



FOREST MANAGEMENT



DIRECTORATE OF FORESTS
GOVERNMENT OF WEST BENGAL



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Aranya Bhavan
LA – 10A Block, Sector III
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PREFACE

Forestry is a multi-disciplinary subject. Being equipped with the knowledge and expertise of various subjects, a forester is ultimately required to apply the same in forest management. He has to know how to plan, organize and execute the appropriate management practices for the best interest of the forest wealth and the society. Under the JICA project on 'Capacity Development for Forest Management and Training of Personnel' being implemented by the Forest Department, Govt of West Bengal, this course material on Forest Management has been prepared for induction training of the Foresters and Forest Guards. The object of this training manual is to help the frontline forest personnel have a better perception about basic principles and procedures involved in forest management.

The subjects covered in these materials broadly conform to the syllabus laid down in the guidelines issued by the Ministry of Environment of Forests, Govt of India, vide the Ministry's No 3 -17/1999-RT dated 05.03.13. In dealing with some of the parts of the course though, the syllabus has been under minor revision to facilitate better understanding of the subjects and to provide their appropriate coverage. The revised syllabus, with such modifications, is appended.

The contents of the course material have been compiled and edited by A Basu Ray Chaudhuri, IFS (Retd). Books and literature that have been made use of in preparing this course material have been cited in the respective lessons. Shri A Basu Ray Chaudhuri is indebted to many forest officers who have helped in the preparation of this material.

The efforts that have gone into making this course material will be best rewarded if the frontline staff of the forest department finds it useful in their day-to-day work.

Kolkata, 2015

A Basu Ray Chaudhuri, IFS (Retd)
For IBRAD (Consultant)

N K Pandey, IFS
Chairman, SPMU, Forest Department,
Govt of West Bengal



Syllabus (Revised)

Forest Management

| Forest Management (10 hours)*, Tour 3 days | | |
|---|---|----------|
| 1. Functions and Scope*; Objectives | <ul style="list-style-type: none">• Production (economics)• Protection (Conservation)• Bio-aesthetic• Concurrent List*• Principles of Forest Management – National Forest Policy* | 1 hour |
| 2. Forest Organization* | <ul style="list-style-type: none">• Territorial classification*• Management (Silvicultural) Classification*<ul style="list-style-type: none">- Working Circle- Felling Series- Coupe- Cutting Section• Periodic Blocks: Uniform System*• Felling Cycle-Selection Forest*• Felling Series in Coppice- with- Standards (CWS) system* | 2 hours* |
| 3. Sustained Yield*; Normal Forest* | <ul style="list-style-type: none">• Sustained Yield*<ul style="list-style-type: none">➤ Concept and Definition➤ Prerequisites for Sustained Yield Management• Normal Forest*<ul style="list-style-type: none">➤ Definition➤ Attributes/Characteristics of Normality➤ Normality related to treatment and rotation | 1 hour |
| 4 Growth of forests | <ul style="list-style-type: none">• Increment<ul style="list-style-type: none">➤ Factors that influence increment➤ Increment is an important characteristic➤ Current Annual Increment – Definition and concept➤ Mean Annual Increment – Definition and Concept➤ Variation of CAI and MAI with age | 1 hour |
| 5. Rotation | <ul style="list-style-type: none">• Rotation<ul style="list-style-type: none">➤ Introduction – Definition➤ Rotation in Regular and Irregular Crop➤ Types of Rotation<ul style="list-style-type: none">- Physical Rotation- Silvicultural Rotation | 1 hour |

| | | |
|---|---|----------|
| | <ul style="list-style-type: none"> - Technical Rotation - Rotation of Maximum Volume Production - Rotation of Highest Income / Revenue - Financial (or Economic) Rotation | |
| 6. Yield regulation | <ul style="list-style-type: none"> • Yield Regulation <ul style="list-style-type: none"> ➤ Principles and Objects ➤ Regulation of Final Yield ➤ Basis of Yield Regulation ➤ Yield regulation in Clear-felling system ➤ Yield Regulation in Regular Shelterwood System <ul style="list-style-type: none"> ➤ Yield based on area allotment by periods ➤ Yield based on Volume of Growing Stock | 1 hour |
| 7. Working plan, Working Scheme, and Micro-plan | <ul style="list-style-type: none"> • Working Plan <ul style="list-style-type: none"> ➤ Introduction and Definition ➤ Working Plan, Working Scheme, Micro-plan ➤ Goal and Objectives of Working Plan ➤ Organizational Structure ➤ Working Plan Period ➤ Inputs to WPO ➤ Preliminary Working Plan Report (PWPR) ➤ Draft Working Plan ➤ Sanction of the Plan • Survey and assessment of forest resources* • Writing up of Working Plan* <ul style="list-style-type: none"> ➤ Format and guidelines prescribed in National Working Plan Code 2014. | 3 hours* |
| Field Study | Observation of an example of Working Plan | |

* These are modifications to the MoEF-prescribed syllabus, indicating revision/addition of topics and lesson hours.



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| 2 | <ul style="list-style-type: none"> • Lesson Plan • Forest Organization <ul style="list-style-type: none"> ➤ Territorial classification ➤ Management (Silvicultural) Classification <ul style="list-style-type: none"> - Working Circle - Felling Series - Coupe - Cutting Section ➤ Exercise | 10-14 |
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| 4 | <ul style="list-style-type: none"> • Lesson Plan • Sustained Yield <ul style="list-style-type: none"> ➤ Concept and Definition ➤ Prerequisites for Sustained Yield Management • Normal Forest <ul style="list-style-type: none"> ➤ Definition ➤ Attributes/Characteristics of Normality ➤ Normality related to treatment and rotation | 21-26 |
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| 6 | <ul style="list-style-type: none"> • Lesson Plan • Rotation <ul style="list-style-type: none"> ➤ Introduction – Definition ➤ Rotation in Regular and Irregular Crop ➤ Types of Rotation <ul style="list-style-type: none"> - Physical Rotation - Silvicultural Rotation - Technical Rotation - Rotation of Maximum Volume Production - Rotation of Highest Income / Revenue - Financial (or Economic) Rotation ➤ Fixation of rotation | 32-37 |
| 7 | <ul style="list-style-type: none"> • Lesson Plan • Yield Regulation <ul style="list-style-type: none"> ➤ Principles and Objects ➤ Some definitions ➤ Regulation of Final Yield ➤ Basis of Yield Regulation ➤ Yield regulation in Clear-felling system ➤ Yield Regulation in Regular Shelterwood System <ul style="list-style-type: none"> ➤ Yield based on area allotment by periods ➤ Yield based on Volume of Growing Stock | 38-43 |
| 8 | <ul style="list-style-type: none"> • Lesson Plan • Working Plan <ul style="list-style-type: none"> ➤ Introduction and Definition ➤ Working Plan, Working Scheme, Micro-plan ➤ Goal and Objectives of Working Plan ➤ Organizational Structure <ul style="list-style-type: none"> - At national level - At the State Level ➤ Working Plan Period ➤ Inputs to WPO ➤ Preliminary Working Plan Report (PWPR) <ul style="list-style-type: none"> - Preparation and Finalization of PWPR ➤ Draft Working Plan ➤ Sanction of the Plan | 44-49 |
| 9 | <ul style="list-style-type: none"> • Lesson Plan • Working Plan (Continued) • Survey and assessment of forest resources <ul style="list-style-type: none"> ➤ Examination of territorial units ➤ Forest resource assessment ➤ Growing stock estimation ➤ Assessment of non-timber forest products | 50-55 |



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| 10 | <ul style="list-style-type: none"> ● Lesson Plan ● Working Plan (Continued) ● Writing up of Working Plan <ul style="list-style-type: none"> ➤ Format and guidelines prescribed in National Working Plan Code 2014. | 56-68 |



Lesson 1

Time 1 hour

Lesson Plan

Objective: To study

- **Forest Management**
 - Definition
 - Functions and scope
 - Objectives
 - Production (economics)
 - Protection (Conservation)
 - Bio-aesthetic
 - Principles of forest management – National Forest Policy

Backward linkage – nil

Forward linkage – subsequent lessons

Training materials – Copy of Lesson 1 to be circulated beforehand

Allocation of time –

- **Forest Management**
 - Definition 5 mts
 - Functions and scope 8 mts
 - Objectives 12 mts
 - Production (economics)
 - Protection (Conservation)
 - Bio-aesthetic
 - Principles of forest management – National Forest Policy 30 mts
- **Discussion/Miscellaneous** 5 mts



1. Definition

Forest management is defined as the practical application of the scientific, technical and economic principles of forestry. Not a basic subject in itself, forest management is concerned with practical application of science, technology and economics to a forest estate for achievement of certain objectives. The subjects on which forest management is grounded are Silviculture, Ecology, Geology, Soil Science, Botany, Mensuration, Pathology, Economics, Finance etc.

1.1 Functions and scope

It follows from the definition that **forest management** aims to achieve three main functions, namely,

- (1) Control of composition and structure of growing stock;
- (2) Harvesting and marketing of forest produce;
- (3) Administration of forest property and personnel.

It is the job of forest managers to constantly manage the growing stock to achieve given objects of management. The scope of management encompasses a wide range of activities. Some major activities are described below.

- Site adaptation;
- Choice of species;
- Manipulation of stands;
- Harvesting the produce;
- Regeneration;
- Protection;
- Transportation and communication;
- Marketing data;
- Sale of produce;
- Value addition;
- Revenue;
- Distribution of benefits;
- Forest organization;
- Management of personnel;
- Monitoring and evaluation of works;
- Financial management and efficiency
- Integration in rural development.

2. Objectives

The forests in India, which are mostly state owned, are managed for various purposes, namely **productive, protective, recreational and bio-aesthetic**.

2.1 The productive purpose or production forestry - While working within scientific norms, the forests are primarily managed for direct material benefits. The management objective would be to maximize production of timber and other marketable forest produce on a sustained basis, and maximize economic return. In this type of management approach, the focus will be on regeneration of commercially valuable species, establishment of a regular crop of fewer species being easy to manage, application of intense tending operation to maximize dia-volume increment, adoption of improved logging mechanism for intensive harvest and good marketing initiative.

2.2 The protective purpose or protection forestry - Forests are managed for indirect benefits. In this approach, the forests are not considered as mere growing stock but a complex ecological system which should be managed to obtain supporting and regulating services of forests. For example, in wildlife reserves and national parks the objective is not to harvest forest produce and find ways to earn more revenue, but to maintain a good habitat to support the wildlife and biological diversity. Similarly, management of forests on hill slopes is not aimed at maximizing annual harvest and undertaking commercial plantations, but trying to conserve the vegetation for soil conservation and ecological development.

2.3 The recreational and bio-aesthetic purpose or recreational forestry - Forests are managed to enhance and enrich their bio-aesthetic value and recreational potential. The concept is rather new and the major beneficiaries are the people residing in urban areas. The recreational forests are therefore mostly located in and close to planned towns. The focus of management is to create and maintain wooded lands in natural landscapes, ecological parks of species of interest, wetlands as habitat of birds or other aquatic species, greeneries of aesthetic beauty etc. Sometimes, part of wildlife reserves is also dedicated for recreational purpose. Examples of recreational forestry are Banabitan at Salt lake (Kolkata), Bibhutibhushan Park at Parmadon (North 24 Parganas Division), Bethuadahari (Nadia-Murshidabad Division), Rashikbil (Coochbehar Division) and Dakshin Khairbari (Jaldapara Wildlife Division).

2.4 The various purposes or objectives are not mutually exclusive of each other. A scientifically managed forest can fulfil more than one objective, though one or the other objective receives priority. In case of extensive forests, it is possible to allocate separate forests to fulfil distinctly separate functions. **The Working plan** (a written scheme of management to achieve the objects of management) of a forest division, while specifying the general objects for the entire Working Plan area (i.e. Division), divides the area in several Working Circles. Each Working Circle, normally characterized by distinct vegetation and site factors, is considered more suited for



certain purposes than others and is assigned some special objects of management and one set of Working Plan prescriptions. The Working Plan thus prioritizes objects of management for different Working Circles and such priorities of objects vary from Circle to Circle. In certain circumstances, Working Circles may overlap.

3 Forests on Concurrent List

In appreciation of the importance of forests for the well-being of the nation, the Parliament by the 42nd Amendment to the Constitution brought Forests and Wildlife on the Concurrent List of the Seventh Schedule. This has enabled the central government to promulgate legislation on Forests and Wildlife.

4. Principles of Forest Management – National Forest Policy

The objects of forest management in the regional and local level should be so formulated that they are in perfect harmony with and flow from the fundamental principles of forest management as embodied in National Forest Policy.

In its resolution No. 3-1/86-FP dated 7th December, 1988, the Ministry of Environment of Forests, Govt of India, notified the National Forest Policy. While justifying the need to review and revise the Policy of 1952, the National Forest Policy of 1988, in its preamble, defines the job of conservation as one which includes preservation, maintenance, sustainable utilisation, restoration, and enhancement of the natural environment. We describe herein below some salient features of National Forest Policy (**The full text of the Resolution may be seen in the website <http://moef.gov.in/sites/default/files/introduction-nfp.pdf>**).

4.1 According to this Policy, the **ESSENTIALS OF FOREST MANAGEMENT** will be -

- Existing forests and forest lands should be fully protected and their productivity improved. Forest and vegetal cover should be increased rapidly on hill slopes, in catchment areas of rivers, lakes and reservoirs and ocean shores and, on semi-arid, and desert tracts.
- Diversion of good and productive agricultural lands to forestry should be discouraged in view of the need for increased food production.
- For the conservation of total biological diversity, the network of national parks, sanctuaries, biosphere reserves and other protected areas should be strengthened and extended adequately.
- Provision of sufficient fodder, fuel and pasture, specially in areas adjoining forest, is necessary in order to prevent depletion of forests beyond the sustainable limit. Since fuelwood continues to be the predominant source of energy in rural areas, the

programme of afforestation should be intensified with special emphasis on augmenting fuelwood production to meet the requirement of the rural people.

- Minor forest produce provides sustenance to tribal population and to other communities residing in and around the forests. Such produce should be protected, improved and their production enhanced with due regard to generation of employment and income.

4.2 STRATEGY

The strategy laid down by the Policy is briefly described below.

4.2.1 Area under Forests

The national goal should be to have a minimum of one-third of the total land area of the country under forest or tree cover. In the hills and in mountainous regions, the aim should be to maintain two-third of the area under such cover.

4.2.2 Afforestation, Social Forestry & Farm Forestry

- A massive need-based and time bound programme of afforestation and tree planting, with particular emphasis on fuelwood and fodder development, on all degraded and denuded lands in the country, **whether forest or non-forest land**.
- To encourage the planting of trees alongside of roads, railway lines, rivers and streams and canals, and on other unutilised lands under State/corporate, institutional or private ownership.
- **Village and community lands**, not required for other productive uses, should be taken up for the **development of tree crops and fodder resources**. **Technical assistance and other inputs** necessary for initiating such programmes should be provided by the Government. The revenues generated through such programmes should belong to the panchayats where the lands are vested in them; in all other cases, such **revenues should be shared with the local communities**. The vesting, in individuals, particularly from the weaker sections (such as landless labour, small and marginal farmers, scheduled castes, tribals, women) of certain ownership rights over trees, could be considered, subject to appropriate regulations; beneficiaries would be **entitled to usufruct** and would in turn be responsible for their security and maintenance.
- Land laws should be so modified wherever necessary so as to facilitate and motivate individuals and institutions to undertake tree-farming and grow fodder plants, grasses and legumes on their **own land**. Appropriate **regulations** should govern the **felling of trees on private holding**.



4.2.3 Management of State Forests

- **Schemes and projects** which interfere with forests that clothe steep slopes, catchments of rivers, lakes, and reservoirs, geologically unstable terrain and such other ecologically sensitive areas should be **severely restricted**. **Tropical rain/moist forests**, particularly in areas like Arunachal Pradesh, Kerala, Andaman & Nicobar Islands, should be totally safeguarded.
- **No forest** should be **permitted to be worked without** the Government having **approved the management plan**, which should be in a prescribed format and **in keeping with the National Forest Policy**.
- It is necessary to enhance forest cover and productivity of the forests through the application of scientific and technical inputs. **No production forestry programmes** should entail **clear-felling of adequately stocked natural forests**. Nor should **exotic species** be introduced, unless **long-term** scientific trials have established that they are suitable and have no adverse impact on native vegetation and environment.

4.2.3.1 Rights and Concessions

- The rights and concessions, including grazing, should always remain related to the carrying capacity of forests.
- The rights and concessions from forests should primarily be for the bonafide use of the communities living within and around forest areas, specially the tribals.
- The rights and concessions enjoyed by tribals and other poor living within and near forests should be fully protected. Their domestic requirements of fuelwood, fodder, minor forest produce and construction timber should be the first charge on forest produce.
- To relieve the existing pressure on forests substitution of wood needs to be taken recourse to.

4.2.4 Diversion of Forest Lands for Non-forest purposes

- Diversion of forest land for any non-forest purpose should be subject to the most careful examinations by specialists from the standpoint of social and environmental costs and benefits.
- Beneficiaries who are allowed mining and quarrying in forest land and in land covered by trees should be required to repair and re-vegetate the area in accordance with established forestry practices.

4.2.5 Wildlife Conservation

- Forest Management should take special care of the needs of wildlife conservation, and forest management plans should include prescriptions for this purpose. It is specially



essential to provide for "corridors" linking the protected areas in order to maintain genetic continuity between artificially separated sub-sections of migrant wildlife.

4.2.6 Tribal People and Forests

A primary task of all agencies responsible for forest management should be to associate the tribal people closely in the protection, regeneration and development of forests as well as to provide gainful employment to people living in and around the forest. While safeguarding the customary rights and interests of such people, forestry programmes should pay special attention to the following:

- contractors should be replaced by institutions such as tribal cooperatives, labour cooperatives, government corporations, etc. as early as possible;
- Protection, regeneration and optimum collection of minor forest produce along with institutional arrangements for the marketing of such produce;
- Development of forest villages on par with revenue villages;
- Family oriented schemes for improving the status of the tribal beneficiaries;

4.2.7 Shifting Cultivation

Efforts should be made to contain such cultivation within the area already affected, by propagating improved agricultural practices. Area already damaged by such cultivation should be rehabilitated through social forestry and energy plantations.

4.2.8 Damage to Forests from Encroachments, Fires and Grazing

- Encroachment on forest lands has been on the increase. This trend has to be arrested and effective action taken to prevent its continuance. There, should be no regularisation of existing encroachments.
- The incidence of forest fires in the country is high. Special precautions should be taken during the fire season. Improved and modern management practices should be adopted to deal with forest fires.
- Grazing in forest areas should be regulated with the involvement of the community. Special conservation areas, young plantations and regeneration areas should be fully protected.

4.2.9 Forest-based Industries

The main considerations governing the establishment of forest-based industries and supply of raw material to them should be as follows:

- As far as possible, a forest-based industry should raise the raw material needed for meeting its own requirements.



- No forest-based enterprise, except that at the village or cottage level, should be permitted in the future unless it has been first cleared after a careful scrutiny with regard to assured availability of raw material.
- Natural forests will not be made available to industries for undertaking plantation and for any other activities.
- The practice of supply of forest produce to industry at concessional prices should cease.

4.2.10 Forest Extension

It is essential to inculcate in the people, a direct interest in forests, their development and conservation, and to make them conscious of the value of trees, wildlife and nature in general.

4.2.11 Forestry Education

Agriculture universities and institutions, dedicated to the development of forestry education should formulate curricula and courses for imparting academic education and promoting postgraduate research and professional excellence.

4.2.12 Forestry Research

Emphasis must be laid on scientific forestry research, necessitating adequate strengthening of the research base as well as new priorities for action. Some broad priority areas of research and development needing special attention are:

- Increasing the productivity of wood and other forest produce.
- Revegetation of barren/marginal/waste/mined lands and watershed areas.
- Effective conservation and management of existing forest resources (mainly natural forest eco-systems).
- Research related to social forestry for rural/ tribal development.
- Development of substitutes to replace wood and wood products.
- Research related to wildlife and management of national parks and sanctuaries.

4.2.13 Personnel Management

Government policies in personnel management for professional foresters and forest scientists should aim at enhancing their professional competence and status and attracting and retaining qualified - and motivated personnel, keeping in view particularly the arduous nature of duties they have to perform, often in remote and inhospitable places.

4.2.14 Forest Survey and Data Base

Priority needs to be accorded to completing the survey of forest resources in the country on scientific lines and to updating information.



4.2.15 Legal Support and Infrastructure Development

Appropriate legislation should be undertaken, supported by adequate infrastructure, at the Centre and State levels in order to implement the Policy effectively.

4.2.16 Financial Support for Forestry

The objectives of this revised Policy cannot be achieved without the investment of financial and other resources on a substantial scale. Such investment is indeed fully justified considering the contribution of forests in maintaining essential ecological processes and life support systems and in preserving genetic diversity.

Reference material

1. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun
2. Website cited in the lesson.





Lesson 2

Time 1 hour

Lesson Plan

Objective: To study

- **Forest Organisation**
 - Territorial classification
 - Management (silvicultural) classification
 - Felling Series
 - Working Circle
 - Coupe
 - Cutting Section

Backward linkage – Lessons in Silvicultural System.

Forward linkage – Subsequent lessons

Training materials – Copy of Lesson 2 to be circulated beforehand

Allocation of time –

- **Forest Organisation**
 - Territorial classification 10 mts
 - Management (silvicultural) classification 40 mts
 - Felling Series
 - Working Circle
 - Coupe
 - Cutting Section

- **Discussion/Miscellaneous** 10 mts



Forest Organisation

1. Territorial Classification

Block – It is a main territorial division of a forest. It is normally bounded by natural features and bearing a local name. A forest block has clear-cut boundary which should carry boundary pillars. For example, Panjhora is a forest block of Upper Tondu Range, Jalpaiguri Forest Division, representing an identifiable forest area.

Compartment – A block is divided into several compartments. A compartment is a permanent unit of forest for the purpose of administration and record. It is the smallest Working Plan unit of management. Its boundaries are carefully chosen on the ground and marked on the map. The boundaries are formed by natural features or permanent fire lines. The extent of area of a compartment depends on the intensity of management. A compartment is designated by numerals 1, 2, 3 etc.

Sub-compartment – When a compartment area is too big for uniform description or uniform treatment, it is divided into sub-compartments, which then become units of silvicultural management. The sub-compartments are designated by small letters a, b, c etc.

1.1 Territorial classifications in south West Bengal

The classification in terms of blocks and compartments is prevalent in north Bengal, where most of the forests are reserved forests. In south Bengal the classification is in terms of Mouzas and within a Mouza, in terms of Plot Number (or Dag Number).

2. Management (silvicultural) Classification

From the point of view of silvicultural management, forests are classified into (1) Working Circle, (2) Felling Series, (3) Cutting Sections, (4) Coupes, and (5) Periodic Blocks.

2.1 Working Circle – Working Plan (WP) is a written scheme of management aiming at continuity of policy and action and controlling the treatment of a forest (Ram Parkash 1986). A WP is usually prepared for a forest division. That is, for each division there should be a corresponding WP. Since the area covered by a WP (area of a Division) is large and normally heterogeneous in composition, different silvicultural treatments and different working rules (prescriptions) should apply to different parts of the area. The different parts into which the WP area gets divided from the viewpoint of management prescription are called Working Circles (WC). **A W.C may be defined as a forest area (forming part or whole of the W.P area) organized with a particular object and subject to one and the same silvicultural system and the same set of Working Plan prescriptions** (Ram Parkash 1986). In some cases, however, the Working Circles may overlap.

2.2 Felling Series - To avoid concentration of felling to a particular area and to distribute forestry works over a number of Ranges, a W.C is normally divided into **Felling Series (F.S.)**. A F.S. is defined as a forest area forming the whole or part of a W.C. and delimited so as: (1) to distribute felling and regeneration to suit local conditions and (ii) to maintain or create a normal distribution of age classes (Ram Parkash 1986).

[Normal distribution of age class – A complete series of age classes in such proportion as will permit equal volumes from annual or periodic fellings.]

Each F.S. is assigned a self contained unit of management (say, annual or periodic felling area) with a separate calculation of yield and a separate series of silvicultural operations (say tending operations). When a W.C. is not divided into several F.S, one F.S covers the entire W.C.

2.3 Coupe – In a clear-felling system, a F.S. is divided into a number of **Annual Coupes**. If the Rotation age is **R years**, and the area of a F.S. is **A ha**, then the number of annual coupes is **R**, each of area **A/R ha**. Each F.S will have all the R age-gradations. The management unit of coupe is explained with reference to clear-felling system.

The following diagrams give an illustrative example for a felling series of 20 age gradations (R = 20 years). Fig.2.1 shows diagrammatically in plan the F.S of 20 age gradations divided into 20 equal annual coupes. Fig. 2.2 is the profile diagram showing the profile of regeneration after felling of five annual coupes.

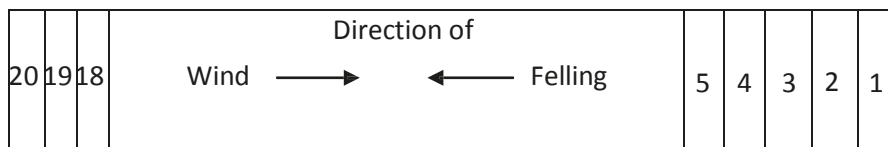


Fig. 2.1 Plan of a F.S with 20 annual coupes



Fig. 2.2 Profile of regeneration after felling of five annual coupes

(Source: Ram Parkash 1986 Forest Management)



It may be noted that felling should start against the prevailing direction of wind. The profile would then be as shown, that is, the smallest trees would be in the windward direction when the felling series has been established. The younger trees will break the wind speed and protect the older ones in the rear.

2.4 Cutting Section – At times, in view of silvicultural considerations, it is advisable that the coupes in successive years should not be contiguous. The silvicultural considerations could be fire hazard or insect attack or creation of wide gaps etc. In such case a F.S is subdivided into a number of **Cutting Sections** and coupes in successive years are moved from one cutting section to the next section. A **Cutting Section** is defined as a sub-division of a F.S. formed with the object of regulating felling in a special manner (Ram Parkash 1986 Forest Management). If the F.S. shown in Fig. 2.1 and 2.2 is divided into 4 cutting sections, the plan and profile of the first eight coupes will be as shown in Fig.2.3 and 2.4. The location of the coupes in successive years has been shown by numbers 1, 2 3, etc. It may be seen that felling in each cutting section will take place at 4 years interval.

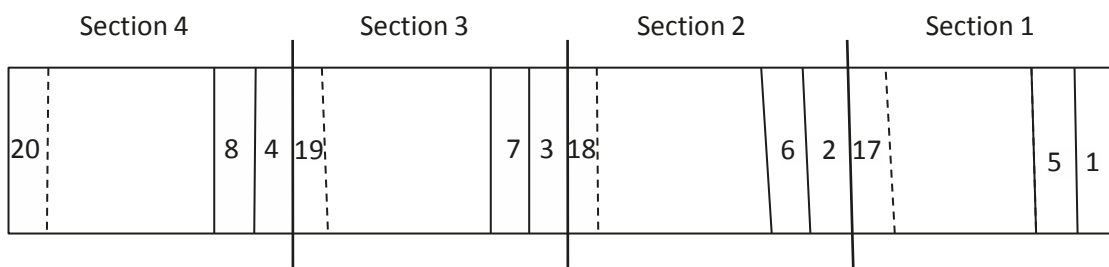


Fig.2.3 Plan of first eight coupes in four cutting sections

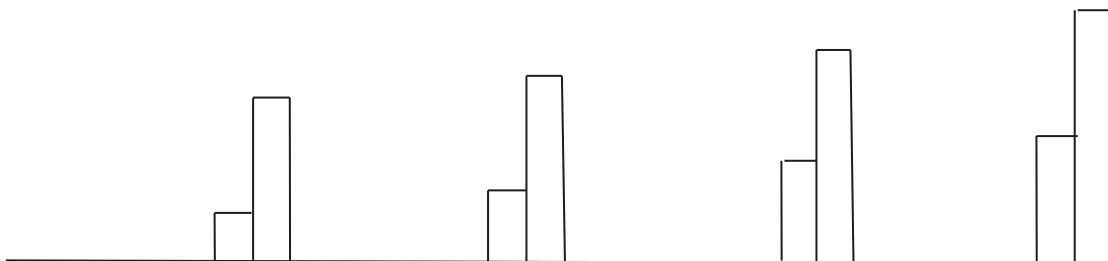


Fig.2.4 Profile of regeneration after eight years following felling of eight coupes

(Redrawn from Ram Parkash 1986 Forest Management)

3. Exercise

Answer the questions related to the following felling series worked on clear-felling system.

Area of Felling Series – 360 ha

Rotation – 30 years.

Number of Cutting Sections of equal size - 5

(a) What is the area of each cutting section?

(b) What is the area of annual coupe?

(c) How many annual coupes should there be in each cutting section?

Draw diagrams showing the plan of annual coupes and profile of regeneration after ten years.

Reference material

1. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun
2. Website cited in the lesson.



Lesson Plan**Objective: To study**

- **Forest Organisation (Continued)**
 - Management (silvicultural) classification (Continued)
 - Periodic Blocks – Uniform System
 - Felling Cycle – Selection System
 - Felling series in Coppice with Standards

Backward linkage – Lessons in Silvicultural System.

Forward linkage – subsequent lessons

Training materials – Copy of Lesson 3 to be circulated beforehand

Allocation of time –

- **Forest Organisation (Continued)**
 - Management (silvicultural) classification (Continued)
 - Periodic Blocks – Uniform System 20 mts
 - Felling Cycle – Selection System 20 mts
 - Felling series in Coppice with Standards 15 mts

- **Discussion/Miscellaneous** 5 mts



Forest Organisation

1. Periodic Blocks: Uniform System

The shelterwood or uniform silvicultural system has been described in “Silviculture of trees and Solviculture system”, which may please be referred to. In this lesson the concept of ‘Periodic Blocks’ is further explained with reference to Felling Series in Uniform System.

- 11 Please refer to management units with reference to Clear-felling system described in previous lesson. In Uniform system of natural regeneration, we have ‘age class’ in place of ‘age gradation’, and ‘periodic blocks (PB)’ in place of annual coupes. Each P.B has one age-class instead of one age-gradation.
- 12 A Periodic Block (PB) is defined as a part of or parts of forest set aside to be regenerated, or otherwise treated, during a specified period. The regeneration block is called “floating” or “single” when it is the only P.B allotted at each Working Plan revision. When all PB s are allotted and they retain their territorial identity at Working Plan revision, they are termed “fixed” or “permanent”. (Ram Parkash 1986 Forest Management)
- 13 We cite below an example of PBs in case of a forest which is worked under Uniform Shelterwood system.

Suppose the rotation is 120 years and the regeneration period 30 years.

[Regeneration period is the period required to regenerate the whole area of a P.B. The regeneration period depends on the species and the locality factors].

The number of PBs in the Felling Series

$$= \frac{\text{Rotation}}{\text{Regeneration period}} = \frac{120}{30} = 4$$

$$\text{The normal area of each PB} = \frac{\text{Area of F.S}}{\text{Number of P.B}}$$

In other words, the total area of the FS (or WC, if there is one F.S) is divided into P.B s (in this case 4 P.B s) of equal size.

Arrangement of age classes is shown in **Fig.3.1**. The PB I contains trees in the age class 91-120 years, PB II trees in the age class 61-90 years, PB III trees in the age class 31-60 years, and P.B IV trees in the age class 1-30 years. Each P.B is regarded as approximately even aged (Even-aged stand is one which consists of trees of approximately the same age. Variation upto 25% of rotation age is allowed when the rotation is 100 years or more. Thus in the present case the PBs are even-aged stands).

The first thirty annual coupes or age-gradations are grouped together to form P.B I . The P.B I coupes will be felled, and regenerated gradually by seedling, secondary and final felling during the period of first thirty years. After the lapse of first thirty years, P.B I will automatically move to PB IV (age class 1-30 years), PBI to PB II (31-60 years), PB II to PB



III (61-90 years) and PB II to PBI (91-120 years). At the end of 120 year rotation, the original P.B I area will again become P.B I, and the whole F.S or WC will be converted into four P.B s containing age classes as shown in Fig.3.1.

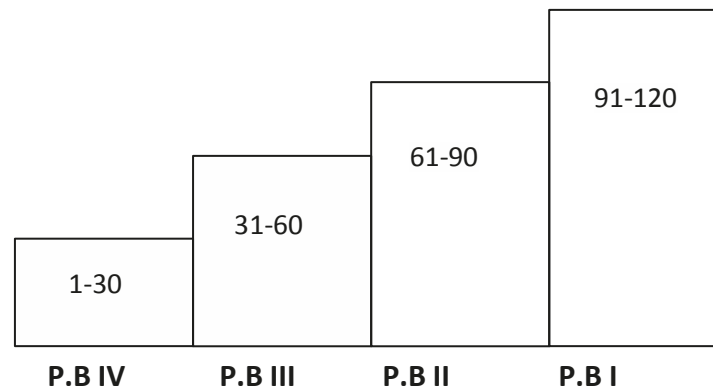


Fig.3.1 Arrangement of age classes and P.B s in a F.S worked under Uniform System

(Source: Ram Parkash 1986 Forest Management)

2. Felling Cycle - Selection Forest

A Selection forest is one which is managed under Selection system. **The Selection system has been described in “Silviculture of trees and silviculture System” which may please be referred to.** A selection forest is an uneven-aged crop containing many, theoretically all age-classes or gradations. (Ram Parkash 1986 Forest Management).

21 Ideally, the entire area of a selection forest should be gone over every year and the entire forest should represent a complete and undivided felling series. Since annual working of the entire area is not feasible, the forest area is divided into a number of coupes. Each of these coupes is worked at an interval of planned number of years, which is known as **felling cycle**.

22 **Felling Cycle** is defined as the time that elapses between successive main fellings on the same area. **The number of coupes will be equal to the number of years in the Felling Cycle.**

23 **Let us take an example of a Selection Forest**

Suppose -

Area of a Felling Series (or W.C if there is one F.S) = 200 ha.

Rotation = 50 years.

[In ideal selection system, the entire 200 ha will be worked annually on selection basis for 50 years, that is trees of rotation age (50 years) will be harvested from the whole forest every year]

However, in periodic felling system, the FS is divided into coupes to be worked in felling cycles.

Suppose,

Felling cycle planned = 5 years,

Then number of felling coupes = 5, each of area 40 ha.

Every coupe will be worked at an interval of 5 years, that is, 10 times during the rotation. In the year of harvest in a coupe, trees ranging from 45 to 50 years in age would be felled, and the coupe will be revisited after 5 years to do the same operation. **In each felling the intensity or quantity of harvest in a coupe will be 5 times of what would have been, had the entire felling series been worked every year as envisaged in ideal or true selection system.**

The Felling series with 5 felling coupes and the sequence of felling is illustrated in Fig.3.2.

| I | II | III | IV | V |
|----------------|----------------|----------------|----------------|-----------------|
| 1,6,11,.....46 | 2,7,12,.....47 | 3,8,13,.....48 | 4,9,14,.....49 | 5,10,15,.....50 |

**Fig.3.2 Felling Series worked on 5-year Felling Cycle.
(Numerical figures denote the year of working)**

(Source: Drawn from Ram Parkash 1986 Forest Management)

3. Felling Series in Coppice- with- Standards (CWS) system

(Ram Parkash 1986 Forest Management)

In CWS, the arrangement of the age-gradations in overwood comprising standards is the same as in theory in Selection Forests, regarding each coupe to be a Cutting Section. **Please see Fig. 3.3**, which represents C.W.S felling Series **immediately before the felling of 10th annual coupe**, where -

r = rotation of coppice (underwood) = 10 years

R = rotation of standards (overwood) = 40 years.

The age gradation of the standards in the various coupes is as follows -

In the 10th coupe - 20, 30, 40 years.

In the 9th coupe - 19, 29, 39 years

In the 8th coupe - 18, 28, 38 years

.....

In the 4th coupe - 14, 24, 34 years

.....

In the 1st coupe - 11, 21, 31 years



It is thus seen that all age-gradations of standards from 11 to 40 years is present in the Felling Series. But the age-class 0 to 10 is missing, which is included in the underwood (Coppice).

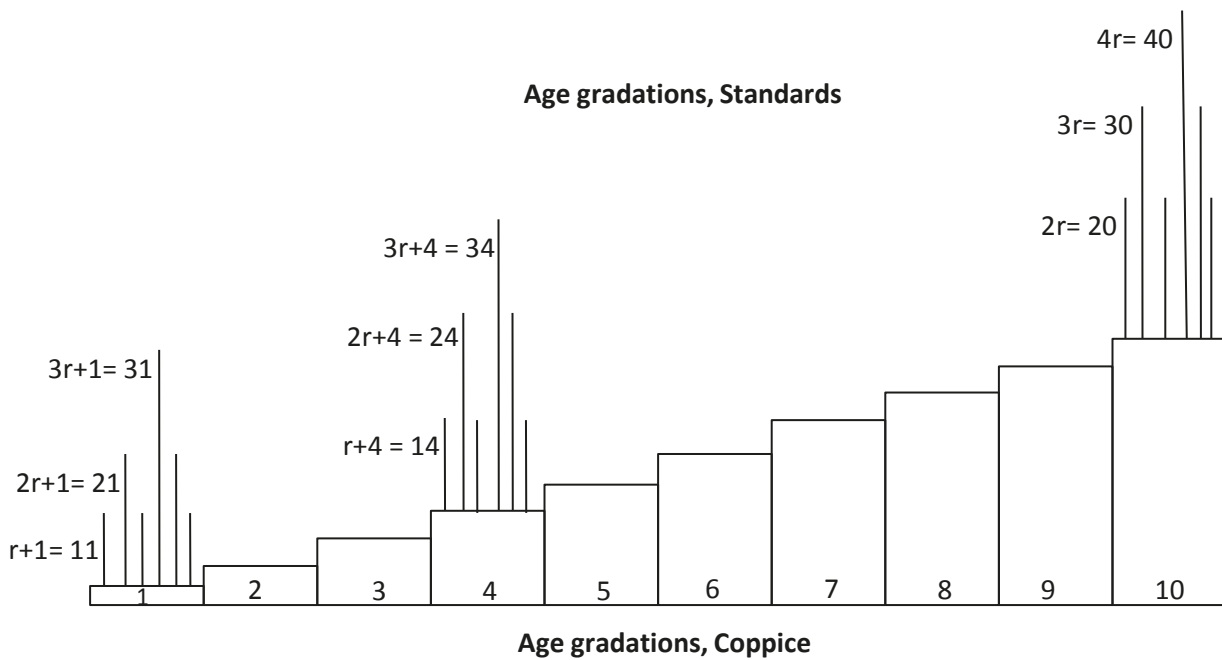


Fig.3.3 Felling Series in C.W.S System

(Source: Drawn from Ram Parkash 1986 Forest Management)

3.1 Calculation of Yields

The yield from the standards will depend on the number of standards of each age that are retained while felling each coupe. Let us take an example.

Suppose in the above example where of $r=10$ years, and $R=40$ years –

No of standards to be retained of age 10 years – 100

No of standards to be retained of age 20 years - 60

No of standards to be retained of age 30 years - 30

Then, when coppice coupe is felled, 100 trees will be left to grow into standards. With such plan of retention of standards, the scenario of the **age-gradation of standards and their corresponding number in the coupes depicted in Fig 3.3 will be as follows.**

| Annual Coupe | Age in years | Number |
|-------------------|--------------|-------------------------|
| 1 | 11 | 100 |
| | 21 | 60 |
| | 31 | 30 |
| | | |
| 4 | 14 | 100 |
| | 24 | 60 |
| | 34 | 30 |
| | | |
| 9 | 19 | 100 |
| | 29 | 60 |
| | 39 | 30 |
| 10 (to be felled) | 20 | 100 (60 to be retained) |
| | 30 | 60 (30 to be retained) |
| | 40 | 30 (to be felled) |

Thus on felling of 10th annual coupe, the yield from standards will be

**40 (=100 -60) trees of 20 years age +
30 (60-30) trees of 30 years age +
30 trees of 40 years age.**

The above will be the **annual yield** of standards from the Felling Series, which is regulated by number. Yield of coppice (underwood) is regulated by area.

Reference material

1. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun





Lesson 4

Time 1 hour

Lesson Plan

Objective: To study

- **Sustained Yield**
 - Concept and Definition
 - Prerequisites for sustained yield management
- **Normal Forest**
 - Definition
 - Attributes/Characteristics of Normality

Backward linkage – Previous Lessons on Forest organization.

Forward linkage – Subsequent lessons

Training materials – Copy of Lesson 4 to be circulated beforehand

Allocation of time –

- | | |
|--|--------|
| • Sustained Yield | |
| ➤ Concept and Definition | 10 mts |
| ➤ Prerequisites for sustained yield management | 15 mts |
| ➤ Normal Forest | |
| ➤ Definition | 5 mts |
| ➤ Attributes/Characteristics of Normality | 15 mts |
| ➤ Normality related to treatment and rotation | 10 mts |
| • Discussion/Miscellaneous | 5mts |



Sustained Yield

1. Concept and definition

The principle of maximum sustained yield forms the basic objective of good forest management. Sustained yield has been defined by many authors in various ways. Some of the definitions of sustained yield, which carry same meaning in different ways, are given below.

- The material that a forest can yield annually (or periodically) in perpetuity.
- The regular, continuous supply of the desired produce to the full capacity of forest.
- The yield of timber or other forest produce from a forest which is managed in such a way as to permit the removal of approximately equal volume or quantity of timber or other forest produce annually, or periodically in perpetuity.

(Ram Parkash 1986 Forest Management)

- 1.1** Yield from forest includes all forest products, both tangible and intangible. So, ideally the principle of sustained yield should ensure continuous supply, in equal amounts, of both material and intangible benefits.
- 1.2** Concept of sustained yield has emanated from the unavoidable obligation that the later generations may enjoy from the forest at least as much of the benefits as the present generation.
- 1.3** The management for sustained yield demands that the annual or periodic fellings do not exceed the annual or periodic growth, as the case may be. The sustained yield is thus expressed as the allowable cut, annually or periodically, which is approximately equal to the net increment of forest (i.e. gross increment minus the natural loss), annually or periodically.
- 1.4** The basic aim of forest management is to keep the forest land productive. It is obvious that sustained yield from the forest is not possible unless the productivity of forest land is kept intact. Sustained yield management therefore means continuity of harvest without impairment of productivity of forest soil.

2. Prerequisites for Sustained Yield Management

The simplest way to achieve sustained annual yield is to maintain a complete succession of equal areas of crops of all ages from one year old upto the age of maturity (rotation), that is, even-aged stand of age 1, 2, 3 etc years (upto rotation age) will occupy equal area of forest. Let us take an example of forest having total area of 10 ha; the maturity age of the crop is say 10 years. The forest area is managed in such a way that 10 equal parcels of 1 ha each bear crop of age 1, 2, 3,, 10 years respectively. Suppose the

volume increment of the forest per year per ha is 50 m^3 . Then the growing stock (the sum, by number or volume, of all the trees in a specified area) of the parcels in this example, expressed in volume, will be as shown in the following Table 4.1

Table 4.1

Theoretical Normal growing stock in a series of 10 equal age gradations (1 ha each)

| Parcel/coupe No | Area (ha) | Age of the crop (Years) | Growing stock (m^3) |
|-----------------|-----------|-------------------------|--------------------------------|
| 1 | 1 | 1 | 50 |
| 2 | 1 | 2 | 100 |
| 3 | 1 | 3 | 150 |
| 4 | 1 | 4 | 200 |
| 5 | 1 | 5 | 250 |
| 6 | 1 | 6 | 300 |
| 7 | 1 | 7 | 350 |
| 8 | 1 | 8 | 400 |
| 9 | 1 | 9 | 450 |
| 10 | 1 | 10 | 500 |

The annual increment of the forest of 10 ha area is 500 m^3 . According to the principle of sustained yield, 500 m^3 of produce can be harvested annually. But in clear-felling system, instead of cutting 50 m^3 from each parcel of 1 ha, the 10th parcel (I ha) containing the mature 10-year old crop is clear-felled, its growing stock of 500 m^3 is removed and the area is planted again. Please note that the 10th coupe containing the mature crop has gained 500 m^3 of volume (growing stock) over the last ten years. As the forest in this example has equal area (1 ha) of every age, an equal area (1 ha) will be available for felling at maturity every year.

2.1 The prerequisite for sustained yield in clear-felling system is thus

- **Establish and maintain equal areas of coupes with a series of age-gradations starting from one year to maturity.**
- **Remove the coupe of mature crop (rotation age) annually.**
- **Plant up the felled coupe every year.**

Establishment of a forest having such a series of age gradations, as described above, is one form of crop necessary for sustained yield management.

2.2 The clear-felling system described above is the simplest way of sustained yield management. This is not, however, the only way. From the point of view of silviculture,



in some cases, it may not be advisable to grow each year's crop on separate area, and thus produce a forest comprising equal areas of pure even-aged stand covering all age gradation. For certain species it may be advisable to grow several age-gradations mixed together, forming an age-class on a proportionately larger area, as is done under Regular Shelterwood (Uniform) system with natural regeneration. **Please refer to Lesson 3. In Uniform system, sustained yield will be available, if all the Periodic Blocks occupy equal/ equiproductive areas.** We may also consider **Selection Forest**, that is, forest worked under Selection System. In Selection Forest, sustained yield will be available if all age-classes are present in the forest in balanced proportion.

2.3 The characteristics of a forest, whether regular or irregular, as described above, that enable a sustained yield are the attributes of the normality of the forest with different patterns of age gradation/class distribution. Hence for sustained yield, the forest must be normal.

3. Normal Forest

At the very outset it should be noted that 'Normal Forest' **does not mean usual, common or regular forest**, as the connotation of the word 'normal' may perhaps indicate. Normal Forest is a conception of forest management based on the principle of **sustained yield**.

3.1 Definition – Normal Forest is variously defined. A couple of definitions are described below.

- i. A forest which, for a given site and given objects of management, is ideally constituted as regards growing stock, age-class distribution and increment, and from which the annual or periodic removal of produce equal to the increment can be continued indefinitely without endangering future yields. A forest which by reason of its normalcy in these respects serves as a standard of comparison for sustained yield management.
- ii. A forest which contains a regular and complete succession of age-gradations or classes (several age gradations thrown together) in correct proportion so that an annual or periodic felling of the ripe woods results in an equalization of the annual or periodic yields.

(Source: Ram Parkash 1986 Forest Management)



3.2 Attributes/Characteristics of Normality (Source: Ram Parkash 1986 Forest Management)

A Normal Forest being an ideal forest managed for sustained yields in perpetuity has the following **three main attributes**.

- I. **A normal series of age-gradations or age-classes.**
- II. **A normal increment**
- III. **A normal growing stock**

3.2.1 Normal series of age-gradations or classes – It means trees of all ages from one year old to rotation age are present in appropriate quantity. If the trees of each age occur on separate areas, they constitute a **series of age-gradations**. When the trees falling within certain age limits occur mixed together on the same area, they form an **age-class**. A very irregular forest which does not exhibit age-gradation or age-class may still be a normal forest, and the sign of normality in this case is the proper distribution of trees of all ages.

3.2.2 Normal Increment – it is the **best or maximum increment** attainable by a given species for a given rotation, per unit area on a given site.

3.2.3 Normal growing stock – It is the volume of stands in a forest with normal age –classes and normal increment.

3.2.4 If the forest has normal age-gradation or age-class and normal increment, obviously it will have normal growing stock. Thus the necessary and sufficient conditions for normality are (i) normal age-gradation or age-class, and (ii) normal increment. It should be remembered that normal forest represents an ideal condition which is rarely achieved in practice.

3.2.5 The easiest way to visualize a normal forest is to consider a forest comprising of a series of even-aged plantations of equal area, each of one age gradation, worked under clear-felling or coppice system as illustrated in para 2 and Table 4.1.

3.2.6 However, it is not necessary that in order to qualify as normal forest, each age gradation/class has to be distinctly separated into separate crops as in forests worked under clear-felling system or Uniform system. Crops of different age-gradations/class may be thoroughly mixed up on the ground as in the case of irregular all-aged Selection forests, provided however those crops of all age and size classes are available in balanced proportion.

3.3 Normality related to treatment and rotation

The concept of a normal forest is artificial, and has been developed to meet the needs of forest management. No virgin forest is normal. The closest position to this theoretical concept can be achieved in plantations which are entirely artificial. The concept of normality is related to both rotation and the system of management. The three main



attributes, namely, normal age-class, normal increment and normal growing stock will vary with rotation. Similarly, the data for normality will vary for a coppice forest, an even-aged high forest and a selection forest. In other words normality attributes will depend on the silvicultural system, even though the species, the site and the rotation remain the same. Normal forest is a mathematical abstract concept. In practice, the forests may deviate from a normal forest, and thus have abnormality in many respects.

- Forests may be over-stocked;
- They may be under-stocked;
- While having normal growing stock, forests may have abnormal distribution of age-classes or age-gradations;
- Increment may be abnormal;

Reference material

1. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun



Forest Management

Lesson 5

Time 1 hour

Lesson Plan

Objective: To study

- **Increment**
 - Factors influencing increment
- **Current Annual Increment**
 - Definition and concept
- **Mean Annual Increment**
 - Definition and concept
- **Variation of CAI and MAI with age**

Backward linkage – Previous Lessons on Forest Management; Lesson 6 of Forest Mensuration

Forward linkage – Subsequent lessons

Training materials – Copy of Lesson 5 to be circulated beforehand; graph paper

Allocation of time –

- | | |
|--|--------|
| • Increment | 10 mts |
| ➤ Factors influencing increment | |
| • Current Annual Increment | 8 mts |
| ➤ Definition and concept | |
| • Mean Annual Increment | 7 mts |
| ➤ Definition and concept | |
| • Variation of CAI and MAI with age | 10 mts |
| • Exercise | 20 mts |
| • Miscellaneous/Discussion | 5 mts |



1. Increment

Increment is the growth of a tree or a crop with age. By the term increment, one may indicate the physical increase of different parameters that increase with time or age. Thus increment may refer to increase of wood content, or any of the factors increasing with age, like, volume, diameter, height, basal area, price etc.

1.1 In Forest Management, the term **increment refers normally to volume increment of crop.**

1.2 Factors that influence increment

Increment of individual trees or crop is influenced by

- **Species** – fast growing species have larger increment than the slow ones in a given period.
- **Site Quality** – it is natural that superior site quality favours higher increment.
- **Silvicultural Treatment** – silvicultural treatment including tending operations have considerable influence on increment.
- **Nature of the crop** – nature of crop, that is whether even-aged or uneven-aged, influences the increment.

1.3 Increment is an important characteristic

Increment is an important characteristic of a forest crop. It is an indicator of the health of the crop, the site quality, and age or maturity of the crop. It is an index indicating suitability of a species at a given site or performance of a silviculture system.

1.3.1 A virgin forest, or a forest which has remained undisturbed for a long time, or a forest which has reached its climax, will not have any net increment. While individual trees may put on increment, other trees decay and die. In fact, the increment may also become negative for a period if there are adverse locality factors. Thus increment may be an indicator for maturity of a crop or impact of locality factors.

1.4 Current Annual Increment – Definition and concept

The growth that takes place in a particular year is called the Current Annual Increment (C.A.I) for that year. Thus CAI indicates the increase in girth, diameter, basal area, height, volume of individual trees or a crop in a specific year.

1.4.1 Annual Increment of individual tree or crop of a species is not constant. It is rather a function of age of the tree (crop). In other words, CAI depends on the age. So while mentioning the value of CAI, it is necessary to mention the age of the tree (crop) to which the CAI corresponds.



So, if

V_{n-1} = volume of wood produced in (n-1) years, i.e. volume at the age of (n-1) years;

V_n = volume of wood produced in n years, i.e. volume at the age of n years,

CAI at the age of n years = $V_n - V_{n-1}$

1.4.2 It would be apparent from above that to obtain accurate values of CAI, it is necessary to know the values of V_{n-1} , V_n , V_{n+1} , V_{n+2} etc. it is, however, not feasible to measure and record the volume (or other parameter) of tree (crop) every year. Measurement of a tree parameter is normally done at periodic intervals of 5 or 10 years, and increment over such period is determined, which is called **periodic increment**. When the periodic increment is divided by the years of the period, one obtains **periodic annual increment**, which is taken as CAI for the period.

1.5 Mean Annual Increment – Definition and Concept

The volume of a tree is built up by the annual increments that the tree puts on in successive years. The CAIs vary from year to year. The mean or average of all CAIs is the **Mean Annual Increment (M.A.I)** which denotes average annual rate of growth upto any given age. M.A.I is thus defined as the total increment upto a given age divided by that age.

In the context of volume increment,

If, V_n = volume of wood produced in n years, i.e. volume at the age of n years,

$$\text{M.A.I} = \frac{V_n}{n}$$

It may be noted that MAI for a tree or crop varies with age.

1.6 Variation of CAI and MAI with age

Both for individual tree and crop, **CAI is small in the early stages** of growth (seedlings and saplings. However, soon **it increases rapidly to a maximum value**, after which CAI declines and finally ceases with the mortality of tree (crop).

The sum of CAIs of volume put on during a period gives the total volume which when divided by the period (age) gives the MAI. Being a mathematically computed figure the MAI coincides with the actual values of CAI only on two occasions in the life of the crop – once at the end of the first year, and later when it culminates, that is, reaches its maximum value.



Please see Fig. 5.1 which illustrates the variation of CAI and MAI of Sal crop in three different site qualities. These are typical CAI and MAI curves whose following features may be noted.

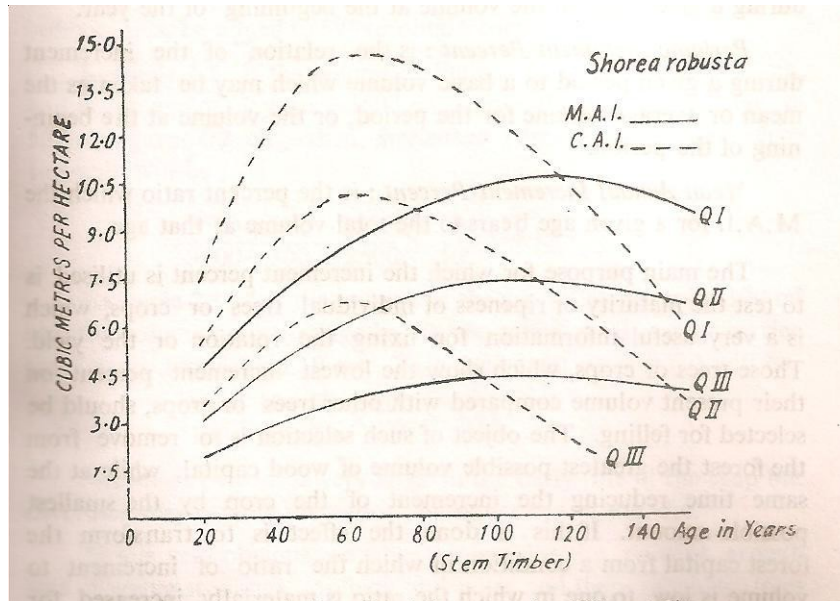


Fig. 5.1 MAI and CAI curves for different site qualities of Sal

(Source: Ram Parkash 1986 Forest Management)

- While the crop is young the CAI increases rapidly till it reaches the maximum value at the middle age.
- On account of rise in the value of CAI, MAI also rises but not so steeply as the CAI, as in the calculation of MAI the effect of increasing CAI gets distributed over all the previous years.
- Even after CAI begins to decline, the MAI still continues to rise for a period, as at this stage the declining CAI still remains greater than the average or mean increment.
- The MAI reaches the maximum value where the two curves intersect. In other words, at the age corresponding to the point of intersection, the CAI and MAI equal each other.
- Beyond the point of intersection, both CAI and MAI continue to decline. At this stage, CAI declines faster than the MAI, and CAI is less than the mean.

2. Exercise

Draw CAI and MAI curves from the data given in the following table.

Table 5.1

| Age (years) | MAI(m³/ha) | CAI (m³/ha) |
|--------------------|------------------------------|-------------------------------|
| 10 | 1.75 | 4.78 |
| 20 | 3.15 | 5.88 |
| 40 | 5.32 | 9.51 |
| 60 | 6.99 | 10.77 |
| 80 | 7.56 | 9.91 |
| 100 | 8.11 | 8.40 |
| 120 | 7.96 | 6.86 |
| 140 | 7.69 | 5.32 |

(MAI and CAI in site quality II crop of Sal, source: Ram Parkash 1986 Forest Management)

Reference material

1. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun



Forest Management

Lesson 6

Time 1 hour

Lesson Plan

Objective: To study

- **Rotation**
 - **Definition and concept**
- **Rotation in regular and irregular crop**
- **Types of Rotation**
 - Physical
 - Silvicultural
 - Technical
 - Rotation of Maximum Volume Production
 - Rotation of Highest Income/Revenue
 - Financial
- **Fixation of Rotation**

Backward linkage – Previous Lessons on Forest Management;

Forward linkage – Subsequent lessons

Training materials – Copy of Lesson 6 to be circulated beforehand;

Allocation of time –

- | | |
|---|--------|
| • Rotation | |
| ➤ Definition and concept | 7 mts |
| • Rotation in regular and irregular crop | 5 mts |
| • Types of Rotation | 30 mts |
| ➤ Physical | |
| ➤ Silvicultural | |
| ➤ Technical | |
| ➤ Rotation of Maximum Volume Production | |
| ➤ Rotation of Highest Income/Revenue | |
| ➤ Financial | |
| • Fixation of Rotation | 8 mts |
| • Miscellaneous/Discussion | 10 mts |

Rotation

1. Introduction – Definition

In the context of harvest, forest crops have some characteristic features.

- The main forest produce, that is, timber takes a long time to mature.
- In general, trees should be harvested when they mature, that is, at an age when the timber attains utilizable size and can fetch good price, and beyond which quality of timber starts deteriorating.
- The age of maturity of timber varies from species to species, and also depends on conditions of growth.
- The standard or yardstick of ripeness or maturity of forest crop, however, varies and is determined by forest policy, planning and object of management. Forest crops have utility at different ages. Talking about timber, price per unit volume rises sharply with size, and therefore if yield of timber is the object of management, crop should be harvested at an age when it gives maximum volume of timber. However, for industrial timber of certain specifications, it may be necessary to harvest trees at a younger stage. For example, for mining timber, stems of pole size are required.

1.1 Rotation or Production period is the time that elapses between the formation and final felling of a forest crop. It is also **defined** in many ways by different authors.

- (1) The planned number of years between the formation or regeneration of a crop and its final felling. In the case of selection forest, the average age at which a tree is considered mature for felling. (Glossary)
- (2) The number of years fixed by the Working Plan between the formation or regeneration and the final felling of a crop. (Brasnett)
- (3) Rotation age is the age of trees or crops at which when they are felled, objects of management for the time being are best served. (Knuchel)
- (4) Rotation is the period which elapses between the formation of a wood and the time when it is finally cut over. (Jerram)

[Source: Ram Parkash 1986 Forest Management]

2. Rotation in Regular and Irregular crop

The concept of rotation, as defined above, strictly speaking, applies to regular crops only. In regular forests, entire crops over a sizable area are felled at a time (as in clear felling system) or over a short period of time (regeneration period in regular shelterwood system). Thus there is



a clear production period. This production period or rotation is planned in advance, and is uniquely fixed for a Working circle.

2.1 In unevenaged (irregular) selection forests, trees are selected for felling individually based on –

- Size, health and marketability;
- Adjustment of proportion of different sizes;
- Silvicultural requirements.

Thus in an irregular forest, size is a major criterion for felling and there is no final felling of a given area of a crop. It is thus more logical to say that rotation in irregular forest is equal to the average age of the exploitable size trees removed. Maturity in selection forests is related to size, and exploitable size is fixed for removal of individual trees. Correct term expressive of maturity in selection forests is exploitable (or utilizable) size. [Source: Ram Parkash 1986 Forest Management]

3. Types of Rotation

In forest management, various types of rotation are in vogue. They are –

- Physical Rotation
- Silvicultural Rotation
- Technical Rotation
- Rotation of Maximum Volume production
- Rotation of Highest Income
- Financial Rotation

3.1 Physical Rotation

Physical rotation is the rotation which coincides with the natural lease of life of a given species on a given site. [Source: Ram Parkash 1986 Forest Management]. It is obvious that physical rotation varies with species and site factors. The concept of physical rotation is to let the trees thrive till they die. It is adopted in protection and amenity forests, wildlife protected area, ecological park, avenue plantations etc. Physical rotation is also interpreted as the age upto which trees remain sound, or produce viable seeds in high forests, or generate coppice shoots in coppice forests.

3.2 Silvicultural Rotation

It is the rotation through which a species retains satisfactory vigour of growth and reproduction on a given site. [Source: Ram Parkash 1986 Forest Management]. From the definition it follows that silvicultural rotation is not less than the age at which trees start producing fertile seeds, and again not higher than the age when their reproductive capacity stops. It is quite long and has a wide range of limits. Silvicultural rotation is applicable in aesthetic and recreational

forests. According to some foresters, there is no distinction between physical and silvicultural rotation.

3.3 Technical Rotation

It is the rotation under which a species yields the maximum material of a specified size or suitability for economic conversion or for special use. [Source: Ram Parkash 1986 Forest Management]. The object of management under technical rotation is to produce maximum material of given specifications of dimensions and quality. Examples are railway sleepers, saw-logs, mining timber, transmission poles, match-wood, paper-wood etc. Since the same tree can produce assortment of material and trees of different species in a crop have varying rate of growth, it is difficult to fix a definite technical rotation for a crop. What is feasible is to adopt limits within which harvest can produce assortment of desired materials in better quantity and quality.

3.4 Rotation of Maximum Volume Production

It is the rotation that yields the maximum annual quantity of material, that is, the age at which the Mean Annual Increment (MAI) culminates. [Source: Ram Parkash 1986 Forest Management]. Please refer to definition and concept of MAI described in lesson 5.

3.4.1 The MAI referred to is that of the stand and not that of individual tree. The quantity referred to includes final volume obtained at the end of rotation, as well as material from all thinnings.

3.4.2 This rotation coincides with the age at which average rate of growth in volume per unit area reaches its maximum value. Please recollect from Lesson 5 that this is the age where CAI and MAI equal each other, that is, the age corresponding to the point where CAI and MAI curves intersect each other.

3.4.3 Suppose, R = rotation, Y = final yield, and $V_1, V_2, V_3 \dots$ etc are the volumes of thinning at various ages, then

$$\text{M.A.I} = \frac{Y+V_1+V_2+V_3+\dots}{R}, \text{ and the age at which this MAI is maximum is}$$

the **rotation of maximum volume production**.

3.4.4 Since the rotation yields maximum volume per unit area per annum, it is adopted as rotation when the production of woody material is the priority of management.



3.5. Rotation of Highest Income / Revenue

It is the rotation which gives the highest average annual gross or net revenue irrespective of the capital value of the forest. It is calculated without interest and irrespective of the times when the items of income or expenditure occur. [Source: Ram Parkash 1986 Forest Management].

$$\text{Mean annual net revenue per unit area} = \frac{Y + \sum T - C - \sum e}{R}$$

Where Y = Value of final felling

$\sum T$ = value of all thinning during rotation period, per unit area,

C = Cost of formation of stand per unit area;

e = Annual cost of administration/maintenance per unit area

$\sum e$ = sum of annual cost of administration/maintenance over the rotation period per unit area;

R = Rotation in years.

The value of R for which the net annual revenue as calculated above is maximum, is the **rotation of highest revenue/income**.

3.6. Financial (or Economic) Rotation

It is the rotation which gives the highest net return on the invested capital. [Source: Ram Parkash 1986 Forest Management]. Financial rotation is different from the rotation of highest income/revenue, as calculation of all revenue and expenditure in this case is done with compound interest at an assumed rate.

3.6.1 Financial rotation is defined as

- The rotation which gives the highest discounted profit, usually at its commencement.
- The rotation which gives the highest net return on capital value, i.e. under which the Soil Expectation Value (S_e) calculated with a given rate of interest is the maximum (Brasnett) [Soil Expectation Value (S_e) is the discounted present value of all future returns minus the discounted present value of all future expenses necessary to earn these returns, the discounting done at a given rate of compound interest.] [Source: Ram Parkash 1986 Forest Management].

4. Fixation of rotation

Rotation of a forest crop is determined upon consideration of many factors. In general, the factors to be considered are given below.

- The size of timber that is in local and national demand is considered.
- Keeping in view the growth rate, the prevailing site quality, and the thinning practice in vogue, the age corresponding to the desired size.
- The age of maximum volume production, and the silviculture of species to arrive at a tentative rotation.
- Determination of rotation of maximum net income;
- Silviculture practice to attain a rotation and feasibility for adoption of such practice.
- Judicious consideration of all relevant factors and to strike a compromise.

Reference material

1. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun



Lesson 7

Time 1 hour

Lesson Plan

Objective: To study

- Yield Regulation
 - Principles and Object
 - Some definitions
- Regulation of Final Yield
- Basis of Yield Regulation
 - Yield Regulation in Clear-felling system
 - Yield Regulation in Regular Shelterwood System

Backward linkage – Previous Lessons on Forest Management;

Forward linkage – Subsequent lessons

Training materials – Copy of Lesson 7 to be circulated beforehand;

Allocation of time –

- | | |
|---|--------|
| • Yield Regulation | 10 mts |
| ➤ Principles and Object | |
| ➤ Some definitions | |
| • Regulation of Final Yield | 3 mts |
| • Basis of Yield Regulation | |
| ➤ Yield Regulation in Clear-felling system | 15 mts |
| ➤ Yield Regulation in Regular Shelterwood System | 22 mts |
| • Miscellaneous/Discussion | 10 mts |

Yield Regulation

1. Principles and Objects

One major objective of forest management is to produce and supply wood on a regular basis. In order to achieve this objective, the forest manager has to undertake continuous or periodic felling of trees or forest crop. Production and supply of wood, that is, yield from a forest crop, however, needs to be regulated.

1.1 Regulation of yield requires (a) calculation of the quantity of yield that may be removed annually or periodically from a forest over a stated period, and (b) formulation of a plan indicating time and place for undertaking felling.

1.2 Principle of Regulation- The most fundamental principle of regulation is to control the rate and progress of felling so as to satisfy the primary object of management, which is production of wood on sustained basis in perpetuity.

2. Definition

Yield Regulation is a term generally applied to the determination of yield and prescribed means of realizing it. It means fixing in advance, usually for the Working Plan period, the amount of timber and other produce that may be removed from the forest annually or periodically. (Source: Ram Parkash 1986 Forest Management)

2.1 Yield is regulated for the Working Plan period which is generally ten years. However, often annual felling does not match exactly with the annual felling prescribed or regulated in the Plan. Under unforeseeable requirements or circumstances beyond control, a forest may suffer unplanned depletion in some year or the other during the plan period. Under such situations it is not desirable to do annual felling every year to the extent prescribed in the Plan. The yield or production in subsequent years, in such case, should be adjusted so that the total yield from the forest remains restricted to prescribed yield for the Working Plan period. This would ensure steady sustained yield over the Plan period, if not every year.

3. Definitions of some terms

Some of the terms related to yield are defined as follows.

- **Yield** – The volume or number of stems that can be removed annually or periodically, or the area over which felling may pass annually or periodically, consistent with the attainment of objects of management.
- **Final Yield** – All the material that counts **against** the prescribed yield and which is derived from the main fellings in a regular forest.
- **Intermediate Yield** – All material from thinnings or operations **preceding** the main felling in a regular forest.



- **Normal Yield** – Yield from a normal forest
 - **Sustained Yield** – The material that a forest can yield annually (or periodically) in perpetuity.
 - **Total Yield** – Sum of final and intermediate yields.
- (Source: Ram Parkash 1986 Forest Management)

4. Regulation of Final Yield

Intermediate yield originates from silvicultural operations like thinning and cleaning. It does not decrease the final yield, rather enhances the quality of final yield. Since silvicultural operations are absolutely necessary for the health and quality of final crop, such operations are not placed under regulation for the purpose of limiting the intermediate yield. **Regulation is exercised only in respect of final felling or yield.**

4.1 While regulating the final yield, the fundamental concept of sustention works as the core objective. It means that **the annual cut should be equal to the annual increment.** If annual felling exceeds annual growth, the growing stock or the capital gets depleted, which would eventually lead to reduced yield in future. On the other hand, if the felling is less than the annual growth, the growing stock will be over-stocked and will adversely affect the health, form and increment of the crop.

5. Basis of Yield Regulation

The yield can be broadly prescribed in three ways – (i) by area, (ii) by volume, or (iii) by area and volume method. We shall discuss below **some of the methods of yield regulation in regular forests.**

6. Yield regulation in Clear-felling system

- Annual Coupes by Gross Area** – This method is applicable to coppice forests and high forests worked on a system of clear-felling and artificial regeneration. In India it is widely used in plantations including those coppiced for fuel. **In its simplest form, the Felling Series (F ha) is divided into a number of annual coupes equal to the number of years in the rotation. Thus if the rotation is R years, there will be R number of annual coupes each of area F/R ha.** The sequence of annual coupes is prescribed in the Working Plan. Annual coupes so formed are equal in area on ground and are known as equi-extensive coupes. Except for the first rotation when the crops are usually irregular both in composition and density, this method ensures equal sustained yield from the second rotation onwards.
- Annual Coupes by Reduced Area** – The fact remains, however, that crop density and site quality may vary from coupe to coupe. So felling of equal annual coupes may not guarantee equal sustained yield over the years. In order to make yield

regulation by area more perfect, suitable reduction factors with reference to normal stock and standard (or mean) site quality should be applied, and based on reduced (or modified) area of the Felling Series, areas are allotted to annual coupes so that annual coupes, though not equi-extensive, become equi-productive. However, reduction for stock density is not normally done, rather yield variation due to varying site quality is taken into consideration and suitable reducing factors are adopted to form equi-productive coupes.

6.1 Yield regulation by area has the advantage that it is easy to apply and that it leads to absolute age-gradations. **Its shortcomings are** (i) change in rotation will require change in coupe area; (ii) it does not take into consideration the variation in crop condition.

7. Yield Regulation in Regular Shelterwood System

(a) Yield based on area allotment by periods

(Please refer to Lesson 3)

Felling areas are not permanently fixed on the ground in the sequence of felling. Compartments or sub-compartments, depending on age-class or maturity, are allotted to specified **periods** of rotation. The rotation is divided into a number of suitable periods of 10 to 30 years, called the regeneration period. Areas allotted to a period of a definite age class form a **periodic block (PB)**. **All PBs are of equal area or equi-productive**. Final yield is harvested from the mature block P.B I, and the yield is regulated by (i) Area, or (ii) Volume, or (iii) Area and Volume

Permanent or Fixed PBs

- **Regulation by Area** - We discuss here the simplest form of regulation in case of permanent PBs. Areas are permanently allocated to all the PBs. If the **rotation is R years**, and the **regeneration period is P years**, the **Felling Series area of F ha** is divided into R/P number of permanent PBs, ~~each of area~~ $(\frac{FF}{RR} \times P)$ ha. Thus the PB I from which yield is obtained is assigned a fixed area, and thereby yield is regulated. The area of PB so fixed is gross area, where the crop and growth conditions are uniform in a regular forest.
- **Regulation by Volume** – Evolved by Hartig in 1795, this method divides the Felling Series into PBs, but instead of equalizing the area, it equalizes the volumes of the various PBs. The procedure is as follows.
 - Firstly, allotment of areas to various PBs is made by age class.



- Volumes of crops allotted to various PBs are determined with the help of Yield Table for the middle of the period when each PB will be due for felling.
- Volume of PB I is determined by actual enumeration.
- If it is found that age-class allotments do not give equal volumes, shiftings are made for adjustment.

The method suffers from the disadvantage that it depends on the use of yield table which may not be available. Further, while the method attempts to equalize the yield for each period during the current rotation, it does not guarantee equal yield in each period in the subsequent rotations.

(b) Yield based on Volume of Growing Stock.

Methods of yield regulation based on volume of Growing Stock (G.S. and/ or increment) are generally referred to as **Formula Methods**. It is said that these methods are liable to give inaccurate results even in case of normal forest, and therefore should not be used as the only basis of yield regulation. The yield calculated by such methods should be modified, as necessary, in keeping with actual conditions of the forest. We shall discuss here only the method based on volume of G.S with the application of Von Mantel's Formula. The objective of yield regulation by volume is to prescribe the annual (periodic) yield equal to the annual (periodic) increment of the Felling Series so as to ensure sustention of yield. In the methods based on volume of growing stock, the increment of Felling Series is calculated by determining the growing stock. The way it is done by application of Von Mantel's Formula is explained below.

Van mantel's Formula –Let us consider a normal forest consisting of r age gradations, each of 1 ha, which is worked on a rotation of r years. If the m.a.i is i m³ per ha, the volume of each age-gradation starting from one year old will be l , $2i$, $3i$, $(r-1)i$, and ri .

It may be noted that

$l = r \times i$ = volume of the oldest or rotation (r) age-gradation.
 = sum of the M.A.I of all age gradations
 = total M.A.I of the series.

Total Growing Stock (**G.S**) on r age gradations

$$= i + 2i + 3i + \dots + (r-1)i + ri$$

$$= \frac{r}{2} (i + ri)$$

$$= \frac{ir}{2} + \frac{r}{2} (r \times i)$$

Substituting I for r.i

$$= \frac{I}{2} + (I \times \frac{r}{2}), \text{ which is the G.S at the end of } r \text{ years.}$$

Now, as the oldest plantation of volume $r \times I = I$, or the annual increment of the whole series I is removed, the G.S at the beginning of the next growing season will be

$$= \frac{I}{2} + (I \times \frac{r}{2}) - I = (I \times \frac{r}{2}) - \frac{I}{2}$$

Thus the volume of the Normal Growing Stock (N.G.S) at the middle of the growing season is the average of the two values = $I \times \frac{r}{2}$

In other words, N.G.S = Annual Increment of the FS $\times \frac{1}{2}$ rotation.

Therefore, Normal Annual Yield = Annual increment of the FS

$$= I = \frac{NGS}{r/2} = \frac{2 NGS}{r}$$

Von Mantel's formula derived from the above relation is:

$$\text{Annual Yield} = \frac{\text{Actual Volume of G.S}}{\frac{1}{2} \text{ rotation}} = \frac{2 G.S}{r}$$

Von mantel's formula is based on the presumption that the annual yield from any forest must bear the same proportion to the actual growing stock as normal increment to the normal growing stock.

It follows from the Von Mantel's formula that yield during the rotation is equal to twice the growing stock. It means the existing GS supplies the yield for half the rotation and yield for the other half is provided by the increment.

Thus annual yield to be prescribed is determined from the Von mantel's formula described above, for which it is required to find the actual volume of G.S.

Because of its simplicity this formula or its modifications are widely used. The main shortcoming of the formula is that it does not take into consideration the difference between the actual and normal GS. Its application has the disadvantage that it requires complete enumeration of the G.S, which is not always feasible.

Reference material

1. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun





Lesson 8

Time 1 hour

Lesson Plan

Objective: To study

- Working Plan
 - Introduction and Definition
 - Working Plan, Working Scheme, Micro-plan
 - Goal and Objectives of Working Plan
 - Organizational Structure
 - Working Plan Period
 - Inputs to WPO
 - Preliminary Working Plan Report (PWPR)
 - Draft Working Plan
 - Sanction of the Plan

Backward linkage – Previous Lessons on Forest Management;

Forward linkage – Subsequent lessons

Training materials – Copy of Lesson 8 to be circulated beforehand;

Allocation of time –

- Working Plan
 - Introduction and Definition 5 mts
 - Working Plan, Working Scheme, Micro-plan 5 mts
 - Goal and Objectives of Working Plan 7 mts
 - Organizational Structure 5 mts
 - Working Plan Period 3 mts
 - Inputs to WPO 7 mts
 - Preliminary Working Plan Report (PWPR) 8 mts
 - Draft Working Plan 7 mts
 - Sanction of the Plan 3 mts
- **Miscellaneous/Discussion** 10 mts



Working Plan

1. Introduction and Definition

Working Plan is the main instrument of forest planning and working for scientific management of forests. It is a very useful document for evaluating the status of forests and biodiversity resources of a forest division, assessing the impact of past management practices and deciding about suitable management interventions for future. (Source: National Working Plan Code 2014).

1.1 A Working Plan (W.P) document is a means of enforcing systematic, obligatory and mandatory regulations for continuous management of a given forest property. The WP does not deal only with silvicultural and management aspects but also covers general administration, watershed management, conservation of biodiversity, soil and water conservation, wildlife etc. In short, a WP is a complete forest plan for the Working Plan period.

1.2 Glossary **defines** Working Plan as a written scheme of management aiming at continuity of policy and action and controlling the treatment of a forest.

2. Working Plan, Working Scheme, Micro-plan

Every working plan includes the specific scientific prescriptions for proper management of forests of a particular forest division. However, working schemes are prepared for smaller areas for a specific purpose or for forest areas under the control/ ownership of such bodies as private, village, municipal, cantonment, autonomous district council etc. These prescriptions should aim at developing forest resources, while meeting the requirements of the objectives of the National Forest Policy and other international conventions/agreements, and satisfying the provisions of the relevant statutes.

2.1 The National Forest Policy clearly states “No forest should be permitted to be worked without an approved working plan by the competent authority”. It is the duty of the manager or owner of the forest area to ensure the preparation of the working plan / scheme. The authority as designated by the MoEF, will approve the working plan and ensure its implementation. Even working schemes have all major elements of a working plan and these schemes also need the sanction of the competent authority. (National Working Plan Code – 2014)

2.2 For involvement and benefit of local stakeholders, micro plans are to be prepared within the ambit of working plan prescriptions for Joint Forest Management (JFM) areas, and eco development plans are to be prepared for eco-sensitive forest areas adjoining the notified protected areas. The micro-plan of jointly managed forests is prepared by the members of the Joint Forest Management Committee (JFMC), through Participatory Rural Appraisal (PRA), with the technical assistance of forest staff of the territorial division as per MoU, for sharing the responsibilities of implementation and equitable

sharing of usufructs among the stakeholders within the broad prescriptions of working plan. Micro plan is approved by concerned Working Plan Officer (WPO)/Divisional Forest Officer (DFO)/Forest Development Agency (FDA) as per prevailing conditions in the state/UT. Proper implementation of the micro plan by each JFMC should be reviewed at least once in two years by the Forest Development Agency (FDA).
(National Working Plan Code – 2014)

3. Goal and Objectives of Working Plan

The goal of Forest Management Planning is that the Plan must provide for **sustainable management of forests and its biodiversity** as laid down in the National Forest Policy. The Plan should encompass the ecological (environmental), economic (production) and social (including cultural) dimensions of management.

3.1 The **objectives** for attaining this goal include -

- conservation of forests and reducing forest degradation;
- maintenance and enhancement of ecosystem services including ecotourism;
- enhancement of forest productivity together with establishment of regeneration to improve forest health and vitality as per ecological and silvicultural requirements of the species;
- progressively increasing the growing stock and carbon sequestration potential;
- maintenance of biological diversity, sustainable yield of forest produce;
- prevention of soil erosion and stabilization of the terrain;
- improvement and regulation of hydrological regime;
 - people's involvement in planning and management of forests;
 - fulfilling socio-economic and livelihood needs of the people, while ensuring simultaneous implementation of the relevant Acts and Rules.

(National Working Plan Code – 2014)

4. Organizational Structure

A. At national level

In order to efficiently monitor the whole process of working plan preparation and adherence to the prescriptions of working plans in all workings/management of forests, the administrative structure operative at the national level includes Director General of Forests & Special Secretary (DGF&SS) to the Government of India, Additional Director General of Forests, Inspector General of Forests, Deputy Inspector General of Forests, and Assistant Inspector General of Forests in the MoEF, New Delhi. This structure is supported by the Regional Offices headed by Additional Principal Chief Conservator of Forests (APCCF)/Chief Conservator of Forests.



B. At the State Level

The organizational structure at the state level varies from state to state. In general, the structure is as follows.

Head (Policy level) – PCCF/APCCF (Working Plan)

Field Supervisory unit – APCCF/ CCF (Working Plan)

Field Functional unit – WPO

According to the National Working Plan Code 2014, a working plan unit (WPU) at the field level should be headed by a working plan officer (WPO) of the rank of Conservator of Forests. However, in West Bengal, the WPOs are officers of the rank of Divisional Forest Officer, and the Field Supervisory unit is headed by an Officer of the rank of Conservator of Forests. There are three WPUs, or Working Plan Divisions in the State.

5. Working Plan Period

Working Plan period is the period for which detailed prescriptions are laid down in a Working Plan. A forest management plan has to deal with long term development and scenarios that cover a long period, e.g. rotation, size of produce intended to grow, intermittent yield etc. However, all such parameters relating to forests depend on many locality factors whose behavior over a long time cannot be mapped with certainty. For example, poor seed years, periods of drought, floods and resulting damage, fluctuations of market may make it necessary to adjust and revise long term plan. On the other hand, frequent revision of plan expends too much of time, labour and money that cannot be afforded. A period of 10 years is generally found to be convenient. According to the National Working Plan Code 2014, generally the working plan is to be revised every 10 years and the preparation of working plan of a territorial forest division should normally take two years which may vary depending upon the volume of work and technical facilities available.

5.1 If the planning/prescriptions are given for a period of more than 10 years (for e.g., in a working circle if the conversion period of the crop is fixed for 30 years) then review will be done at the end of 10 years and the 11th year coupe will become the 1st year coupe, 12th year coupe will become the 2nd year coupe and so on after review.

6. Inputs to WPO

GIS Cell of the Forest Department should provide WPO with

- digital maps of the division based on latest, cloud free, good quality satellite imagery along with the several copies of print outs of the map on 1:25,000 scale.
- Relevant and latest satellite data with spatial resolution of 5.8m or higher which can be used for generating maps up to the scale 1:12,500.
- Spatial database of a forest division with spatial layers which include Division-Range-Beat boundaries, National parks-wildlife sanctuaries, road network, stream network, rest houses, forest cover etc.

- updated compartment / village/ management unit history, deviation forms, control forms, JFM areas etc.

7. Preliminary Working Plan Report (PWPR)

PWPR forms the basis of the WPO's fieldwork and should contain

- necessary details of the working plan area;
- details of management practices adopted during the working plan period;
- aspects of forest management which are considered important for assessing the sustainability, and a set of related quantitative, qualitative *or* descriptive attributes;
- comments on Part I of the working plan regarding such sections which are required to be updated.
- The field work including vegetation survey or other survey or enumeration the WPO has to undertake

7.1 Preparation and Finalization of PWPR

According to the National Working Plan Code 2014 -

- In the working season immediately preceding the one, in which the working plan revision is due to commence (**at least two and half years before the expiry of current working plan period**), the concerned DFO territorial shall be directed by Head, territorial forest circle to **initiate preparation of the preliminary working plan notes**.
- These notes briefly review the results of management during the past years and suggest any necessary change for improvement.
- DFO must complete the notes within two months and submit the note to the Head, territorial forest circle, who in turn inspects the forests concerned and writes the PWPR during or soon after completing the tour within two months and submits the draft to concerned CCF/APCCF/PCCF for consideration of the standing consultative committee.
- The Head, territorial forest circle during the PWPR preparation will hold consultation with local people's forum, JFM committees, village Panchayats and forest development agency (FDA) about the expectations of people dependent on forests and try to accommodate the same as far as possible.
- There shall be a standing consultative committee of the state under the chairmanship of PCCF (HoFF) having representation from the state (including Chief Wildlife Warden) and MoEF (RAPCCF) for preparation of working plans. The experts from FSI and its regional centres and ICFRE institutes may be included in the committee.
- The draft PWPR is deliberated upon in the standing consultative committee meeting chaired by the PCCF (HoFF), which then finalizes the report with changes as deemed necessary.



- The approval of PWPR by PCCF (HoFF) should be granted **at least two years prior to the expiry of the current working plan**, so that the preparation of working plan by the WPO, approval by the designated authority and delivery of approved working plan to the DFO territorial concerned for implementation can be completed prior to expiry of the current plan.

8. Draft Working Plan

WPO writes the Draft Plan as per approved PWPR. It consists of two parts. Part I of the working plan provides the information generated from various sources including forest inventory and assessment. The chapter “Past Systems of Management” and “Statistics of growth and yield” should be written as comprehensively as possible and should be completed soon after the data has been compiled and analysed. Part II will be written chapter by chapter using more or less standardized paragraph headings in their proper order. The write up of Part II shall be based on information provided in Part I.

8.1 The complete plan along with required maps is first vetted by the CCF/APCCF (WP). Copies are circulated to the members of standing consultative committee especially the RAPCCF (MoEF). The members especially RAPCCF (MoEF) should get the copies for examination and comments **at least 45 days** prior to the final meeting of the standing consultative committee. The draft working plan is deliberated upon, in the meeting and commonly acceptable suggestions/alterations/ modifications are incorporated in the final draft working plan for submission to RAPCCF (MoEF).

8.2 Draft WP as deliberated in the standing consultative committee and as revised after incorporating the suggestions of the committee, is sent to the RAPCCF (MoEF) by the PCCF (HoFF) under intimation to the state government.

9. Sanction of the Plan

After examining the plan, RAPCCF (MoEF) accords the approval on behalf of MoEF as such or with necessary suggestions, directions and modifications **within three months**.

Reference Material

1. National Working Plan Code 2014
2. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun

Forest Management

Lesson 9

Time 1 hour

Working Plan (continued)

Lesson Plan

Objective: To study

- **Survey and assessment of forest resources**
 - Examination of territorial units
 - Forest resource assessment
 - Growing stock estimation
 - Assessment of non-timber forest products
 - Biodiversity assessment
 - Assessment of regeneration status
 - Plantation survey and assessment
 - Assessment of bamboo/rattan
 - Soil survey and assessment
 - Socio-economic survey and assessment
 - Assessment of wildlife habitats and species
 - Assessment of trees outside forest (tof)

Backward linkage – Lesson 8 of Forest Management;

Forward linkage – Lesson 10

Training materials – Copy of Lesson 9 to be circulated beforehand;

Allocation of time –

- | | |
|--|--------|
| • Survey and assessment of forest resources | 50 mts |
| • Miscellaneous/Discussion | 10 mts |



Working Plan (continued)

1. Survey and assessment of forest resources

Prerequisite for writing a working plan is to undertake survey and make an assessment of forest resources. **Guidelines, in this respect, laid down in the National Working Plan Code 2014 are briefly mentioned below.**

1.1 Examination of territorial units

- States should digitize the forest boundary and generate geo-referenced version of map of scale 1:50,000 or higher after complete verification.
- WPO will also inspect and examine the forest area (including range, beat, sub beat), village, block, compartment and sub-compartment and ascertain that the extent of forest cover is properly maintained.

1.2 Forest resource assessment

Following the methodology prescribed in the Code, forest data are to be collected to cover the following aspects.

- **Maintenance, Conservation and Enhancement of Biodiversity:** Forest composition and distribution, plant species diversity, status of biodiversity conservation of forests, status of species prone to over exploitation, conservation of genetic resources, fauna and their habitats, threats and challenges to wildlife, protection and management of fauna;
- **Maintenance and Enhancement of Forest Health and Vitality:** Status of regeneration, area affected by forest fires, area damaged by natural calamities, area protected from grazing, lopping practices, area infested by invasive weed species in forests, Incidences of pest and diseases, forest degradation and its drivers;
- **Conservation and Maintenance of Soil and Water Resources:** Assessment of excess runoff from discharge zone and conservation measures for soil, groundwater, and soil moisture. Area treated under soil and water conservation measures, duration of water flow in the selected seasonal streams, wetlands in forest areas, water level in the wells in the vicinity (up to 5km) of forest area, status of aquifers;
- **Maintenance and Enhancement of Forest Resource Productivity:** Growing stock of wood / bamboo, increment in volume of identified timber species, efforts towards enhancement of forest productivity through quality plantation activities, carbon stock, carbon sequestration and mitigation;
- **Optimization of Forest Resource Utilization:** Recorded removal of timber, fuel wood, bamboo/ rattans, and locally important NTFPs including MAPs, demand and supply of timber and important non-timber forest produce, removal of fodder, valuation of the products;
- **Maintenance and Enhancement of Social, Economic, Cultural and Spiritual Benefits:** Number of JFM committees and area protected by them, status of

empowerment of JFMCs, labour welfare, use of indigenous knowledge, extent of cultural/ sacred groves, social customs, status of compliance of Forest Right Act (FRA), other rights and concessions, ecotourism areas and activities, etc.

1.3 Growing stock estimation

From the enumeration/field data, species wise distribution of trees in each diameter class will be generated for compartment/village/any other management unit. This data would be used for population structure and to identify the old group forests. Adding the growing stock of all compartments, the growing stock of the block will be estimated, which will be again integrated up to range level and further at divisional level.

1.4 Assessment of non-timber forest products

WPO may plan and undertake survey, sampling and assessment for estimation of few prioritised species of NTFPs to start within the selected grids. In general, WPO does the assessment of potential NTFPs through available old records, local enquiry, and plot enumeration data. Data collected under different studies and/or maintained in the JFM areas may be used. Summarized estimated quantities may be recorded for every compartment /village/any other management unit in terms of their scientific name, local name, type of plants, their part and its utility, area(ha), quantity per hectare, estimated harvest/hectare, etc. for species of trees, shrubs, climbers, grasses, herbs, lichens, fungi, etc. A separate estimation may be done for MAPs.

1.5 Biodiversity assessment

The data collected during enumeration such as the number of individuals of each species and the DBH of each tree are utilized to derive secondary attributes like basal area (BA, m²/ha), density (D, trees per ha) and frequency (F, number of quadrates where trees are present in relation to total plots observed). Further, relative values of BA, D and F are calculated, and The Importance Value Index (IVI) is calculated by adding up relative dominance (RBAF), relative density (RD) and relative frequency (RF). However, in case of shrubs, herbs, saplings and for regeneration, the IVI is calculated on the basis of relative values, i.e. relative frequency and relative density.

1.5.1 Species diversity is an expression of community structure and is unique to the community. The number of species in a community is referred to as species richness. The relative abundance of all species is called evenness. Species diversity includes both species richness and evenness. Species diversity indices like Shannon-Wiener Index (H') and Simpson's Index (λ) are calculated separately for trees, shrubs and herbs as their individuals differ in size and are sampled differently. Similarity index (community coefficient) is calculated for determining the number of species which are shared among the sites to assess the extent of variation in the species composition.



1.6 Assessment of regeneration status

Young plants of tree species up to 10 cm diameter are taken into consideration for assessment of regeneration status of a particular species as practiced in National Forest Inventory by FSI. Data collected from the square plots of 3x3m for saplings (2cm to 10 cm collar diameter) and from the square plots of 1x1m for seedlings will be generally used to assess the regeneration status of species in the management unit (compartment, village or any other unit). The regeneration status of the sampled species may be assessed in the following categories:

- a. Good regeneration, if seedlings are more in numbers than the saplings and likewise saplings are more than that of adults.
- b. Fair regeneration, if seedlings are more in numbers than the saplings but the saplings are equal or less than that of adults.
- c. Poor regeneration, if a species survives in only sapling stage, but not as seedlings (though sapling may be less, more or equal to adults).
- d. No regeneration, if a species is absent both in sapling and seedling stage, but present as adult.
- e. New regeneration, if a species has no adults but only sapling and/or seedlings.

1.7 Plantation survey and assessment

The assessment of growing stock of old plantations, which attains a minimum size of 10 cm DBH or age of 10 years can be done based on plot enumeration data for such plantation areas. But assessing the status of young plantations having less than 10 cm DBH or age of 10 years is also important. Plantation journals offer the best option for assessing such young plantations. Results of survey should be recorded in the journals which should be made available to WPO by the DFO.

1.8 Assessment of bamboo/rattan

All culms occurring in the clump would be enumerated as per different classes of National Forest Inventory and these data would be used to assess the availability of bamboo/rattan. Data from plot enumeration will be used to estimate the number of clumps per management unit (compartment, village or any other unit) and classify them as:

- (i) Luxuriant – All healthy, un-congested, undamaged and in good condition
- (ii) Degraded – Not capable of being rehabilitated and of attaining normal productivity
- (iii) Culturable – Not included in (i) or (ii)
- (iv) Non-clump forming bamboos

1.9 Soil survey and assessment

Soil properties along with site features like slope, aspect, erosion, climate, etc. brings out information about the land capability class, land suitability, etc. For survey, soil samples may be collected in the selected grids from different horizons i.e. from soil

surface upto 2m depth. The soil samples may also be collected from pre-determined depths like 0- 15cm, 16-30cm, 30-60cm, 60-100cm, etc. The sampling may be carried out by excavating a soil profile or by auger method. The soil samples are collected, labelled and carried to laboratory for the analysis of physical properties such as texture, bulk density, moisture, water holding capacity, field capacity, depth and colour and chemical properties such as pH, organic matter and nutrients. The nutrients mainly include nitrogen, phosphorus, potassium, calcium, and magnesium. However, the detailed soil survey is not required during the revision of working plan. WPO may take help from the secondary sources for the assessment of the forest soil.

1.10 Socio-economic survey and assessment

Available information on socio-economic status of the people living in forest fringe villages should be collected and assessed to bring forth the role of forest products and ecosystem services in their lifestyle. Socio economic survey shall include dependency on timber, fuel wood, fodder, grazing, other NTFPs and livelihood aspects. The detailed survey is not required to be undertaken by WPO during the revision of working plan.

1.10.1 The villages situated within the limit of 3Km from the forests will be considered as forest fringe villages for the assessment. Stratified multistage random sampling will be deployed for the socio-economic survey. The first stage sampling units will be the fringe villages and the second stage sampling units will be the households.

1.11 Assessment of wildlife habitats and species

The WPO is not required to undertake an estimation of faunal populations. Advantage may be taken of study being carried out by the National Tiger Conservation Authority (NTCA) in collaboration with the Wildlife Institute of India and the state forest department. The WPO should identify flagship species including mammals, birds, reptiles, amphibians, plants etc. which may be significant for the area. The WPO should identify suitable habitats and micro habitats for such key wildlife species and appropriate measures needed to conserve and improve the same. The maintenance and restoration of grasslands, wetlands, wildlife corridors and water points must be identified. Threats, such as habitat loss and/or fragmentation; illegal trade; road and rail networks; etc. should be identified and appropriate corrective measures should be suggested for implementation. Similarly, areas of man animal conflict deserve special attention for amelioration.

1.12 2 Assessment of trees outside forest (tof)

For assessing **tof**, geometrically rectified IRS P-6 LISS IV (5.8m) or any higher version imageries may be procured from NRSC, Hyderabad. Forest area of the division is masked out from them and classified map is generated having different strata namely, block plantation, linear trees, scattered trees, area with no trees, cropland etc. Stratified



random sampling may be undertaken to assess the growing stock and the potential area for extension of forestry outside forests and sustainable land use management within the forest division. This requires inter-sectoral synergy and convergence. WPO may therefore prepare a separate strategy as new chapter, not being part of general prescriptions of a working circle for forests.

Reference Material

1. National Working Plan Code 2014
2. Ram Parkash 1986 Forest Management, International Book Distributors Dehra Dun



Forest Management

Lesson 10

Time 1 hour

Working Plan (continued)

Lesson Plan

Objective: To study

- **Writing up of Working Plan**
 - Format and guidelines prescribed in National Working Plan Code 2014.

Backward linkage – Lesson 8 and 9 of Working Plan.

Forward linkage – To study, during tour, management practices in some forest divisions with reference to the Working Plans of such Divisions.

Training materials – Copy of Lesson 10 to be circulated beforehand;

Allocation of time –

- **Writing up of Working Plan** 50 mts
 - Format and guidelines prescribed in National Working Plan Code 2014.

- **Miscellaneous/Discussion** 10 mts



Working Plan (continued)

1. Writing up of Working Plan

The Working Plan should be written in a standard format, dwelling on contents under standard title/sub-title. The **format and guidelines** have been prescribed in the National Working Plan Code 2014. [Please refer to the website <http://envfor.nic.in/sites/default/files/National%20Working%20Plan%20Code%202014.pdf>]. The said format and **excerpts** from guidelines may be seen in **the Annexure**.

1.1 Exclusive or Overlapping Working Circles

According to the National Working Plan Code 2014, besides the working circles related to maintenance and enhancement of forest resource productivity, suitable prescriptions should be made for the **following exclusive or overlapping working circle**.

- **Overlapping working circle for sustainable management of bamboos /rattans** based on the availability and assessment of bamboos/rattans.
- **exclusive or overlapping plantation working circle** to cover existing plantations, blanks and under stocked areas not suitable for ANR, clear felled areas, road side, river side, canal side, rail side and sea side areas and lands under CAMPA etc. which are suitable for plantations. Such areas should be identified and allocated to different years of plan period along with prescription of sustainable management.
- **exclusive or overlapping working circle for important NTFPs** like gums and resin, tendu leaves, medicinal and aromatic plants (MAPs), fruits and seeds, etc.
- **exclusive or overlapping working circles namely Fringe Forest Management, JFM and Community Forest Management** in the working plan for sustainable management of forests.
- **exclusive or overlapping mandatory working circles** related to maintenance, **conservation and enhancement of biodiversity**, maintenance and enhancement of **forest health and vitality**, conservation and maintenance of **soil and water resource**, maintenance and enhancement of social, economic, cultural and spiritual benefits and institutional (infrastructural and capacity building) support subject to their applicability for a given forest division.

1.2 Additional chapters

The National Working Plan Code 2014 further prescribes that in addition to the chapters covering prescriptions for the various working circles, the Working Plan should contain exclusive additional chapters on matters like financial forecast, miscellaneous regulations, rights and concessions, science and research, preservation /sample/ regeneration /NTFP plots, trees outside forests etc.

Reference Material

1. National Working Plan Code 2014



Annexure to Lesson 10

WRITING UP THE PLAN CONTENTS OF THE PLAN (To be written by WPO)

The standard working plan headings are reproduced in the table given below:

| Chapters | TITLE / SUB-TITLE | EXPLANATION |
|----------|--|--|
| | Executive Summary along with the constraints faced during writing of the plan | |
| I | INTRODUCTION | |
| II | GLOSSARY OF TERMS | |
| III | List of Flora (indicating RET and unique species) | Local names of trees, shrubs, herbs and climbers (including epiphytes, parasites, grasses etc.) with English names, if any, in alphabetical order, followed by their botanical names. Make it as exhaustive as possible with a separate list of rare, endangered and threatened (RET) species of medicinal and aromatic plants and plants of ethno-botanical importance found in the Division. |
| IV | List of Fauna | Local names with English name, if any, in alphabetical order, followed by their scientific names. List may be made as exhaustive as possible. |
| V | Others | List of lichens, algae, fungi, etc. |

| PART- I | | |
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| Summary of facts on which proposals are made | | |
| 1. | The Tract Dealt with | |
| 1.1 | Name and situation | Name of the division and its geographical location, demographic and administrative details |
| 1.2 | Configuration of the ground | It may be categorized as flat, gently rolling, hilly, very hilly, undulating foothills, gullied including description of slope, aspect, etc. |
| 1.3 | Geology, rock and soil | Describe the geological and rock formation, soil types in particular along with Geological Survey of India (GSI) references. |
| 1.4 | Climatic parameters | Data on rainfall and temperature. |

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| 2. | Maintenance/ increase in the extent of forest and tree cover | |
| 2.1 | Area of forests under different legal classes (RF, PF, UF and others) | Area of the forest under different legal classes (Reserve Forest, Protected Forest, Un-classed Forest, Village Forest, etc.) along with number and date of notification for creation of reserve/protected forest is given; and mention is made of various forest settlements. |
| 2.2 | Forest area under different working circle/ management plan | Range wise entire forest area is covered under WP/ management plan. |
| 2.3 | Percentage of forest with secured boundaries | Locations of the boundary pillars should be shown on the map with latitude/longitude on village map or such other map of convenient scale. |
| 2.4 | Land use, land use change and forestry (LULUCF) | It is to be described here that the base year status of land use and forest cover is maintained or improved. Summary of changes occurred during last plan period may be given. |
| 2.5 | Threats to the forest | |
| 2.6 | Distribution of different forest types. | |
| 2.7 | Tree cover outside forest area | Assessment of the growing stock and the potential area for extension of forestry outside forests and sustainable land use management within the geographical area of the forest division. |
| 3. | Maintenance, Conservation and Enhancement of Biodiversity | |
| 3.1 | Forest composition and distribution | A summary of important trees and other species found in the area with their floristic composition and condition (age class, health, and quality of the trees) is given. |
| 3.2 | Plant species diversity | Biodiversity assessment in terms of density, frequency, total basal cover, dominance, IVI, etc. should be given. |
| 3.3 | Status of biodiversity conservation in forests | Status of implementation of the state guidelines/ strategic plan, if any should be given. |
| 3.4 | Status of species prone to over exploitation | Details of current harvesting practices of forest produce and preparation as well as implementation of measures for conservation of biodiversity; as far as possible status of the |



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| | | species prone to over exploitation and destructive harvesting should be given; |
| 3.5 | Conservation of genetic Resources | Preservation plots, sample plots, medicinal plants conservation areas, community conservation areas, etc. |
| 3.6 | Fauna and their habitats | Give description of flagship wild species including mammals, birds, reptiles, amphibians, etc. along with their suitable habitats and micro habitats. |
| 3.7 | Threats and challenges to wildlife | Give details regarding habitat fragmentation/ loss, illegal trade, road and rail networks, extended habitats in proximity to protected areas for rare and endangered species; man animal conflict. |
| 3.8 | Protection and management of fauna | Details of measures taken and its effect therein. |
| 4. | Maintenance and Enhancement of Forest Health and Vitality | |
| 4.1 | Status of regeneration | As per the base year assessment, the data on population dynamics of seedlings, saplings and young trees should be collected to monitor the status periodically and find out the conditions in which a species regenerates best. |
| 4.2 | Area affected by forest fire | Details of the locations along with area affected by fire incidents and appropriate measures taken may be analysed from the records of the fire register and appropriate prescription given. |
| 4.3 | Area damaged by natural calamities | The area affected by natural calamities such as storm, flood, frost, drought, erosion, etc. should be given. |
| 4.4 | Area protected from grazing | Number of livestock grazing in the forest, availability of palatable species and pasture land, etc. to assess the grazing pressure and potential, based on socio-economic survey and assessment. |
| 4.5 | Lopping practices | Status of existing of lopping practices during fodder/NTFPs collection extent of damage to the affected species, if any; and period of lopping, etc. should be provided. |
| 4.6 | Area infested by invasive weed species in forests | Details to be given of forest areas infested by different invasive species. |
| 4.7 | Incidences of pest and diseases | Details of different incidences of pest and diseases are provided. |



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| 4.8 | Forest degradation and its drivers | Details of drivers of forest degradation like unregulated removal of forest produce, encroachment, over grazing, mining, etc. along with the area description under different levels of degradation. |
| 4.9 | Pollution control and protection of environment | Incidences, extent of forest land degradation due to pollution (soil, water, in some cases air) and the measures taken to mitigate them. |
| 5. | Conservation and maintenance of soil and water resources | |
| 5.1 | Area treated under soil and water conservation measures | Soil erosion vulnerability assessment and intervention taken may be provided along with map. |
| 5.2 | Duration of water flow in the selected seasonal streams | Periodic monitoring of river flow pattern with reference to annual rainfall/duration of flow may be provided to show the status of improvements, if any. |
| 5.3 | Wetlands in forest areas | Details of wetlands in the forest areas along with maps may be provided for periodic monitoring using remote sensing technology. |
| 5.4 | Water level in the wells in the vicinity (up to 5km) of forest area | Periodic monitoring of water level with respect to annual rainfall should be provided for the status of ground water assessment. |
| 5.5 | Status of aquifers | Details of aquifers to monitor their sustainability. |
| 6. | Maintenance and enhancement of forest resource productivity | |
| 6.1 | Growing stock of wood | Trend detection in growing stock of wood with respect to the condition of fully stocked forest as per the site quality over the years and explanation thereof. |
| 6.2 | Growing stock of bamboo | Growing stock of bamboo indicating the number of clumps and clump size with respect to base year. |
| 6.3 | Increment in volume of identified timber species. | Mean annual increment (MAI) of tree species is maintained or increased with respect to base year. |
| 6.4 | Efforts towards enhancement of forest productivity through quality plantation activities | Details to be given based on survey and assessment of areas under the plantation. |
| 6.5 | Carbon Stock | Details of biomass for carbon stock assessment |



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| | | may be given based on the forest types and land use. |
| 6.6 | Carbon sequestration and mitigation | Enhanced carbon sequestration through recognised and innovative silvicultural practices, eco-restoration of degraded/ mined out forestlands, improved biomass productivity, etc. results in improving forest health and vitality. |
| 7. | Optimization of forest resource utilization | |
| 7.1 | Recorded removal of timber | Details of all removals of timber except for petty felling as per the control forms. |
| 7.2 | Recorded removal of fuel wood | Information based on socio-economic survey and assessment may be provided. |
| 7.3 | Recorded removal of bamboo/ rattans | Assessment of bamboo/rattans and mechanism for generating quantified data on their removal and sharing with the community should be provided. |
| 7.4 | Recorded removal of locally important NTFPs including MAPs | Assessment of demand and supply, sustainability and potentiality. |
| 7.5 | Demand and supply of timber and important non-timber forest produce | Description of recorded removal for agricultural customs, local needs, market and marketable produce including that of forest development corporations and other agencies may be given. |
| 7.6 | Import and export of wood and wood products | Data on import and export of wood and wood products may be collected and analysed for the entire division. |
| 7.7 | Import and export of NTFPs | Data on import and export of NTFPs may be collected and analysed for the entire division. |
| 7.8 | Removal of fodder | Description of cattle rearing community of forest dwellers with regard to removal of fodder and availability of palatable species and pasture lands, etc. |
| 7.9 | Valuation of the products | Valuation of products may be done by including past and current prices of different forest products with price trend. |
| 8. | Maintenance and enhancement of social, economic, cultural and spiritual benefits | |
| 8.1 | Number of JFM committees and area (s) protected by them | Should match the JFM resolution; extent of the forest area under JFM. |
| 8.2 | Status of empowerment of | Aspects related to regular meetings at the community level and representation and |



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| | JFMCs | participation of members belonging to different categories in JFMCs and their role in functioning of the forest development agency may be given to indicate the status of empowerment. |
| 8.3 | Labour welfare | Details of welfare measures along with direct employment in forestry activities. |
| 8.4 | Use of indigenous knowledge | Documentation of the indigenous traditional knowledge and incorporation of the same in the micro-plans and other prescriptions of the plan. |
| 8.5 | Extent of cultural/sacred groves | Details of cultural and sacred groves along with ownerships, status of management and interventions to conserve them may be provided in the appendix. |
| 8.6 | Ecotourism areas and activities | |
| 8.7 | Social customs | Prevalent social customs relevant to forests. |
| 8.8 | Status of compliance of Forest Right Act (FRA) | Status of registration of all the claims and settlement of the genuine claims; |
| 8.9 | Other Rights and Concessions | A brief account of other rights and concessions, their extent, nature, etc. |
| 8.10 | Dependency of local people on NTFPs | Economic dependency on NTFP along with clear rights and responsibilities to access, use and manage the NTFPs resources; |
| 8.11 | Other aspects | Other aspects which are not mentioned above but are intrinsic to forests. |
| 9. | Adequacy of Policy, Legal and Institutional framework | |
| 9.1 | Existing policy and legal framework and their compliance | Status of compliance for sustainable management of forests may be given. |
| 9.2 | Status of approved working plan and compliance | A summary of prescription of approved working plan and valid reason for deviations in implementation of the plan should be given (as per deviation statement). |
| 9.3 | Number of forest offences | Details of all the cases booked and taken to court of law may be provided in the appendix. |
| 9.4 | Status of research and development | Application of research findings in addressing the problems along with appropriate transfer of technology to field should be given. |
| 9.5 | Human resource capacity building efforts | There should be a human resource capacity building plan (training plan) for efficient utilization of the human resource. |



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| 9.6 | Forest Resource Accounting | All tangible benefits should be reported. |
| 9.7 | Budgetary allocations to the forestry sector | Budget provision of the last plan period may be provided and the prescribed budget may be justified accordingly. |
| 9.8 | Existence of monitoring, assessment and reporting mechanism | Monitoring and evaluation parameters may be provided for all the prescriptions of the plan as control forms. |
| 9.9 | Public awareness and education | The efforts to increase public awareness of the importance of and the benefits provided by forests and sustainable management of forest; |
| 9.10 | Adequate manpower in forest division | The details of sanctioned, permanent, temporary, and seasonal posts are given in the appendix. |
| 10. | Five Year Plans | WPO has to describe the activities taken up under preceding Five-year plan, (plan wise and scheme wise) and make summary suggestions for future. |
| 11. | Past systems of management | |
| 11.1 | General history of the forests | The historical background from the beginning of management of forests may be given with mention of source of information. |
| 11.2 | Past system of management and their results | The system of management which has been followed in the past will be briefly discussed. |
| 11.3 | Special works of improvement undertaken | Summary and results of works such as fire-protection, improvement in communication, interface activities, amenities to staff, etc. |
| 11.4 | Past yield, revenue and expenditure | This is given year-wise in a tabular form. |
| 12. | Statistics of growth and yield | WPO has to assess the availability of volume/yield tables for the main timber species, which have been prescribed for felling in various working circles for calculation of outturn/yield. If such tables are not available, then the possibility of stem and stump analysis for such species may be examined and implemented if possible for preparation of local volume table. In case, this is also not feasible, then nondestructive method for preparation of local volume may be adopted. |



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| 12.1 | Statistics of forest carbon stock | Default values used with respect to estimating forest carbon stock must be brought clearly so that specific values can be developed through experimentation and research. |
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PART II
Future Management

| Chapters | TITLE / SUB-TITLE | EXPLANATION |
|----------|--|---|
| 1. | Basis of proposals | |
| 1.1 | Objectives of management | The objectives of the forest management plan may be organized around the following major elements: (i) Dynamics of Forests and Stands: (ii) Forests and Soil: (iii) Forests and Water: (iv) Forest Biodiversity: (v) Climate and Forests: (vi) Socioeconomic considerations and generation of forest based employment opportunities and livelihood options: (vii) Tool for integrated development: |
| 1.2 | Method of treatment to be adopted | A brief account may be given about the ecological and silvicultural requirements for sustainable management of different identified forests or crops. |
| 1.3 | Constitution of working circles | Mapping and listing of different working circles (including overlapping ones), their area and distribution giving justification for their constitution; |
| 1.4 | Period of working plan and necessity for intermediate revision | Generally the period of working plan will be for 10 years. A midterm review of WP should be undertaken for mid-course correction by the consultative committee under the chairmanship of PCCF (HoFF) with representation from RAPCCF (MoEF). |
| 2. | CHAPTER 2 to last CHAPTER (say N) | |
| 2.1 | (Name of) working circle (Clearly marked on GIS based maps(1: 50,000) | There will be a separate chapter for each working circle including the overlapping ones. Last chapter identified with a working circle is presumed as N (last in row) which has a |



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| | | numerical value like 15, 16, etc. |
| 2.2 | General constitution of working circle | Mapping and summarization of working circle area statement by ranges, blocks, and compartments included in the circle indicating gross area and showing forest type and density classes (as adopted by FSI). |
| 2.3 | General characteristics of vegetation | Concentrate on aspects of vegetation pertinent to management objectives outlined for the working circle, e.g., composition, age class distribution, density, growing stock, status of regeneration, special problems like menace of weeds and invasive species growth, etc. |
| 2.4 | Felling series, cutting sections and JFM areas | Name them and give the reasons for their constitution. JFM areas may be described as per existing village level JFM committees/ micro-plans. |
| 2.5 | Blocks, compartments and JFM area (marked on GIS based maps) | In a tabular form felling series, cutting section, range, block, compartment, quality and area in hectares. JFM areas may be described as per existing village level JFM committees. |
| 2.6 | Special objectives of management | These are enlisted in order of priority. |
| 2.6.1 | Analysis of the crop | Stock maps, range and mean of quality and age class distribution, selection of sample units, type of enumeration, assessment of NTFP bearing species, status of regeneration, comparison with previous data and special features, if any, are to be described. |
| 2.6.2 | Silvicultural system | Define the system and give reasons for its adoption. |
| 2.6.3 | Rotation period | The growth and other data on which the rotation is based are discussed. |
| 2.6.4 | Harvestable diameters | These are prescribed species wise according to their site quality. |
| 2.6.5 | Reducing factors and reduced areas | In general, reducing factors are used for quality and density for species for which yield tables are available. |
| 2.6.6 | Felling cycle | Wherever applicable, it is fixed and reasons given. |
| 2.6.7 | Division into periods and allotment to periodic | This is done for the shelter wood systems. |



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| | blocks (PB) | |
| 2.6.8 | Calculation of the yield | The yield calculation method adopted for sustainable harvesting should be indicated. |
| 2.6.9 | Table of felling | Fellings are tabulated year-wise by ranges, blocks, compartments, and sub-compartments for each felling series, village level JFMC areas. |
| 2.6.10 | Method of executing the felling | Guiding principles (general marking rules); |
| 2.6.11 | Subsidiary silvicultural operations cleaning and thinning | Good practice guide for silvicultural operations including thinning and its grades etc. should be given. |
| 2.6.12 | Regeneration | Methods of assisted natural regeneration based on status of natural regeneration may be prescribed. |
| 2.6.13 | Associated regulations and measures | May cover controlled grazing, lopping schemes and regulated firewood removals; soil and moisture conservation measures; fire protection; forest protection from illicit felling, unregulated removal of NTFP and MAPs, encroachments, illegal mining, jhumming, etc.; restriction on felling along rivers, highways, hill slopes, etc., which are relevant to the working circle. |



