.

Forest cover, compared with open land, affects both the pattern and total quantity of water discharge from a catchments area.

3.3.1 Pattern of Discharge

It has been noted that loss of vegetation leads to more severe flooding. It is well established that a forested watershed shows lower peak flow rates after a storm than one denuded of forest or under arable farming or overgrazed. The forest exerts some regulating influence on the flow of water. The mechanism is the same as that which reduces soil erosion, forest cover slows the movement of water through part of the hydrological cycle. The slowing, combined with the barrier and absorptive effect of the litter, lead to better filtration of water into the soil, reduced surface run-off, and therefore slower drainage from the catchments into streams and forest the infiltration rate is about twice that under cultivated ground.

Tree planting in catchments areas has the following effects:

(a) While it is best to retain natural forest and vegetation, including grassland, it is important to maintain and under storey, ground vegetation and surface litter layer.

(b) Afforestation of a catchments will reduce total water yield, but may prolong dry season water flow if infiltration rate are much improved by the vegetation cover.
(c) Tree-planting should be seen as one type of better land use practices notably avoidance of overgrazing, control cultivation and buffer zones to moderate part of water cycle.

3.4 Provision of Shelter

Trees provide shelter from hot sun and from strong winds. Planting trees for these purposes is not new but the need for it, especially in arid zones is more important than any other single environmental improvement purpose.

A shelterbelt fulfils several protective roles:

(a) Appropriately design belt will significantly reduce wind speeds on the windward side. In Nigeria the moderating influence on wind speed of shelter belts established to protect millet was found to be profitable and in the famous maggia valley project in Niger, shelter belts of *Azadiracta idica* (neem) interplanted with *Poisopis juliflora and Acacia nilotica* reduce wind speed by up to 60 percent.
(b) Within and to the leeward, temperature extreme and evapo-transpiration stress are moderated. The consequence of reduced rates of evaporation is that soil dries out more slowly in semi-arid areas, soil moisture storage is typically improved by 5 to 15 percent as a result of sheltering from windbreaks. The improvements in soil moisture are the main reasons for increased yields of crops grown between shelterbelts and moisture soil is less liable to wind erosion.
(c) The physical obstruction of a belt will trap airborne particles:- sand, dust, topsoil etc. one of the objectives of the "green be it" of *Eucalyptus* species around khartoun (Sudan) is to provide shelter from dust and sand storms.

4.0 CONCLUSION

The planted trees must be allowed to grow to fulfill its conservation responsibility to protect and stabilize the soil from erosion.

5.0 SUMMARY

In this unit we have learnt the following:

- That tropical ecosystem is very fragile and as such the urgent need for protective afforestaion.
- That loss of vegetation cover has caused immense damage to the ecosystem.
- That soil erosion if not prevented leads to impoverishment of the soil, accelerate surface run-off and siltation of rivers and dams.
- That soil covering by ground vegetation brings about moisture retention, binding action of roots and effective watershed management

6.0 TUTOR-MARKED ASSIGNMENT

1. List five purposes for retention of forest or planting of trees in the tropics.
2. Briefly explain one of these purposes.

7.0 REFERENCES/FURTHER READINGS

Evans, J. (1992). *Plantation Forestry in the Tropics*. (2nd Edition). New York: Oxford Uni. Press.

UNIT 5 LOGGING AND TRANSPORTATION

CONTENTS

1.0 INTRODUCTION

Logging means the harvesting of tree crops. In strict forestry terms the word exploitation is often used instead of harvesting. Forest exploitation is therefore synonymous with forest harvesting. Harvesting constitutes a vital link between timber production and consumption. It involves problems of technology and transportation. Efficient forest harvesting requires the construction of landing sites, as collection points for felled timber. The most important item is the provision of infrastructure such as forest roads to facilitate transportation to the mills. Adequate training must be provided for operating the diverse harvesting equipment, tools and machines such as axes, chainsaws, tractors, skidders and trucks for haulage which are employed in harvesting.

2.0 OBJECTIVES

At the end of this unit the student should be able to:

- outline methods of obtaining logging rights
- list timber inventory and methods of sales of standing trees
- enumerate procedure for felling a tree, harvesting plan and factors to consider in determining the length of buck and delimbing a log
- explain and transportation of forest products.

3.0 MAIN CONTENT

3.1 Logging of Forest Products

Logging has mainly to do with the production of logs for sawmilling veneer and pulpwood production, either locally or overseas and will be considered in these aspects. In the world-wide sense it also includes the production of railway sleepers, poles, pilling, mine timbers, firewood and many other products.

Logging is the most important step in the utilization of a forest, as the quality of the logs produced, costs and wastage due to careless felling and crosscutting all have their effect on the success or failure of the full utilization of a forest area. Good quality logs immediately step up output from a sawmill or ply wood factory and increase prices if the logs are intended for export. Costs are all important as excessively high logging costs naturally have a depressing effect on mill or export profits.

Wastage in the bush particularly in felling and crosscutting is generally an indication of poor management and at the same time a waste of money as a considerable expenditure is involved in preparatory work, before the first tree is felled. In many cases, a look around the felling areas and loading depots can give a very good idea as to the standing and seriousness of the operator.

Planning, maps and methods of enumeration, length of tractor haul, sitting and condition of truck roads, loading methods and major transport systems are also important factors in the overall logging operation.

In America, Europe and Africa, the utilization of the forests plays a very important part in the social economic welfare of these countries. The lumber and associated industries employ large numbers of men, vast amounts of capital are invested, and large sums of money flow to and

fro from the workers and operators and corporations concerned with equipment for logging and sawmill operations.

Logging can be divided into the following main groups:

i. The felling and preparation of logs for transport.
ii. Minor transport or collecting the logs.
iii. Major transport, or main log haul.

In the case of naturally regenerated forests, careful logging can assist silviculture. Continuity of production, or sustained yield is the main principle of forestry practice. The method by which the forests are logged is an important factor without which sustained yield may not be assured.

In America, progress in improved logging methods as a silvicultural as well as a utilization measure, has been directed to selective felling. In the past the object of selection, was to get the most profit possible and not to see that the forests continued for ever. Silviculturists were not generally interested in methods and costs and loggers in the past cared little for the future of the stands. This has happened in many other part of the world as well, but nowadays, in India, Europe and Africa we find the forester and lumber man working in much closer cooperation, to make sure that the forest will last for ever and provide work and revenue for the country.

The forester's part is to assist in the reduction of general extraction cost, create more demand for forest products, find profitable ways of disposing of wood and mill waste for by doing this he will be helping in the better business management of the forest on a sustained yield basis. Economical logging is important to successful forest practice. Great steps in this direction have been made in America and Europe where advice is given to private owners by the forestry services and trained foresters are often employed by private firms to properly manage their forest.

3.1 Factors to Consider in Planning Logging and Transportation

For every operation, there must be a carefully considered plan which is drawn up on the following guide lines:

i. The special features of the area must be considered. This includes information as to the exact location and extent, with respect to known points such as rivers, towns, roads and possibly railroads. If a mill is to be constructed for the manufacture of the timber to

be moved, it should be located so that the forest products can be delivered at the most economical cost, with due consideration being given to facilities for shipping and moving finished products to market.

ii. The distribution of timber must be decided and the amount estimated, sometimes this is provided by the government. forest services, but in many parts of Africa the actual mapping, counting of trees and general preparation must be done by the concessionaire himself. Usually in the forest reserves the trees are marked for felling by the forest department and control is strict with heavy fines for felling unmarked trees and damaging young standing trees of valuable species.

iii. Methods of extraction must be studied.

iv. Financial policies settled.

v. A careful study of he probable cost must be made.

These costs can be split as follows:

1. Cost of construction for major transport.(forest to mill or waterside)
2. Cost of operation and maintenance of major transport.
3. Cost of camp construction.
4. Cost of construction for minor transport. (Stump to main road, rail or river).
5. Cost of operation and maintenance of minor transport.
6. Loading and unloading cost for major and minor transport.
7. Cost of operating loading dumps etc. under these method of transport.
8. Cost of felling, log making and clearing.

All these cost must be considered together with equipment, labour available and never treated as separate items.

3.1.1 Labour

Some inducement must be offered to men, to leave their villages and come to work in the remote parts of the bush. These are usually offered in the following forms:

1. Good wages, with or without a contract.
2. Cheap or free rations. A most important item.
3. Good houses. These can be made from local materials to suit the individual needs of the workers. Simple wooden pre-fab houses can be built for senior staff.
4. A shop supplying cheap necessities.
5. Medical and sanitary services.
6. Saving scheme from wages.

7. Bonus for good work.
8. Leave to visit their villages.
9. Land for farms on the concession, if this is possible.
10. Amusement such as football.

A happy contended labour force will give better work and make the project successful while one which is discontented will work badly and may result in serious losses due to strikes, go-slow and careless work.

All work in the forest should be done on a task basis if possible, felling, cross-cutting, skidding, loading and even rafting or transport. This leads to easier control and everyone knows what has to be done and the task can be fixed so that each man does a full days work. When he has finished his task the rest of is his own for his farm or family. In America and Europe, daily or weekly wages are paid to labour and in Africa the pay is usually every fifteen days or per month of thirty days loss Sundays and rest days.

3.1.2 CAMPS (Location)

1. Convenience to the present working area is of the greatest importance together with the possibilities of working other areas from the camp. The camp should be sited as near the centre of the working areas as possible, to avoid moving too often.

2. Dry ground is essential for health and sanitation purposes. Nothing can be worse than a badly sited camp and it is better to go up a hill than build in a poorly drained hollow. For sanitary reasons, heavy bush should be cleared away from the camp site and the site kept free from small bush, which will grow very quickly.

3. A good clean water supply must be near, as many troubles can arise if the water is bad. Rivers can be used for washing but it is better to make sure that the drinking water comes from springs or wells.

4. Always consider the possibility of constructing a small air-strip for light planes to use in cases of emergency, sickness or supply of urgent materials etc. accidents can easily happen in the bush, especially when felling trees and skidding logs and nothing is so disastrous as to be without transport with an injured man in the camp, or lacking some urgent items of supply.

3.1.3 CAMP Construction

The camp or village should be constructed in an orderly manner with houses arranged in lines, with roads or tracks, as a camp is much easier to keep clean if it is properly laid out. Labourers houses can usually be constructed from local materials by the men themselves. If there is more than one tribe working in the area there will usually prefer to have their own sections of the camp and elect their own headmen.

There are usually Government. rules regarding the size of the houses, but if not, plenty of room should be given to married men with families and two bachelors can share the same house. It is a good idea to keep married men with families and bachelors separate as far as possible as there will be less trouble. A chapel or church should be constructed and the camp made as much like a small town, as possible.

Senior staff can be housed in wooden pre-fabricated houses, which are easy to build and can be taken down and moved to a new camp without much difficulty. Latrines arrangement must be made and this must be checked and re-made when necessary.

It is quite possible that there will be a main camp near a sawmill or main logging with smaller camp in the forest for felling or crosscutting, road clearing and skidding. Those smaller camps should be within reasonable distance of the main camp, for control of the work and supplies and always linked by a road.

3.2 The Marking for Felling

This operation can be conveniently combined with the inventory taken during the preparation of the logging plan. It does not follow that all species will be extracted at one time; this depends on market condition available. The normal method is to plan or scribe the numbers on the trees to be felled and at the same time form an estimate of the height and measure the girth or diameter at breast height, the result are recorded for each species and provide essential information as to the species available in a given area and also provide a reasonably accurate estimate of the timber volume. If more detailed records are required the felled trees must also be numbered and a check kept on the actual measured output from each tree. This system of numbering, carried forward throughout the logging operations also provides a method of ensuring that all trees in the area have been felled, crosscut and skidded to the loading depots.

3.2.1 Selection of Trees for Felling

This usually governed by the following factors:

1. **Minimum Diameters:** these are usually laid down for each species.
2. **Type of Operations:** depends upon the ultimate use of the producer.
3. **Harvesting Cost:** those naturally hinge around the marginal tree and log.
4. **Management Policy:** Forests under proper management are cut according to plan. This may call for the retention of seed trees of any particular species, the retention of lower girth trees to provide a future crop or clear cutting for replanting or some other purpose.

The choice of trees to be cut in managed forest is largely based upon the management plan and the silvicultural system in pratice. Forest not under any fixed system of management and working to girth limits the cutting specification should preferably be written and clearly specify for each species, the minimum diameter or girth, either over or under bark, which can be removed.

In reserved forests were seed trees are to be left, the marking must be carried out by a responsible forest officer who is fully conversant with the management and silvicultural plans. The marked trees should be entered on the forest map and some indications given as to the extraction routes, all which will assist in the final harvesting of the area.

In some countries and with some species, trees are girdled at the same time as selected to allow for preliminary seasoning, with the object of reducing the moisture content and possibly making the trees floatable.

Any extra cost involved in this work is fully justified in the easier control of the extraction operations and the provision of data for future operations in the particular forest area.

3.3 Methods of Obtaining Logging Rights.

In carrying out exploitation, a strict management approach is followed, so that forest areas are not unduly depleted. Logging can be carried out based on

a. **Ownership of a Private Forest-** This is where a farmer plants and manages his own tree farm. Harvesting is usually done to ensure protection of the environment.
b. **Right to exploit in private or public land-** In this case a forest permit (concession) is often considered necessary and is obtainable from the resident forest officer before any form of exploitation or harvesting. The permit or concession is a license which empowers one to cut down tree crops.

There are two approaches to timber exploitation; it is either selective or total. In selective exploitation, it is the act of felling only trees that have been marked for a particular purpose while total exploitation involves clear-felling of all the trees in plantation or forest, thereafter selection is made for different end uses.

3.4 Method of Sales of Standing Tree

On obtaining the concession or permit, there are three approach adopted by forestry department for the sales of standing tree. These are:

1. **Out-Turn Volume (OTV):** this method is mostly used in concession area granted to big timber companies and is based on the actual out turn volume of trees of different species. Prices are set at fixed rates per cubic meter of merchantable volume of each tree and trees are classified according to their economic importance.

2. **Stumpage Rate/Single Tree Permit:** this system is based on the market popularity of tree species and assumes a certain average of each tree. Different species usually have different tariff rate.

3. **Area Bases Assessment:** under this method, forest is demarcated into coupes. The inventory of the merchantable timber standing in each coupe is taken and mapped. Based on the stock map, a bill of quantity which approximates the value of standing timber is prepared.

3.4.1 Timber Inventory/Enumeration

Timber inventory is embarked upon to obtain data with regards to species available in an area, their size and level of maturity. Such information help in planning and execution of logging programmes.

Timber inventory procedure involves the following:

1. Map out the area of operation in square km from which felling of expected species is to be done annually.
2. Mark out boundary demarcation for these annual areas into blocks.
3. Divide the blocks into 8 compartments.
4. Enumerate economic trees with the aid of an enumeration gang.

After the inventory procedures, trees are marked for felling. Such trees could be thinning, diseased or injured trees and choice species.

Whatever the method of felling employed, care must be taken to:

a) Protect water and watershed.
b) Protect other trees not ear-marked for felling.
c) Protect grazing land, shelter belts etc.
d) Ensure minimal damage to the eco system allowing water percolation and soil aeration which in turn prevents soil erosion.

LOGGING FLOW CHART

Felling

Extraction

Buking (Sawing To Desire Length)

Yarding/Skidding (dragging to gantry) ⇨ documentation

Loading Onto Transport Equipment

Transportation

Long Storage Yard

Equipments used in felling are:

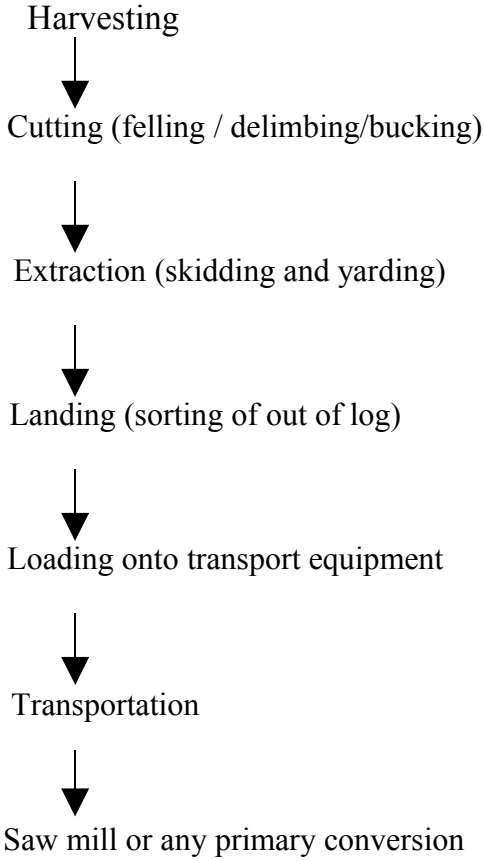
1. Axe.
2. Handsaws.
3. Chainsaws.
4. Shears.
5. Wedges (prevents pinching & directs tree fall).

6. Gunstick (precision in directing tree fall).
7. Springboard (platform when felling large buttress trees).

3.5 Procedure for Felling a Tree

1. Make a back cut on the side the tree is to fall (less than 45 degrees).
2. Make under cut at height slightly higher than the back.
3. Push in wages as you cut.

Modern logging flow chart



1. Harvesting plan

This is the same as land use management plan and involves a land management map and a written plan. There are 2 aspects of harvesting plan:

a. **Strategic plan-** This gives a long term description of what should be done to ensure a technically and environmentally sound logging operation. It involves drawing of map to scale such as 1:10,000, and to 1: 50,000. Such maps could be fairly detailed in terms of the topography of the area, vegetation type, annual areas of operation (coupes), location of communities, reserves, religious and cultural grounds.

b. **Tactical plan-** This is a short term plan and is usually more detailed. It gives information on the various trees that should be felled in each coupe, the number of loggers or crew required to do the job, and other equipments that may be required to ensure a hitch free operation.

2. **Cutting-** Involves all operations in preparing the tree for extraction such as felling, delimbing and bucking. In felling of selected stands, there is need to ensure minimal damage to the eco system for long term productivity and profitability. Delimbing involves cutting off of branches from the log using an axe, handsaw or the chainsaw. Bucking involves cutting of the logs to desired length, which may apply to branches of large diameter. Bucking is influenced by the shape of the log as well as the requirement. It is a critical operation which can easily lead to wastage.

Factors to consider in determining the length of buck log are:

a. Log taper.
b. Straightness of log.
c. Crookness of log.
d. whether branches are incorporated.

3. **Extraction-** Refers to the series of procedures from the removal of logs (felling) to the point of transportation. It involves delimbing, cutting to a desired length and minor transportation (skidding and yarding). Tractors and hinches are used for transportation, so also special equipment is used for gripping of logs to facilitate sliding along the ground. Timber arches (in form of inverted **"U"**) earned on wheels are set on caterpillars or trucks to lift large diameter end of logs between the fork of frames by means of a hinch but allow the small end to drag on the ground. Transport can also be by head cable ways and skyliners depending on the terrain.

4. **Landing-** Refers to the collection point in the forest where logs are stored pending their transportation to mills. At this point, logs are stored out and given some identification mark. Landing site

should be accessible and centrally located in the forest to ensure collection of plenty logs from the various sites of felling.

5. **Loading-** Various equipments are used for loading onto vehicles, they include, guyline loading, gunpole, heel booms, and cranes.

6. **Transportation-** Various methods exist from landing area to mills such as:

a. Animal transport
b. Road haulage
c. Water transport
d. Rail transport
e. Skyline

3.6 Log Transportation

This involves the movement of felled trees from their collection points to various primary procession points where there are processed or conditioned for further uses. This is often critical because careless handling may lead to deterioration in quality of logs thus affecting both technical and economic value. Logs are usually loaded onto transport equipment by cranes mounted on heavy trunk or overhead cranes.

3.6.1 Factors That May Cause Log Deterioration during Transportation and Storage

i. **Seasoning Degrade-** Wood is a hydroscopic material and thus losses and gains moisture depending on the environmental condition, in doing thus it exhibits a marked anisotropy in movement below FSP. Green wood will quickly loose moisture to the environment at a faster rate than the interior. This will create an uneven stress distribution in the fibre, and the effect of such uneven movement is usually split and checks which are both disruption in fibre continuity and thus adversely influence mechanical property. To prevent seasoning degrades, end of logs (exposed surfaces) should be coated with impermeable substance and quick transport and processing.

ii. **Handling Damage-** These are mechanical damage resulting from rough handling of logs, this causes fracture of wood fibre hence lowering mechanical and economic value. Careful handling is recommended in other to abate this, so also immobilizing the logs while in transport prevents excessive shaking of logs in transit.

iii. **Wet Wood or Woods with High Moisture (near but below FSP)** – Such woods are susceptible to attack from various microbes (Basidiomycetes, Ascomycetes, & Bacteria) and attack by certain insects (Embrocia, beetle) and marine borers attack when transported by sea. At moisture above FSP prevents attack by organisms because of the low level of O_2 in water soaked wood. So also at reduced moisture level, well below FSP biodeterioration will cease. Exposed end should be treated with wood chemical preservatives thereby impacting fungicidal & insecticidal properties.

iv. **Chemical Stain (Enzymatic Stain) –** These are non microbial with certain species of wood. They result from the reaction between oxygen and 0_2 certain chemicals (extractives) present in the wood such as tannin. This can be prevented by quick reduction of moisture to a level of FSP and also a correct kiln schedule is essential in situations where reduction of moisture cannot control.

3.6.2 Log Transportation Methods

The choice of method to be used will depend on:

a) Level of infrastructural development.
b) Cost benefit of using the method of choice.
c) Level of technology.
d) Topography of the area.
e) The volume of timber available.

1. **River/Water Transport –** involves the use of mass body of water through public or private canal. Logs are moved through rafting or the use of the ships and tugs attached to requirement for water transportation are:

i. Logs should be floaters
ii. Water must be deep enough to support weight of logs and to keep them afloat.
iii. Water should be flowing otherwise additional energy will be required in movement.
iv. Water must be navigable (absence of rocky obstruction,)

ADVANTAGES

i. Low cost due to little energy expended and sometimes very little is expended on infrastructural development.
ii. Protects wood from seasoning degrade as wood is totally saturated with water.

iii. Prevents microbial attack by fungi, sap stain or blue stain and insect.
iv. Can convey large quantity of log at a time.

DISADVANTAGES

i. Usually slow there by requires large material out flow to ensure continuous operation.
ii. There is possibility of loosing logs on transit if rafters break.
iii. Transportation could be seasonal as the volume of water drops during dry season.
iv. In maritime environment, logs may be attached by marine borers. Thereby reducing the quality. There is also the possibility of bacterial attack which leads to increased permeability with adverse effect on utilization such as loss of toughness, effects on absorption of adhesives, finishes and preservatives.

2. Road Haulage – refers to transport on road using trucks, trailer, wagons, etc.

ADVANTAGES

i. Effective where road network is developed.
ii. Enjoys minimum cost with optimum result when compared with other methods.
iii. Also enjoys a unique competitive cost effectiveness.

DISADVANTAGES

i. Roads may be seasonal thus hindering regular supply to mills.
ii. Vehicles have limited carry capacity and the maximum permissible load is thus per axle (truck = 4 axle=3)
iii. There is possibility of mechanical damage such as drying stress leading to splits, checks, and out cup fracture where logs are not fastened together tightly to resist movement when in gallops and also microbial damage as a result of sap stain or blue stain and as wood loses moisture. Both of which can be controlled by bathing ends of log with chemicals.
iv. Movement is slow as there is a maximum speed limit of heavy trucks which is 56km|hr.
v. Has high maintenance cost when compared to others.

3. Rail Haulage – Involves the use of rail wagons on railway network.

ADVANTAGES

i. Conveys large quantity of log at a time thus it is considerably cheaper.
ii. Gentle movement ensures minimal mechanical damage.

DISADVANTAGES

i. Limited distributions as areas covered by rail tracks are only a small fraction of possible destination of logs.
ii. There is double loading and off loading – logs are loaded onto trucks to rail station and then off-loaded onto trucks again to mills. This causes an additional cost and increases the possibility of mechanical damage.
iii. It is slow, thus resulting in drying stresses and microbial attack.
iv. Require high capital output to lay rail tracks where it is not in existence.

4. Animal Transport – Involves the use of domestic animals such as bulls, oxen, elephants, etc to move logs from site of extraction to mills usually for limited distance.

ADVANTAGES

i. It is very cheap.

DISADVANTAGES

i. It is slow.
ii. Tends to cause mechanical damage as logs are dragged along the ground.
iii. It is restricted to short distances.

5. Skyline (Helicopters/Balloons) – Involves the use of helicopters and balloons to air lift logs from extraction sites to mills. It is commonly employed in difficult terrains (steeply or swampy areas). It involves high cost, thereby practiced where it is commonly justified.

4.0 CONCLUSION

Effective planning and careful management plan is required in felling and transportation of logs. This is because of the several risks involved since any mistake could lead to serious injury or even death.

v.0 SUMMARY

In this unit we have learnt that:

1) The study of the special features of the area where timber exploitation is to be carried out is important.
2) Good incentives put in place for the labour force and workers should be carried along in planning and implementation of polices.
3) Good accommodation and efficient transport system be put in place for the work force.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the following planning labour and camp construction as necessary ingredient for effective timber harvesting.
2. State the advantages and disadvantages of water and road transportation.

7.0 REFERENCE/FURTHER READINGS

Evans, J. (1992). *Plantation Forestry in the Tropics*. (2nd Edition). New York: Oxford Uni. Press.

MODULE 3

Unit 1 Principles of Wildlife Management
Unit 2 Animal Behaviour
Unit 3 Wildlife Damage Problems
Unit 4 Wildlife Conservation

Unit 5 Methods of Wildlife Conservation

UNIT 1 PRINCIPLES OF WILDLIFE MANAGEMENT

CONTENTS

1.0 INTRODUCTION

Wildlife management is the art of making land produce sustained annual crops of wild game for recreation use (Aldo Leopold 1932). In 1969, Giles expanded on Leopold's definition by stating that wildlife management is the science and art of changing the characteristics and interaction of habitats, wild animal populations, and men in order to achieve specific human goals by means of wildlife resource. While the principle of wildlife management is scientific, their integration for application with other technologies is truly on art. Wildlife management is based on ecologic principle.

2.0 OBJECTIVES

At the end of this unit the student should be able to:

- outline the management practice necessary for the improvement of the habitat, which will in turn increase the wildlife population
- enumerate some basic ecological and environmental factors which make a game range habitable for the animals.

3.0 MAIN CONTENT

3.1 Ecological Basis of Wildlife Management

Wildlife management is based on ecological principle. This is the relation of an organism to its environments, including other living organisms that co-inhabit the same basic resources of soil, water, vegetation and atmosphere. With the decrease of land used for agriculture in some areas, more habitats became suitable for wildlife. Conversely, in some places, the balance is towards loss of habitat as a result of high way construction, dams, urban uses, and intensified agriculture. Thus the game manager tries to identify the factors limiting the abundance of wild game. By controlling this entity, more wildlife can be produced for recreational use. The earliest attempts centered on control of hunting, control predators, providing refuges to insure breeding stock, and the artificial replenishments of game to restock uninhabited or overshot ranges.

3.2 Control Hunting

Hunting of resident small game is self regulatory since hunting success and hunting pressure decline as the season progresses. After reasonable hunting seasons, enough game birds or mammals usually remain to provide a breeding stock for the ensuring year. On the other hand, some migratory games e.g. waterfowl, prefer habitats in limited supply and habitat where hunting is often concentrated. Limitation of hunting is usually important to assure survival of a breeding stock of these species. Hunting may exterminate any game whose range has been restricted to small areas. Animals transplanted into new areas, or areas which they formally inhabited, are usually protected from hunting until the population becomes well established. Trapping and transplanting have combined as a technique to extend populations of antelope, wild turkey and other North American game. When a new population of wildlife is transplanted into favorable habitat, the population increases faster at first than it does when the species approaches saturation of the available environment. For some wildlife, shooting is a beneficial part of management. Many kind of wild games respond to an increase dry

season hunting harvest through greater breeding success and survival of the young. The manager should therefore endeavor to increase recreational harvest to the point where breeding success and survival of young are near the maximum. In such instances, the population is said to have a high "turnover" rate.

3.3 Refuge

Protected areas where animals could hide against hunting and predator is known as refuge. Refuges were first used extensively to protect farm game, but a number of studies have shown them to be ineffective as a widely used measure. For example, very little difference was found between pheasant populations in open hunting areas and those on adjacent protected areas in Wisconsin. Natural mortality harvested the fall surplus on the refuge, while hunting took that on the open range. Many refuges established were meant to relieve agricultural damage, however, many are now used to enhance and protect endangered wildlife. Where harvest is too limited because refuge of establishment, the animals may become unthrifty, over-populate the range, and seriously damage it.

3.4 Predator Control

Wolf, lion, bobcat and fox bountries are the major animals that prey on other game. Avian predators have been much reduced through pesticides interference with their reproduction. Control of the offending individual or family group may be advantageous.

3.5 Artificial Stocking

Artificial stocking of birds and animals reared in game farms has been a costly and generally inefficient method of providing for hunting. Birds produced under conditions of domestication are less able to compete/ survive after liberation than the wild stock already a field. This, in part, is a consequence of genetic selection. For example, game farm turkey's restocked in Missouri did not survive as well as wild stock and posed anatomical and physiological characteristic which made them more vulnerable to the wild environment.

Artificial stock does provide recreation on specially managed areas, such as shooting preserves, where birds are released a few hours before they are to be hunted. The greater the time lapse between stocking and harvest, the lower will be the return to the hunter and the preserve manager.

3.6 Carrying Capacity

Stocking of birds and animals in range already occupied by their kind, fundamentally limit success because of a principle called “carrying capacity”. Carrying capacity is the sum of the environmental factors which make a game range habitable, food, water, escape cover, nesting cover, loafing areas, brood and feeding areas are all important. All of these must be within daily and seasonal range of the animal. Wild games animal normally produce more than ample young to fill all the available “home range”. Game farm reared individuals, released into occupied range, are most vulnerable and are usually the first individuals lost when the carrying capacity is exceeded. There are upper limits to carrying capacity. Bob-white quail can seldom be increased to more about one bird/acre, possibly because individuals become “stressed” when the level of tolerance of their own kind is exceeded. Carrying capacity changes from season to season on same range. Despite the increased sophistication of management techniques, we still can not circumvent the long established principle that wild animals cannot be stockpiled in excess of the carrying capacity.

3.7 Habitat Improvement

Habitat improvement consists of bringing into useful association those conditions needed by species to reproduce and survive. If openings are created in uniform forest lands, it could encourage the production of herbaceous cover, increase population of birds etc.

Provision of water holes
Encouragement of salt licks
Clipping and productivity estimation
Creation of small openings

3.7.1 Interspersion

Interspersion is the positioning, configuration, and size of the lands of vegetation needed to sustain the species. Numbers of wild game usually depend on the interspersion of habitat types and their relation to the species cruising radius (the daily and seasonal movements). Grass cutter, Bob-white quail and guinea foul ordinarily require woodland, brush land, grassland, and cultivated land, which illustrate the principle that game depends largely on ‘edges’ because it is the edges of vegetation types that are most used for feeding, loafing, resting, calling and resting. The abundance of non-migratory wildlife depends upon the edges of interspersion of essential habitat types because this determines the amount of edges.

3.7.2 Territories

All wild game, at some point during their life circle, exhibits a fixation for a territory, an area which contains all the immediate necessities for life. Roan antelope travel a distance averaging about 40km while songbirds have a territory of only a few hundred metres radius. The game manager endeavors to increase the number, and decrease the size of such territories, through changing the vegetative components in such a way that all the life's necessities are within the smallest unit of range that the species will inhabit. Among migratory birds, individuals have a strong attachment for their natal territories, returning year after year to breed in the same areas. This territorial homing tendency is now being exploited by game managers.

3.7.3 Assessment of Vegetation for Habitat Improvement

Vegetation is the plant cover of the earth, and comprises all plant species growing in a very great diversity of assemblage.

Several methods can be used to assess vegetation but only two are discussed. These include:

1. **Assessment of Canopy Cover**

The cover of species is defined as the proportion of ground occupied by perpendicular projection on to it of the aerial parts of individuals of the species under consideration.

Cover is normally expressed as a percentage, so it is obvious that the maximum cover of any one species is 100 percent. But in normal multi-species vegetation the total cover of all the species present is usually greater than one percent.

If the total cover is less than 100 percent, then the vegetation is "open" with gaps in the foliage. Otherwise, the vegetation is "closed" with no appreciable gaps in the canopy.

When assessing canopy cover the following steps are followed:

- To measure the plot (area concerned)
- To map out the canopy of the trees
- To measure the diameter of the canopy of trees
- To calculate the uncovered area (uncovered area = total area plotted – area covered)
- To find the percentage of the covered and uncovered area

A practical was carried out on a plot of 50 x 50m

The objectives of the practical were:

- To make the vegetation assessment
- To relate it to the total area
- To interpret the results (comments, observations, suggestion)

Individual	**Diameter (d) in m**	**Radius (r) in m**	**Area(ΠR2) in m2**
A	5.45	2.725	23.32
B	5.18	2.59	21.1
C	3.715	1.86	10.83
D	6.4	3.2	32.15
E	4.685	2.34	17.23
F	5.245	2.6225	21.59
G	8.975	4.4875	63.23
H	4.685	2.3425	17.23
I	9.625	4.8125	72.72
J	3.135	1.5675	7.71
K	5.725	2.8625	25.73

CALCULATIONS

Area of the Plot = 50m × 50m =2500m2
Total area covered = Σ Π R2 =23.32 + 21.1 + 10.83 + 32.15 + 17.23 + 72.72 + 7.71 + 25.75 = 312.86m2

Area uncovered = area of the plot – total area covered = 2500m2 – 312.86m2 = 2187.14m2
Percentage of covered area on canopy area = $\frac{312.86 \times 100}{2500}$ =12.51%

Percentage of uncovered area = $\frac{2187.14 \times 100}{2500}$ = 87.49%

INTERPRETATION

- The total cover was less than 100 percent (12.51%) the vegetation was "open" with gaps in the foliage.
- It means also that most of the soil was exposed to direct sunlight, thus enhancing evaporation (loss of soil moist) and the soil was exposed to erosion because of the presence of few trees.

In conclusion it can be said that this habitat was poor or bad. In effect, the amount of leaves shed by the trees was not enough to fertilize the soil. To render the habitat at least fair, more trees should be planted, or the area should be properly managed to prevent fire.

4.0 CONCLUSION

Wildlife management is based on ecological principles that change the characteristic interactions of habitat with man and the animal population.

5.0 SUMMARY

In this unit we have learnt the following:

- That wildlife management is based on ecological principles. The earliest attempts centered on control of hunting, control of predator and providing refuges to insure breeding stock.
- That stocking of animals in range already occupied by their kind is fundamentally limited in success because of a principle called "carrying capacity". Despite the increased sophistication of management techniques, we still cannot circumvent the long established principles that wild animals cannot be stocked piled in excess of the carrying capacity.

6.0 TUTOR-MARKED ASSIGNMENT

1. Write on hunting control and refuge as factors limiting the abundance of games in a park.
2. Write short notes on the following:

i. Carrying capacity
ii. Predation
iii. Interspersion
iv. Control Hunting

7.0 REFERENCES/FURTHER READINGS

Dasmann, R. F. (1976). *Wildlife Biology*. (2nd Edition). New York: Oxford Uni. Press.

UNIT 2 ANIMAL BEHAVIOUR

CONTENTS

1.0 INTRODUCTION

The behavior of animal is the overt expression of the coordinated life process of the animal. In simple term, behavior can be described as an expression of the effect of all of the factors that are influencing an animal. The factors that affect an animal are stimuli, these are genes that cause changes in the activity of the organism, and the changes are called responses. The animal is constantly receiving stimuli from its environment, and is continuously integrating and filtering these stimuli. Response is made to them in different ways.

Stimuli may cause conflicting responses. When a prey animal sees a predator, for example the prey may have a tendency to remain hidden or to run, and the response the prey animal makes is dependent on the many stimuli being received at that time and on the past experience of the prey. Roan antelope that are hunted have a greater tendency to run

farther from a man (predator) than roan that is not hunted. Thus the behavioral responses that were seen in animals are a complex integration of many factors or stimuli.

Animals received stimuli from their environment through several means, including, sound, sight, mechanical forces (touch), and chemicals (scent, taste, and internally secreted hormones). Humans have these sensual capabilities too, but the ability of humans to detect these stimuli is very different from the ability of lower animals. Some animals have keener abilities to detect sounds, sights, and smells than humans do. In some cases animal's abilities are quite beyond the imagination of all but those people that are actively involved in these kinds of behavioral studies. Owls, for example, can locate prey with great accuracy in very dim light or even total darkness. Some carnivores can smell their prey very well, and hawks have exceptionally keen eyesight for locating prey in the ground cover.

It is be easy to recognize the obvious behavioral responses of animals such as running, flying, and feeding. Many behavioral responses are internal responses only, but they may have an effect on a latter activity. Athletes that are mentally ready for competition illustrate this point; the excitement of the contest causes additional adrenalin to be released into the blood stream with the final result being an increase in the ability of the athlete to compete.

It might be easy to conclude that the behavior of an organ in the body, such as the adrenal glands, is more properly classified as physiology from behavior and this is a serious biological mistake. Physiology and behavior are linked together in a functional way, and both must be considered before one can understand how an animal lives under natural conditions.

Many of the stimuli that an animal receives are from internal sources, and these act in conjunction with stimuli from external sources to elicit a particular behavioral response. One of the most striking examples of the chain of events that include both internal and external stimuli is reproductive behavior. When pheasants are exposed to longer periods of daylight, their reproductive organs reach a functional condition. The testis and ovaries become active; sperm and eggs are produced, and mating can successfully occur. The actual time of mating depends on external stimuli that the males exchange with the females, including displays of colour, body posture, and other signals that inform the male that conditions are right for copulation. Thus there is a chain of events that begins with the effects of light on the re-productive organs, changes in the reproductive organs, and finally an external behavioral response that result in successful mating.

Behavioral responses are the results of the basic drive, within all animals, to survive, and result in the survival of the species. Individual survival depends on the ability of the animal to get food, to find enough protection from the forces of weather, and to escape mortality from diseases, parasites, and predators. The survival of the population depends on the ability of the animal to mate successfully and produce offspring and rear them to the age when they are self-sufficient members of the population, capable of reproducing. The presence of these basic drives in all animals leads to some definite patterns of behavior within animal populations that are characteristic of the species.

2.0 OBJECTIVES

At the end of this unit, the student should be able to understand:

- explain the behavior exhibited by an animal depending on stimuli received from its environment through several means, like sound, light, taste and touch
- indicate that behavioral response is the results of the basic drive, within all animals to survive
- explain that the presence of interactions between animals of the same species and of different species has resulted in the formulation of some principles of behavior that are now common to most animals.

3.0 MAIN CONTENT

3.1 Relationships between Animals

Relationships between animals of the same species (intraspecific) or different species (interspecific) can be classified into three basic forms, including competition, cooperation, or a neutral type relationship where neither animal nor species is affected by the other. It is very important to understand that the relationships between animals change with the season, e.g.

3.1.1 Competition

Result when two animals are after the same component of their environment when the supply of the component is limited. The most obvious type of competition is for a limited food supply, where a dominant animal (who might be the largest, oldest, or most aggressive animal) will usually be in the best position to consume his portion of the food supply first. This is frequently observed in groups of deer in which

the adult female is usually the dominant animal. This dominance patterns or a social rank in animal populations is called “peck order”.

3.1.2 Cooperation

Between members of specie is observed in many kinds of animals. Pronghorn frequently associate in bands, bison live in herds; caribou travel on long migrations together; and most oxen live in a group that functions together as a unit. When danger approaches, they form a circle with each member facing outward. This type of coorporation among members of the same species may be beneficial to their survival under natural conditions. The presence of several pronghorn in a band makes it more likely that one member of the group will spot danger before a single would when traveling alone. On the other hand, dependence may also result in competition since more animals are crowded together. The amount of intraspecific (within species) cooperation varies at different times of the year. Many species are gregarious, but individuals may compete with each other at certain times, especially during the breeding seasons.

Natural types of relationships between animals of the same species are difficult to recognize in the world. Complete neutrality implies that the relationship between different animals is a random one, with no cause and effective relationship. Whatsoever e.g. male deer in late winter may have little or no contact with female deer, but they may have some kind of loose “males only” organization. Thus the degree of competition, cooperation, or neutrality between animals depends on a number of factors, and the complexity of these factors in space and time indicates the dynamic character of wildlife ecology.

The presence of interactions between animals of the same species and of different species has resulted in the formulation of some principles of behavior that are common to most animals viz:

3.1.3 Home Range

Most animals spend most of their lives in a given area. Red fox, for example, once they have ceased to be transients or wanderers in search of a home area, will settle in a home range where they will secure their food and raise their young. The home range of one pair will not likely include any other red fox. When this competitive exclusion occurs, the home range is approximately called a territory. Home ranges of several individuals of the same species may overlap. This is common in field mice, and it is tolerated until certain population densities are reached. When the number of animals on a given area of land has not reached a critical point, it is very difficult to drive them out of their home range.

Further, if a high density does not cause emigration, they may stay even to a point where starvation and death occurs. This is observe in kob population that tend to congregate in kob yard – which is a special type of dry-season home range-when individuals will not move out to better food conditions.

3.1.4 Territory

This term was introduced when the idea of competitive exclusion was attached to the concept of home range. The basic difference between a home range and a territory is that the home range is not defended against intruders of the same species but a territory issong/birds, for example, defend an area where they feed, mate and produce their young. Normally, males are most conspious in defense of territories against other males of the same species.

3.1.5 Peck order

The social hierarchy or "peck order" has been mentioned earlier. These social ranks develop from experience, age, physiological condition, and physical size. Establishment of social order in the group of animals does not necessarily result in a perfect dominance hierarchy. The dominant animal and the most repressed animal may remain in their positions, but those between these two extremes may change positions, or at least give that appearance to the human observer. Mech (1966) pointed out that the most conspicuous wolf in a park of 16 was one who was clearly the most repressed individual. The leader was not always in the front of the pack.

The three factors above have some benefits of:

1. The isolation of individuals during the breeding season tends to disperse the population and provide for a more even use the available resources, especially food.
2. The more aggressive and dominant animals may be more successful as breeders, especially if the population is high and food or space on the range is in short supply.
3. With the spacing of animals, there are better food conditions and higher reproductive rates. It also results in a favourable growth of the individuals in a population.
4. A social order that is recognized by members of a population of animals will result in reduction of fighting between individuals.
5. The more or less organized dispersal of the population may result in a more stable productivity because the food and other resources on the range are utilized more evenly.

6. The even distribution of a population may distribute predators that can occur, since predators cannot take advantage of a high concentration of prey, there will be a greater stability in the predation rate.

3.2 Predation: Problems and Principles

Until about 50 years ago, predators were to be killed at every opportunity, recently the carnivores are recognized as occupying an important place in nature. It is now realized that an individual lion has far more aesthetic appeal, scientific interest, recreational value, and economic impact than an individual kob or an antelope.

The principles of predation may thus be stated as follows:

i. The term predator does not necessarily denote a destructive animal. Some of the animals most beneficial in respect of man's economy are predators for example, the barn owl is capable of killing as many 8,000 rats and mice in a single year.

ii. Generally speaking, predators live on the animal surplus produced by a prey species. Their influence seldom causes a serious reduction in succeeding breeding population. The law of "diminishing returns" preserves the prey species from serious decimation. Except in rare instance, the predator turns to other prey when a species becomes sufficiently reduced to be difficult to find.

iii. Except under the most extenuating circumstances, no predator except man is capable of exterminating a prey species. Only man with his sophisticated equipment and materials (guns, traps, nets, poisons etc) can reduce animal populations to extermination. Only man, sometimes with the aid of his domestic animals can destroy the habitat of animal species. Only man can utilize biological methods, such as sterilization to accomplish total control.

iv. The most destructive predators, when occurring only sparsely, can have little effect upon the total numbers of desirable prey species. However, only slightly destructive predator animals if it occurs in sufficient abundance can become a potent decimating agent. It is obvious that neither the rare cheetah nor the equally rare leopard would likely exert much pressure on prey populations when the numbers of each are very low. On the other hand, the ground squirrel or the grass cutter, occupying by the

millions could be tremendously destructive if each of them took one guinea fowl egg during the entire year.

v. A reduction in number of predators on a given area does not necessarily mean a reduction in predator pressure on a specific prey animal. This is because a certain segment of a prey population appears to be vulnerable to predation. Conversely, another segment appears to be relatively secured. These predators which can survive the control efforts merely live better.

vi. Herbivorous animal populations tend to increase toward self destruction, if not held in check by various counterforces, predation may be considered as a beneficial service for most prey species of this type. Predators may be an important factor in the survival of some prey species. Hoofed animals and rodents are inclined to overpopulate their habitat when effective controls are absent. The end result of this ever – populated is usually a "crash" brought on by starvation, disease, or emigration.

vii. The net effect of predation upon a particular prey species is measured, not in terms of its % occurrence in the predators diet but rather in terms of the numbers lost to predation in relation to the total population of the prey species.

viii. Availability, above all, governs the diet of most predatory animals. The availability of prey animals may be regulated or controlled by cyclic influences, weather conditions, presence of protective cover, adequacy of nutrition, parasites, or diseases and probably other factors. Usually a predator transfers its pressure to other species when the primary prey species becomes relatively or totally unavailable. In some cases, when the predators concentrate on a single prey species, it emigrates or starves when its source of food becomes unavailable.

ix. Predator control may benefit a desired species on areas where other environmental conditions are favorable for increase, especially when the numbers of the prey species are well below normal. This applies particularly to big game species and large predators.

x. The need or value of predator control in game management is proportional to the intensity of the game harvest. Predator control efforts can be considered worth while only where any considerable portion of increase generated is utilized by man for food or recreation.

Problems related to predation and predator control are:

1. There is a need for a proper definition of the word predator and a better identification of predators to be classified as truly destructive and requiring control.
2. Control efforts need to be specific for the target predator.
3. The cost of predator control to protect live stock has often cost more than the livestock is worth.
4. Emphasis should be upon control or alleviation of the damage, rather than upon control of predators.

4.0 CONCLUSION

Behavior can be described as an expression of the effect of all the factors that influence an animal, and these factors are called stimuli, which cause all the changes in the activities of an organism.

5.0 SUMMARY

In this unit we have learnt the following:

i. That competition result when two animals are after the same components of their environment when the supply of the component is limited.
ii. That behavior is an expression of the effect of stimulus that causes changes in the activities of the organism.
iii. That the presence of interactions between animals of the same species and of different species has resulted in the formulation of some principles of behaviors that are referred to as home range, territory, and peck order.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain how competition, cooperation and neutral type of relationships affect relationship between animal of the same species or different species.
2. Enumerate the principles of predation and state problems relating to predation and predator control

7.0 REFERENCES/FURTHER READINGS

Roberts, M. B. V. (1984). *Biology, a Functional Approach.* (3rd edition).

UNIT 3 WILDLIFE DAMAGE PROBLEMS

CONTENTS

1.0 INTRODUCTION

At some times, every wildlife biologist, manager, and administrator encounters a wildlife damage problem. Action taken depends upon his knowledge of wildlife damage principles, his proximity to or his receipt of accurate information about this particular problem, and his position and degree of responsibility.

To ensure proper interpretation of damage problems and appropriate recommendations for their solution, it is obvious that the first basic requirement is accurate problem identification. Many damage situations are appraised too superficially, or by someone not experienced in reading the symptoms of damage. In many cases, even experienced professionals must make detailed examinations, repeated observation, or

technical analysis to positively define the cause of damage by wildlife. For example, the wide spread problem of tree back damage is obtainable at Yankari. Precise identification of the predator involved is essential. It is then necessary to determine the seriousness of the damage. How many baobab trees by age and land are damaged and to what extent, or how many acres of farm land, or how many elephants were killed or destroyed, and in how many areas the damage is repeated. Complete reporting also includes severity of damage .i.e. whether total destruction or only temporary setback in the case of offence, if damage is continuing or is likely to reoccur, after this information might have been gathered, the proper control measures may be planned and carried out.

2.0 OBJECTIVES

At the end of this unit, the student should be able to:

- give proper interpretation of damage problems and prefer appropriate recommendation and solution
- make detailed examinations, repeated observation, to positively define the cause of damage by wild life, and precise identification of the predator involved
- determine the seriousness of the damage, how many acres of farm land involved, the number of wildlife killed or destroyed, and how many areas is the damage repeated.

3.0 MAIN CONTENT

3.1 Wildlife Damage Problems

3.1.1 Control

Control is not justified because damage occurred, but only when human interests are significantly more valuable than the wildlife involved. This is not a moral and economic decision. Economic does damage assessment and control could be corrected out evaluation must determine if effective control can be accomplished for less cost than the appraised damage. Regardless of the details under question or wildlife species involved, the professional damage appraised should bear in mind the wide and often divergent social views related to the problems. An increasing segment of the public is interested in the positive values of wildlife and questions the necessity of wildlife populations. A different view is held by land resource managers and supervisors of land use industries who are responsible for a total resource operation. To form a proper policy of wildlife damage control, it is necessary to recognize

fully these view points. Public attitude towards animal control have changed and so have those of control personnel. Formerly, numerous animals and bird species were grouped as pests, and control programs were aimed at their eradication. Some insects and lower animal forms are still regarded as wholly injurious, but this is generally not true for animals, birds, and most other vertebrates.

Today, extermination is not the goal of damage control programs. Indeed, it could be attained because of economic, technical, or biological limitations. Wildlife damage control programs should not be based upon animal population figures. Rather, the aim is to eliminate or reduce damage to a tolerable level. The amount of control to be applied should be the minimum necessary to achieve that objective.

The most frequent damage problems, control methods, and wildlife groups involved may be classified in several ways:

3.1.2 Nature of Damage

a) To other wildlife; for instance:

i. Predation on game species, such as antelope, boboat-wild turkey, recon duck-nesting.
ii. Indirect damage, such as beaver activity making water temperature unbearable for trout.

b) To surrounding natural resources: for instance, rodent and big game damage to native vegetables.
c) To agricultural crops or other interests of economic value: for instance:

i. Deer – livestock forage competition.
ii. Rodent damage to orchard and timber trees.
iii. Migratory bird damage to cereal, fruit and vegetable crops.
iv. Beaver and muskrat damage to water structures.

d) In wildlife- livestock disease transmission e.g., Anaplamosis in Deer from cattle and tuberculosis in wild pig from cattle, brucellosis in elk from cattle, Rinderpest in Buffalo from cattle.
e) Endangering of public health or safety. Examples are:

i. Wildlife-human health, rabies (fox, bat etc).
ii. Bears or rattlesnakes at campgrounds.
iii. Bird hazards to aircraft.
iv. Deer-automobile collisions.

3.1.3 Nature of the Animal and Their Habitats

a. Local or wide-ranging in feeding habits.
b. Migratory or non-migratory.
c. Native or introduced species.
d. Seasonal or year round activity

3.1.4 Legal Status of the Animal

a) Fully protected mammal or bird, parrots, patas monkey and cheetah.
b) Game mammals or birds; Deers and Elephant (timber and crop damage). Ducks (crop damage especially cereals).
c) Furbearer; muskrat (canal and stream baak damage). Beaver (causes flooding, out trees) weasels (kill poultry, game birds).
d) Non –protected, classed as pest or predator e.g. rats (health hazard, crop and poultry damage) starlings (city nuisance, crop damage).
e) Wild domestics: e.g. feral house cats (kill game birds). Feral dogs (kill games, livestocks).

3.1.5 Control Technology

a) Lethal control: Gassing and shooting wood ducks, poisoning orchard field rodents, special deer and hunts to lessen damage to vineyard, croplands and tree plantations.
b) Preventive control: - This includes fencing, frightening devices, chemical repellants and trapping. Transfer of offending animals, carbide exploders and distress calls to repel blackbirds, bird roost repellants, live- trapping for beavers and grass cutters.
c) Environmental control attempts in reducing animal damage by making the damage less attractive to the offending species or by improving habitat for them on attractive areas e.g. vegetation removal in airport vicinity to prevent starling concentration hazard to air craft, weed control in orchard to remove cover for mice at the base of trees, waterfowl refuges could also be provided to offer attractive resting and feeding areas as an alternative to croplands.
d) Physiological control attempts at modifying the offending animals' ability to survive resist other control measures or reproduce. For instance, in the control of blackbirds and starlings, the use of wetting agents to induce, exposure symptom and chemosterliant application in pigeon control.
e) Crop damage insurance has been used in Canada in mitigating grain damage by water fowl and has been suggested for compensation for wildlife damage is not a control but an alternative to control. This compensatory approach to game damage may have a place, but it cannot be regarded as an ultimate solution as it ignores the reason for the wildlife conflicts.

In conclusion, **optimum control may include most of these procedures**

i. Some reduction in animal numbers to immediately alleviate damage.
ii. Fencing or other mechanical barriers to prevent access to the crop.
iii. Frightening techniques.
iv. Encouragement of adequate game harvest by hunters.
v. Adjustments of agricultural practices.
vi. Establishment of feeding and resting areas on non-crop lands.

4.0 CONCLUSION

In order to form a proper policy of wild life damage control, it is necessary to recognize fully these view points. Public attitude towards animal control have changed and so have those of control personnel. Formally, control programmes were aimed at total eradification of the wildlife causing the damage. Today, the aim is to reduce damage to a tolerable level, and the amount of control to be applied should be the minimum necessary to achieve that objective.

5.0 SUMMARY

In this unit we have learnt that:

The most frequent problems, control methods, and wildlife groups involved may be classified in several ways.

1. Nature of Damage

- To other wildlife e.g.
  - Predation on games species, such as antelope.
  - Indirect damage, such as beaver activity in water ways.

2. To surrounding natural resources e.g. rodent and big game damage to vegetables.

a) To agricultural crops or other interest of economic value e.g.

- Antelope-livestock forage competition.
- Rodent damage to orchard and timber trees.
- Migratory bird (quela birds) damage to cereals, fruits and vegetable crops.

b) Wildlife- livestock disease transmission e.g. Rinder rest in Buffalo from cattle and tuberculosis in pigs from cattle.
c) Endangering the public health or safety e.g.

- Wildlife- human health, rabies (fox and bat).
- Bird hazard to air craft.
- Deer- automobile collision.

3. other damage problems and control methods include the following:

- Nature of animal and their habitat.
- Legal status of the animal and
- Control technology

6.0 TUTOR-MARKED ASSIGNMENT

Explain control technology as one of the best method of controlling wildlife damage problem.

7.0 REFERENCES/FURTHER READINGS

Ogogo, A. U. (2004). *Wildlife Management in Nigeria*.

UNIT 4 WILDLIFE CONSERVATION

CONTENTS

1.0 INTRODUCTION

Wildlife conservation is the social process including both professional and lay activities, which defines and seeks to attain wise use and perpetuation of wild animals and the biotic communities to which they belong. Wildlife conservation is thus a state of harmony between man and land.

As a prelude to the goals, policies and methods of managing wildlife to achieve the above definition, it is pertinent to quote in full a brief report by the committee of the First World Conference On National Park In July 1962 i.e.

1. Management is defined as any activity directed towards achieving or maintaining a given condition in plant and or animal population and or habitats in accordance with the conservation plan for the areas. Management may involve active manipulations of the plant and animal communities, or protection from modifications or external influence.

2. Few of the world parks and nature reserves are large enough to be self regulatory ecological units; rather, most are ecological inlands subject to direct modification by activities and conditions. In conclusion, **optimum control may include most of these procedures** (1) some reduction in animal numbers to immediately alleviate damage (2) fencing or other mechanical barriers to prevent asses to the crop (3) frightening techniques (4) encouragement of adequate game harvest by hunters (5) adjustment of agricultural practice (6) establishment of feeding and resting areas on non crop lands. These influences may involve such factors as immigration and or emigration of animal and plant life, changes in the first fine regime, and alterations in the surface and sub surface water.

3. There is no need for active modification to maintain large examples of the relatively stable "climax" communities which under protection perpetuate themselves indefinitely. Examples of such communities include large tracts of undisturbed rain-forest, tropical mountain prawees and artic tundra.

4. However most biotic communities are in a constant state of change due to natural or man caused processes of ecological succession. In these successional communities, it is necessary to manage the habitat to achieve or stabilize it at a desired stage, e.g. fire is an essential management tool to maintain East African open savanna or American prairie.

5. Where animal population gets out of balance with their habitat and threatens the continued existence of a desired environment, population control becomes essential. This principle applies, for example, in situations where ungulate populations have exceeded the carrying capacity of their habitat through loss of predators, immigration from surrounding areas or compression of normal immigratory patterns. Specific examples include excess population of elephants in some African parks and of ungulates in some mountain parks.

6. The need for management, the feasibility of management methods and evaluation of result must be based upon current and continuing research.

   Both the research and management itself should be undertaken only by qualified personnel. Research, management planning and execution must take into account and if necessary regulate, the human use for which the park, reserve is intended.

2.0 OBJECTIVES

At the end of this unit, the student should be able to:

- deduce that conservation seeks to attain wise use and perpetuation of wild animals and the biotic communities to which they belong
- explain that where lethal methods are used to control wild life damage to crops, it is important they be specific or selective so that the will not destroy non target species or have a long lasting effect upon the environment
- list the goals and benefits of wild life conservation.

3.0 MAIN CONTENT

3.1 Goals or Benefits of Wildlife Conservation

1. Metaphysical goals.
2. Preservation for its sake.
3. Recreation.
4. Physical utility.
5. Contribution to ecosystem.
6. Gene pool potentials.
7. Monitoring of environmental quality.
8. Monetary benefits

Some of these goals overlap but the creation of the above system and how to resolve conflicts among objectives or between groups of people is the essence of management.

i. Some people hold private objectives for the wildlife resources. Hence, wildlife managers must manage wildlife to satisfy these categories of people apart from other desired objectives.

ii. Wildlife manager and the public are interested in animal preservation. There may be other reasons for preserving a species, but discriminating this objective helps direct managerial action. Animals are seen as essential part of the land character and vitality.

iii. Wildlife related recreation includes the sport of hunting and fishing, following track trails, taking birds walks, looking for game and taking cross-country census routes, watching birds at feeding. Reading about wildlife and watching televised wildlife programs (the last three are passive activities).

iv. Perhaps the oldest reasons for managing wildlife is that it provides meat, fur, hides, horns, bones, hairs and other products to meet mans needs either directly or through sale or barter.

v. The vast interactions of animals with their environment are poorly understood, despite years of investment in research. Nevertheless enough is known to community about wildlife losses or extreme abundance. Major changes in wildlife can lead to dangerous less or more harm to the ecosystem.

vi. Losses of wildlife species through domestication can also result in losses of certain heritable characteristics, perhaps essential for long term survival in new dynamic manipulation. Wildlife can provide the genetic resources, the gene pool for studying and developing useful hybrid forms.

vii. By observing wildlife, the status of the ecosystem within which humans live may be appraised. Wildlife becomes the index to environmental quality, and early warning system that may suggest when action is needed to check deterioration of the human life style or decline in longevity. Recons *Procyon lotor* are studied to asses heavy metal build ups - along streams, starling *Strurnnus vulgaris* are collected to access pesticide buildup. Wildlife may also provide a human health analog. Experimental populations of animals show the effect of crowding and other phenomena to be potentially analogous to their effect on humans. With increased crowding of vertebrates there is a corresponding increased disease susceptibility, homosexuality and rescripts of embryos as well as reduced care of young's and reduced infant survival.

viii. It has been said, erroneously in many wildlife conferences and gathering that a monetary value cannot be placed on wildlife. It can, and many wildlife populations are managed to increase monetary returns, or reduced losses from wildlife. These include hunting activities and equipment fees, fur sales, crop and livestock damage and differences in land values due to the presence of wildlife.

3.2 Dynamics of Conservation Policies

Attitudes towards wildlife and wildlife values continue to change. New methods for pest control evolved. Intensification of land uses creates wildlife problems where none previously existed. The problem of wildlife damage and control from a historical view point is referred to as dynamics of wildlife conservation.

Predation upon life stock by large carnivores is one of the earliest most sustained and most widely recognized types of wildlife damage.

Wildlife conflicts with crops where birds may cause severe damage to fruits or agricultural crops, and for several reasons the incidence of damage seems to be increasing. The natures of modern agriculture with the emphasis upon monoculture and highly specialized crops, and the high cost of bringing the crops to the harvesting stage, are among the factors involved. Accurate estimates of the value of fruit or grain destroyed by birds are extremely difficult to obtain. Devices of various kinds to frighten the birds and spreading grains near the marshes of lure them from unharvested grain fields, are two methods that have been used. Both are cumbersome and expensive and are not always effective. The problems of bird conflicts with crops are so numerous, complex and varied that no one solution can be expected. Some effective control

measures have been developed, but many more are needed, adaptable to the peculiarities of the problem faced. Non lethal methods are particularly appropriate, for many of the birds that cause trouble one situation is valued in others. Where lethal methods deemed necessary it is important that they be specific or selective, so that they will not needlessly destroy non target species or have a long-lasting effect upon the environment as it is done by many of the pesticides now commonly used.

Wildlife problem involving the forest and range: Damage to the forest by wildlife is widely scattered and usually attracts little attention. Perhaps the commonest effect is upon tree reproduction, because a large number of birds and mammals feed upon the seeds. Both artificially seeded and natural forest reproductions have been severely damaged by a variety of small mammals, particularly mice and squirrels. Areas cleared through logging or fire is particularly vulnerable to wildlife damage during the stage of reseeding and growth of seedlings, because many spp of wildlife are attracted into the openings. Two other types of damage widespread in the forest are clipping and browsing of timber spp by big game, rabbits, hares and others: and the bark and root damage caused by rodents, such as mice and porcupines. Deer, elk and other ungulates have frequently become so numerous that their feeding has caused severe damage to forest, especially to seedlings. In most areas, however, population control is now being achieved through regulated hunting and this type of damage is far less widespread than in the past. The total ecological impact of rodent on range land is clearly a result of a variety of factors (burrowing, sand building and food storage activities). Both natives and domestic animals affect vegetation: it is of primary importance to determine precisely what these effects are: how they are brought about. A final and more difficult step is to develop management practices that maintain a vegetational complex such that there will be minimum rodent and rabbit damage and maximum forage for livestock and game animals.

Non agricultural wildlife problems: wild birds and mammals act as carriers or reservoirs for certain diseases of man and domestic animals. A few of these, such as rabies, are of great economic importance but the majority are local or temporary and do not usually result in controlling demands of any magnitude perhaps the most spectacular conflict between birds and man involves the birds – air plane problem, which was brought dramatically to public attention in 1960 when a jet plane crashed at Logan International Airport, Buston, killing a number of persons. In this instance, flock of starlings was socked into the jet engines. In Canada, the Air-Canada has maintained records of strikes with birds and costs of repairing damage have been high running to millions of dollars annually. More accurate data must be maintained as a

basis for remedial action, but the one simple fact that has come true most clearly, is that habitat conditions particularly attractive to birds cannot be tolerated in the immediate vicinity of jet airports.

Positive Values of Predators and Rodents:

Need for damage control research: The variety and magnitude of wildlife damage to man's crops and property are sufficient to demand more effective control than are available at present. Research is urgently needed to develop the changes in agriculture and land use, and changes in wildlife population and their behavior repeatedly brings about new situations where damage by wildlife occurs. Furthermore, public attitude towards wildlife home changed so much that it is more essential than ever that non lethal types of control be used where ever feasible. **Methods of controlling or alleviating damage fall into** at least four broad categories, **biologica**l and **cultural**, **mechanical** and **electronic,** chemical and payment for damage.

1. **The Biological or Cultural** includes some cases of California were water fowl have been lured from rice fields to areas of food planted especially for them. It also covers situations around air port where habitat have been modified to reduce their attractiveness to birds. And it might well include the development of crop varieties that are resistant to birds, though little has been accomplished so far with this approach.

2. **The Electronic and Mechanical** category includes various types of scaring devices of which the most successful to date have used recorded alarm or distress calls of gregarious birds. This last techniques has been used with considerable success against starlings in vineyards in Germany and France.

3. **Chemical Methods** have been used and are being given more attention e.g. toxicants, repellants, soporifics or stupefacient and the anti fertility agents that are been considered as away of holding some annual population in check.

4. **Payment for Damage**, as exemplified by the water fowl depredation crop insurance plan used in Canada, may have applicability to some conditions in the United States not Nigeria.

4.0 CONCLUSION

Wildlife conservation is the use of wildlife resources in order to obtain the highest quality of wildlife for subsistence harvesting. The values of

wildlife conservation are enormous ranging from contributing immensely to the eradification of protein deficiency in the rural villages to increasing the national GDP and the maintenance of eco system.

5.0 SUMMARY

In this unit we have learnt the following:

a) The optimum control may include :

- Reduction in animal's number to immediately alleviate damage.
- Encourage adequate harvest by hunters and establishment of feeding and resting areas on non crop lands.
- Fencing barriers to prevent access to the crop.

b) Where animal population gets out of balance with their habitat and threatens the continued existence of a desired environment, population control becomes essential.

c) The benefits of wildlife conservation includes:

- Promotion of tourism.
- Bush meat production.
- Contribution to ecosystem stability.
- Monetary benefit.
- National heritage.
- Hides and skin production.
- Traditional medicine and medical research.
- Employment opportunity.

6.0 TUTOR-MARKED ASSIGNMENT

Write concisely on the benefit of wildlife and its conservation.

7.0 REFERENCES/FURTHER READINGS

Ogogo, A. U. (2004). *Wildlife Management in Nigeria* (1st Edition). Calabar Nigeria.

UNIT 5 METHOD OF WILDLIFE CONSERVATION

CONTENTS

1.0 INTRODUCTION

There are essentially two aspects to the practice of fish and game management. The first step is the direct manipulation of wildlife populations. Most commonly, such manipulation involves exploitation or harvest for economic or sporting purposes. "Population manipulation may also include the protection of endangered spp for aestheric, educational, and scientific purposes, and it may involve the control of economically undesirable spp. For example, good Park management requires that ungulate populations be reduced to the level that the range will stay in good health and without impairment to the soil, the vegetation, or to habitats of other animals. Balance may be achieved in several ways:

2.0 OBJECTIVES

At the end of this unit, the student should be able to understand:

- explain that wild life conservation will essentially addresses population control of the games and the manipulation of the environment to enhance the survival of the game
- distinguish between policy of the past, which lay more emphasis on the preservation of wild life for future generation and today's policy which focuses more on recreation, tourism, bush meat production and preservation for future generation.
- predict that a need for the law must be clear to the public and to professional wildlife resources managers, on harvesting, ecotourism and conservation.

3.0 MAIN CONTENT

3.1 Methods of Wildlife Conservation

3.1.1 Natural Predation

The effort to protect large predators in and around the parks should be greatly intensified. At the same time, it must be recognized that predation alone can seldom be relied upon to control ungulate numbers, particularly the larger spp such as bison, moose, elk and deer, additional artificial controls frequently are called for.

3.1.2 Trapping and Transplanting

Traditionally, in the past, the National Park services have tended to dispose of excess ungulate by trapping and transplanting. Since 1892, for example Yellow-Stone National Park alone has supplied 10,478 elk for restocking purposes. Thousands of deer and lesser numbers of antelope, mountain goats and bison also have been moved from the parks. However most big game ranges of US are essentially filled to carrying capacity and the cost of continuing programme of trapping a transplanting cannot be sustained solely on the basis of controlling populations within the parks. Trapping and handling of a big game animal usually costs several dollars. Since annual surpluses will be produced indefinitely into the future, it is patently impossible to look upon trapping as a practical plan of disposal.

3.1.3 Shooting Excess Animals that Migrate Outside the Parks

Many park herds are migratory and can be controlled by public hunting outside the park boundaries. Effective application of this form of control frequently calls for special regulations, since migration usually occurs after normal hunting dates. Most of the surrounding states should thus co-operate with the National Park service in scheduling late hunts for the specific purpose of reducing park game herds, and in fact most excess game produced in the parks is so utilized. This is by far the best and most widely applied method of controlling park populations of ungulates. The only danger is that migratory habits may be eliminated from a herd by differential, which would favour survival of non-migratory individuals. With care to preserve, not eliminate migratory traditions, this plan of control will continue to be the major form of herd regulation in National Park.

3.1.4 Control by Shooting within the Parks

Where other methods of control are inapplicable or impractical, excess park ungulates must be removed by killing. The park policy board

should make sure that such is carried out by competent personnel, under the sole jurisdiction of the National Park services, and for the sole purpose of animal removal, not recreational hunting. If the magnitude of a given removal programme requires the services of additional shooters beyond regular Park service personnel, the selection, employment, training, deputization and supervision of such additional personnel should be entirely the responsibility of the National Park service. Only in this manner can the primary goal in wildlife management in the parks realized. A limited number of expert riflemen properly equipped and working under centralized direction, can selectively cull a herd with a minimum of disturbance to the surviving animals or to the environment. General public hunting by comparism is often non selective and grossly disturbing.

In summary, control of animal population in the National Parks would appear to us to be an integral part of park management, best handled by the National Park service itself. In this manner, excess ungulates have been controlled in the National Park of Canada since 1943, and the same principle is been applied in the parks of many African countries.

The second aspect of fish and game management is manipulation of the environment to enhance or reduce the spp in question according to the need. More often than not, the wildlife we utilized is produced in ecosystems not specifically manipulated by man for its production although such ecosystem may be substantially altered by or for other human activities. In some cases, however, our wildlife harvests are derived from systems managed with varying degrees of intensity for wildlife production.

3.1.5 Introduction of Exotics Species

This is a manner whereby the list of animals in an area can be changed by introductions of the efforts that have been made to stock exotics species; there have been few successes due to the following reasons.

1. The species (spp) may become a pest or a failure because no one can predict how an animal will eat under the stress of new environments or populations interactions.
2. It is impossible to do pre stocking research either in area suitability or pest hazards. Deduction can only be made.
3. The ecological community can be disrupted, and it may not be restored by simply subtracting the problem animals.
4. Foreign diseases and parasites of wildlife can be transmitted and may become epidemic as in Hawaiian birds.

5. Stocking efforts tend to be newsworthy and thus tend to detract from the needed management of native species (spp) problems. The result is a net reduction in public wildlife management involvement.
6. Importations are an admission of defeat in managing native populations to meet existing needs.
7. The total selection, transportation, quarantines and supervision cost are very great.
8. Exotic wildlife may not stay where it is put.
9. Recreational quality of a hunt may be reduced for a significant number of sports men since they can no longer choose, after successful stocking, to go into an area of only native wildlife.

Because there have been some successes, stocking of exotics is likely to continue, despite the many reasons why it can rarely be justified. In such cases, the wildlife biologist will insist upon the following minimal analysis, prior to releases.

1. Criteria for selecting and collecting vigorous animals.
2. Appropriate minimum stocking numbers.
3. Proper sex ratio.
4. Efficient, stress minimal transportation.
5. Quarantive hazards.
6. Parasites and diseases leads.
7. Possible role of the new species in the new environment.
8. Behavior – relative to objectives of stockings.
9. Reproductive capacity.
10. Resistance to native diseases and predators.
11. Possible actions as pest or predator.
12. Elusiveness and ability to withstand user pressure.
13. Possibilities of hybridization.
14. Probabilities of movement out of the target area.
15. Suitable control methods if they are needed.
16. Biostatistical methods for properly evaluating success or failure of the effort.

Note the following:

Primary Stocking – the releasing of animals from one area into an area in the Species has never occurred.

Secondary Stocking – the releasing of animals into an area from which the species has been exterminated.

Primary Transplanting – the capturing of native wildlife in the field and Moving the animals directly to another site (whether previously occupied or Not).

Secondary Transplanting – the movement of the offspring taken in the field, of 1^0 or 2^0 stocking efforts into another area.

Released Game – the game released in an area prior to hunting period.

The first step in habitat management is historical research to ascertain as accurately as possible what plants and animals and biotic association that existed originally in each locality. A second step should be ecologic research on plants and animal relationship leading to formulation of a management hypothesis. Next should come small scale experimentation to test the hypothesis in practice. Experimental plots can be situated out of sight of roads and visitor centers. Lastly, application of tested management methods can be undertaken on critical areas.

3.1.6 Policy

Prior to the eastern Nigeria game law of 1916, there was practically no national or regional policy on wildlife conservation in Nigeria. This shows the idea of protecting wildlife started with the creation of Nigeria, since the amalgamation of the southern and northern parts of Nigeria was in 1914. In 1928, western region enacted her own game law and in 1963, the northern region did the same. Because of abundance of wildlife at the time of their enactment, the three game laws focused on the preservation of wildlife for future generations, without any reference to utilization for a particular purpose. The emphasis on preservation by those laws also showed that the philosophy and hence the policy for wildlife management was primarily directed to the protection of Nigeria's wildlife species (spp) as a national heritage for future generations. Later the colonial officer found it convenient to include hunting for sporting purposes in the national wildlife policy, perhaps to satisfy their own excitements. The Creation of Yankari Game Reserve in 1956 And Borgu Game Reserve in 1962 stimulated the management of Nigeria's wildlife to include recreation and tourism. In 1967, the national wildlife conservation committee (NWCC) claimed that shortage of animal protein was the major cause of indiscriminate hunting of wildlife in protected areas and therefore argued for an enlargement of the national policy on wildlife management to include conservation for meat production. Today, the national wildlife policy laws LAY equal emphasis on recreation, tourism, bush meat production and preservation for future generation. A national policy to integrate tourism and bush meat production should allow for creation of buffer zones in tourist-oriented game reserves and national parks and the development of techniques for cropping animal when their numbers rise above the carrying capacity of the habitats.

3.1.7 Legislation

There is no unified national wildlife conservation law. Conservation and protection of wildlife in Nigeria is still governed by the three old game laws and their several modifications which emerged with the creation of States in 1967. Each law has its territorial coverage viz. The 1916 law is used in Anambra, Cross River, Imo and Rivers States. The 1928 law is used in Edo, Lagos, Ogun, Ondo and Oyo states while the 1963 law is used in Bauchi, Benue, Borno, Adamawa, Kaduna, Kano, Kwara, Niger, Plateau and Sokoto states. An attempt was made in 1973 to have a unified and more detail national wildlife conservation law by NWCC and the drafted law are titled "national fauna conservation law" there was the endangered spp (control on international trade and traffic) decree No. 11 of 1985.

Enforcement of laws regulating harvest of game was the first wildlife management tool, preceding refuge establishment, predator control, stocking and habitat manipulation.

Law enforcement is the basic tool of management. Also, Leopold defined game management as the act of making land produce sustained annual crops of wildlife for recreation use. The produce that sustain annual crop for recreational use involves protection, regulation and thus law enforcement. There are nine criteria for strengthening wildlife agency legal policy and providing further context for the enforcement agent.

1. A need for the law must be clear to the public and to professional wildlife resource managers. This need should be well articulated and should express an expected long-term net public benefit from having such a law.
2. The law must order some particular action or attempt to prevent it. The objectives of laws must be narrow enough to enable their effect to be recognized. The theoretical question must be asked. If the law were perfectly enforced, what changes would actually occur? The best intended laws may not be enforceable. Even perfect enforcement may not achieve the desired change.
3. The cost of enforcing the law should not exceed the estimated net social good resulting from compliance with that law.
4. Counter productive results of the law should be anticipated by as many techniques as possible including conferences, task forces and simulations.
5. The law must be directed at ensuring the existence of a species or species group at or above all minimum three holds for survival.

6. Wildlife law must not directly reverse an existing law or condition without the relevant agency generating public commitment to the new law. The implication is that initiating or changing laws must be preceded by planning and education.
7. A wildlife law should result in likely positive change for the resource or resource users. Harvest regulations may have no effect on game populations or have no significant effect in increasing resource utility to large percentages of resource users. Questions of scientific substance must be asked about the proposed regulations. For example, does weapon 'X' significantly change the vulnerability of species Y or age-class Z? Is a law justified in protecting Y or Z by regulating X? Time and method of game harvest are examples of restrictions that have been approved without prior evidence of real population protection or hunter safety.

i. Objectives of Wildlife Legislation

Objectives are absolutely essential for the design analysis and evaluation of all wildlife management activities. Without them, there is no direction, no destination, and no criteria for goodness or optimum performance.

The first-order objectives or goals are the broad statements of what an agency should be. They provide general guidance and direction but rarely provide the basis for determining whether a program is good or an agency is performing well. The second order objectives specify what an agency should do. These are fundamental criteria for designing and evaluating execution of the design for a law enforcement agency. The third order objectives specify acts to be carried out e. g. to make three arrests for spotlight poaching of deer. Whether or not they are achieved does not affect the 1st and 2nd orders.

ii. 1st Order Objectives

Wildlife law enforcement has the following 1st order objective:

1. To prevent wildlife populations, particularly endangered, migratory and breeding population from becoming exterminated in an area.
2. To protect the ecological health of habitats especially from conflicts of land users.
3. To assure that desired, calculated harvests are achieved.
4. To regulate the rate of exploitation of wildlife populations.
5. To assure each licensed person an equal opportunity to pursue fish or game.
6. To maximize the opportunities of all citizens, licensed or not, to experience benefits from wildlife.
7. To assist in balancing users satisfactions with expectations.

8. To balance the allocation of the resource to the users, properly weighing special group interests and influence (e.g. hunting clubs, anti-hunting hobbies) preventing exploitative group from forming, and minimizing private interests` preying in public "capital".

4.0 CONCLUSION

Methods of wildlife conservation will involve integrated management approach, which will incorporate population manipulation to prevent over population and environmental management to encourage constant supply of needed resources by the wildlife.

5.0 SUMMARY

In this unit we have learnt the following:

That population explosion of wildlife can be achieved through:

- Natural predation or introduction of predators to control excess games.
- Trapping and transplanting, which is the process of moving games from one park to another.
- Shooting of excess animals that migrated outside the parks and also shooting within the park can control surplus games in the park.
- A national policy be put in place to include bush meat. Production and creation of buffer zones which allows cropping of games when their numbers rise above the carrying capacity of the habitat.

6.0 TUTOR-MARKED ASSIGNMENT

1. List 4 essential aspect of wild life conservation method.
2. Write on how wildlife population growth can be controlled in a national park.

7.0 REFERENCES/FURTHER READINGS

Ogogo, A. U. (2004). *Wildlife Management in Nigeria* (1st Edition). Calabar Nigeria.