सत्यमेव जयते

FOREST PROTECTION

বন বিভাগ
পশ্চিমবঙ্গ সরকার

DIRECTORATE OF FORESTS
GOVERNMENT OF WEST BENGAL

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Aranya Bhavan
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PREFACE

Among the objectives of forest management, the one which stands uppermost is Forest protection. A forest manager is supposed to have knowledge about the various factors that cause damage and degradation to forests. He should be able to identify the symptoms of damage and should know how and when to take preventive and remedial measures. As part of the JICA project on 'Capacity Development for Forest Management and Training of Personnel' being implemented by the Forest Department, Govt of West Bengal, these course materials on Forest Protection have 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 the challenges of forest protection and enhance their capacity to deal with the task.

The subjects covered in these materials broadly conform to 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 undergone 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 materials have been compiled and edited by A Basu Ray Chaudhuri, IFS (Retd). Many books and literature including those available in internet have been made use of in preparing these course materials and references of such books and documents 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 these materials.

Efforts that have gone into making of these course materials will be best rewarded if the frontline staff of the forest department find these materials useful in their day-to-day works.

Kolkata, 2015

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

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

Forest Protection Syllabus (revised)

Forest protection (10 hours), excursion 1 day, tour 4 days		
1.Introduction*	1.1. Status of Forests. - Forest status in India - Forest status in WB 1.2 Need for Forest Protection 1.3. Factors responsible for degradation of forests 1.4 Legal powers of frontline staff in forest protection	1 hour*
2.Forest fires	2.1 Causes, types and effect on forests. 2.2 Preventive measures - Indirect measures* - Direct measures* 2.3 Combative measures - Detection of forest fire* - Fire combat operations* - Post-suppression operations* 2.4.fire occurrence and damage reports 2.5 Legal provisions in dealing fire offences*	2 hours
3.Injuries by animals *	- Domestic animals* - Effects of grazing and browsing - Measures*	1 hour
4.Human interfaces and their control	4.1.Damage caused through human interface - Deforestation* - diversion of forest land, shifting cultivation, mining, encroachment - Illicit felling and illicit removal of forest produce* - Faulty management* - Defects in management plan - Defects in execution - Other damage*	$3\frac{1}{2}$ hours*
5.Injuries by plants	-Damage due to excessive number of desired Species* - Injuries by unwanted species -climber -weeds -parasites	$\frac{1}{2}$ hour*

6. Injuries due to wild animal, pests and diseases	- Role played by carnivores* - Injury by herbivores* - Protection measures - Injury by insects* - Pests in nurseries - Pests of important forest trees - Injury due to diseases * - Categories - Common symptoms - Disease in forest trees	1 hour
7.Injuries due to natural calamities	-Flood and land slide -Drought -Frost -Snow	1 hour
Field study	Observation of fire lines etc.	

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

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- **Lesson Plan**
- **Human Interfaces and their Control (Continued)**
  - **Faulty Management**
  - **Defects in Management plan**
  - **Defects in Execution of Plan**
  - **Other Damage**
- **Injuries by Plants**
  - **Introduction**
  - **Damage due to excessive number of desired species**
  - **Injuries by unwanted species**

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- **Lesson Plan**
- **Injuries by wild animals**
  - **Introduction**
  - **Important role played by the carnivores**
  - **Injury by Herbivores**
    - Protection Measures
  - **Injury by Insects**
    - Pests in nurseries
    - Pests of Important forest trees
  - **Injury due to diseases**
    - Plantations are more disease prone
    - Exotics may be vulnerable
    - Categories of Disease
    - Progress of disease
    - What is expected of a forest manager
    - Some common symptoms
    - Disease in Forest Trees

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- **Lesson Plan**
- **Injuries due to natural calamities**
  - **Flood**
    - Direct damage
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    - Symptoms of flood stress
  - **Landslides**
    - Silviculture measures
  - **Drought**
    - Measures
  - **Frost**
    - Categories
    - Frost pocket

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	○ Injuries due to frost ○ Protection measures ➢ **Snow** ○ Injuries due to snow	

Lesson 1

1 hour

Lesson Plan

Objective:

- To know about scope of Forest Protection
- To know about status of forests – global, in India and West Bengal
- To understand the need of forest protection
- To know the various factors responsible for forest degradation

Backward Linkage: Nil

Forward Linkage:

- Elaboration of various degradation factors in subsequent lessons.
- To observe forest degradation sites during tour

Training Materials Required:

- Copy of lesson 1 to be circulated beforehand

Allocation of time:

- Introduction – 5 mts
- Status of forests – 15 mts
- Need for forest protection – 8 mts
- Factors responsible for forest degradation – 22 mts
- Discussion/ Miscellaneous – 10 mts.

1. Introduction

Forest Protection is defined as that branch of forestry that deals with measures aimed at prevention and control of damage to forests caused by man, animals, insects, fungi, injurious plants and adverse climatic factors. Despite the wide range of benefits – direct and indirect- provided by the forests to the human society, forests worldwide are under severe threat. Although there is growing awareness about the services that forest ecosystems provide and though more and more people now realize the crucial linkage of forests to existence of man on this planet, forests are not in a happy state. People are not doing enough to preempt the threat that forests are faced with, and it has been a matter of concern that a major part of damage to forests is caused by man only.

2. Status of Forests

Global Status: Salient points of Global Forest Resources Assessment, 2010 by FAO are furnished below.

- The rate of deforestation (conversion to other uses) and loss of forests from natural causes, though showing signs of decrease, is still alarmingly high.
- The rate decreased from an estimated 16 million ha per year in 1990's to 13 million ha per year in the last decade.
- Net changes in the forest area has been estimated at (-) 5.2 million ha per year during 2000-2010, down from (-)8.3 million ha per year during the period 1990-2000.

(Net change is the difference between deforestation and afforestation. The above figures show that forests are lost at a faster rate than that of creation. It is encouraging of course that difference between the rate of deforestation and creation of new forests has reduced in the last decade.)

- Primary forests which account for 36% (1.4 billion ha) of world's forest area shrank by more than 40 m ha – at a rate of 0.4% annually – over the last ten years.

  [Primary forests are those which show no signs of human intervention. These forests, in particular, tropical moist forests, contain some of the world's most species-rich and diverse ecosystems.]

2.1 Forest Status in India

According to **India State of Forest Report* 2013 by FSI** –

- Forests cover which comprise 69.79 million ha account for 21.23% of geographical area.
- Growing stock within forests is estimated as 4173.362 million m^3.
- Total carbon stock in forest is estimated as 6941 million tones.

[* Based on interpretation of satellite data (Oct 2010 to Jan 2012) and inventory of forests]

In comparison to 2011 assessment,

- Forest cover has shown an increase of 5871 km^2.
- In hill districts forest cover increased by 40 km^2
- In tribal districts forest cover increased by 2396 km^2 .
- In North-eastern states, forest cover (which accounts for 1/4th of country's cover) shows net decline of 627 km^2.
- Mangrove cover has increased by 34 km^2 .
- While there has been an increase in forest cover, the growing stock inside forests has decreased by 325.369 million m^3. The decline in growing stock is due to loss of 1991 km^2 of Moderately Dense Forest (MDF)[1], which eventually got converted to Open Forest (OF)[2].

[1] MDF means forest with tree canopy density of 40% and more but less than 70%.

[2] OF means forest with tree canopy density of 10% and more but less than 40%

2.2 Forest Status in WB

According to India **State of Forest Report 2013** by FSI –

- Total Forest Cover – 16805 km^2 (18.93% of geographical area)
  Very dense forest – 2971 km^2
  Moderately dense forest– 4146 km^2
  Open forest– 9688 km^2

In comparison to 2011 assessment,

- Net increase in forest cover is 3810 km^2. The increase is due to coppice growth and afforestation within forests and growth of commercial plantations and shade trees in tea gardens etc. outside forests.
- While there has been an increase in total forest cover, **Very Dense Forest (VDF) suffered a decrease of 13 km^2, Moderately Dense Forest (MDF) suffered a decrease of 500 km^2, whereas Open Forest (OF) area increased by 4323 km^2**.

3. Need for Forest Protection:

Thus going by the statistics and figures it is clear from above that even with large scale afforestation and conservation programme launched in many countries, the global scenario is that depletion of forest cover occurs still at a higher rate than regeneration. At the national level, during the period between FSI 2011 and FSI 2013 report, while there has been increase in forest cover, growing stock in forest has declined due to degradation of MDF to OF. At the state level of WB, during the said period between FSI 2009 and FSI 2011 report, while the forest area has increased due to regeneration programme that was

undertaken, there has been decline in quality of forest, as area of VDF and MDF got reduced. That is, while on the one hand we have created new forests during the intervening period, considerable amount of growing stock has been lost in the same period by some means or the other. It only means that the massive afforestation programme undertaken in our country has not led to any gain in forest resources. It is noteworthy that even though we have been able to somehow contain the loss in forest cover, the undisputed decline in the quality of forests is continuing. Therefore the need to protect whatever forests we have and create new forests cannot be overemphasized.

4. Factors responsible for degradation of forests

There are many factors that have been identified to be responsible for degradation of forests. Some major factors coming under different categories are mentioned below.

a) **Vast expanse and easy access** – Forest has large geographical expanse and is open. Unlike other precious wealth, it cannot be locked in a vault or a strong room. Forest spreads over large area and except for very difficult terrain, it is easily accessible. These two characteristics of forest – large expanse and easy accessibility – make it very difficult to protect this natural resource from illicit felling, damage by cattle, fire caused willfully or inadvertently, and climatic factors.

b) **Cost factor** – Enforcing forest laws over large expanse of forest areas require a big protection force, that is, a large number of executive forest personnel. Maintaining huge forest personnel for protection has a cost which often the government budget cannot sustain. Effective protection from fire requires intensive and scientific monitoring of fire incidence, identification of fire prone areas and taking control measures. All these need considerable amount of fund. Taking help of forest fringe dwellers in protection measures sometimes demands undertaking welfare and development measures for them, which again entail considerable cost. More often the Department budget cannot afford to bear the cost that protection measures, in an ideal scenario, demand, and protection of forests is therefore compromised.

c) **Dependence of neighbouring villagers** - The neighbouring villagers depend on forests for fuel, fodder, small wood, medicinal plants and things alike. They collect the forest produce not only for their own consumption but also to earn something for their livelihood. The quantity they harvest often exceeds the rate at which the forest produce regenerates and thus leads to degradation of forests.

d) **Wrong notion about forest productivity** – Even as forests are subjected to meet increasing demand of fringe population, the pace of degradation of forests is slow, unless there are instances of mass looting. This creates a notion among the fringe

dwellers that the forest is an inexhaustible source of fuel and small timbers and they can collect forest produce in unlimited quantities for indefinite time.

e) **Climatic and natural factors** –There are climatic and natural factors that may take heavy toll on forest resources. These are –
   - Flood
   - Drought
   - Earthquake
   - Landslide
   - Other natural calamities

   Unfortunately, man can do very little to prevent the damage caused by these factors.

f) **Biotic factors –** These are the factors caused by man and the cattle. They include –
   - Grazing and browsing
   - Deforestation by illicit removal
   - Forest Fire (man made)
   - Faulty management practice
   - Encroachment of forest land
   - Diversion of forest land for non-forestry purpose
   - Other damage like lopping, removal of leaf litter, removal of flowers and fruits, poaching, environmental pollution etc.

   These biotic factors define the areas where forest managers are called upon to play a significant role.

5. Legal powers of frontline staff in forest protection

The lesson materials in Forest law may please be consulted in this matter.

Source of Lesson materials:

1. Global Forest Resources Assessment, 2010 by FAO
2. India State of Forest Report 2013 by FSI
3. L.S Khanna 1998, Forest Protection

Lesson 2

1 hour

Lesson Plan

Objective:

- To know about Forest Fires
- To know about causes of forest fires
- To understand the types of forest fires
- To study the effects of forest fires
- To know the various preventive measures

Backward Linkage: Nil

Forward Linkage:

- To observe effects of forest fires and preventive measures during tour

Training Materials Required:

- Copy of lesson 2 to be circulated beforehand

Allocation of time:

- Introduction – 5 mts
- Causes of forest fires – 10 mts
- Types of forest fires – 8 mts
- Effects of forest fires – 12 mts
- Preventive measures – 15 mts
- Discussion/ Miscellaneous – 10 mts.

1. **Forest Fires**

Next to deforestation forest fire causes the most severe damage to the forests. One single uncontrolled fire can destroy the forest wealth which foresters have toiled over years to establish. Although fire is clearly a disturbance that disrupts the development of the existing stand, fire is a natural factor in the forest ecosystem, and its effects have been incorporated in species' adaptations and ecosystem dynamics.

1.1 Fire influences –

- geomorphic and hydrologic processes of hill slopes and stream channels;
- physical and chemical properties of soil;
- nutrient loss;
- biomass accumulation;
- genetic adaptations of plants;
- plant composition and diversity, mortality, regeneration, growth and succession;
- wildlife habitat and wildlife population dynamics;
- presence and abundance of forest insects, parasites, and fungi.

(Burton V Burnes et al 1998 Forest Ecology John Wiley & Sons, Inc.)

2. **Causes of forest fires**

Broadly, there are two causes of forest fires, namely, **(1) natural and (2) man-made, that is, fires caused by humans.**

2.1 Natural Causes – The natural causes that prompt fire are lightning, rolling stones or rubbing of dry bamboos. The major among these causes is the lightning. Between 70 and 100 lightning flashes are estimated to occur every second worldwide, but not all strike the ground (Burton V Burnes et al 1998). In our country the number of fires that may be caused by all the three natural causes are not more than 5 % of the total number of fires caused in a year (L S Khanna, 1998).

2.2 Fires caused by humans – Throughout the world humans have been the most significant causes of fires. About 95% of fires in this country are caused by man (L S Khanna, 1998). Fires caused by humans may be due to carelessness or could be a deliberate action.

2.2.1 Accidental fires due to carelessness may be caused by any of the following incidents –

- Leaving fire burning after cooking in forest camps;
- Throwing burning match stick or bidi or cigarette;

- Throwing torch wood by the travelers at night;
- Burning of fields or grass lands adjoining to forests;
- Accidental spread of fires while burning fire lines

2.2.2 Deliberate or intentional fires are caused normally in the following cases –

- Burning the undergrowth to collect minor forest produce;
- Inducing new shoots of grass by burning the dry grass;
- Scaring away wild animals from the villages in the forest fringe;
- Destroying or charring the stumps of illicitly-felled trees.

3. Types of forest fires

According to the level at which they occur, forest fires are of the following types-

- **Ground fire** – it burns the ground cover only, i.e. the carpet of herbs and low shrubs which cover the soil.
- **Surface fire** – It burns not only the ground cover but also the undergrowth. This is the most common type; it consumes litter, killing aboveground parts of herbs and shrubs, and typically scorching the trees. Surface fire is very sensitive to wind speed. It tends to kill young trees of all species (often, however, just the aboveground portion) and most of the trees of less resistant species of all sizes (Burton V Burnes et al 1998).
- **Crown fire** – It spreads through the crowns of trees and consumes all or part of upper branches and foliages. This usually occurs in coniferous forests.

4. Effect on forests

Forest fires cause the following damage to forests.

- **Damage to plants** – The ground flora of shrubs and herbs and the undergrowth are most vulnerable to surface fire, which is most common. Trees, in the upper storey, however, depending on species and age, suffer in varying proportion due to forest fire. The species which have thick corky bark are less prone to damage than those with thin bark. The broad-leaved species are less affected by forest fire than the conifers.
- **Damage to regeneration** – Forest fire causes enormous damage to regeneration of plants and young plantations. Even a ground or surface fire of moderate intensity can totally destroy the regeneration. If the species concerned are good

coppicer, and their root stock does not get destroyed, regeneration can appear again, but still the vigour of growth gets retarded.

- **Damage to soil** – Fire bares the forest soil to eroding agents like sun, wind and rain. Soil erosion thus gets enhanced. Forest fire also depletes organic matter and nitrogen reserve. Fire also makes the soil more compact and impervious.
- **Damage to productive potential** – Fire reduces the productive potential or capacity of forests. Repeated fires may change the type of forests, for example, an evergreen forest may turn into a deciduous forest of poorer quality. Owing to natural adaptive character of the plants, valuable species may be replaced by inferior fire-hardy species. Fires also adversely affect the crop density and yield. Thus on repeated occurrence of fires, forest yield suffers both in terms of quality and quantity.
- **Damage to conservation potential** – Even as ground and surface fire burns down the ground flora and undergrowth, there is considerable increase in the runoff. As a result, the capacity of forest to conserve soil and ground water is reduced. The streams passing through forested watershed witness sudden spurt in channel flow, if the watershed is burnt. Studies have revealed that stream flow from a watershed with protected ground vegetation is more uniform and steady than from a watershed whose soil and protective cover has been damaged.
- **Damage to wild animals** – Forrest fire destroys the eggs and young ones of wild animals. Sometimes the bigger animals also become victims of fire. Fire thus inflicts an enormous damage to wild animals and the biological diversity of forest.

5. Preventive Measures- Preventive measures are those which reduce the chances of occurrence of fire. There are many factors that create an environment where fire becomes a likely phenomenon. The aim of the preventive measures is to address those causal factors. Broadly, preventive measures can be grouped into two major classes, namely, (1) **indirect measures** and (2) **direct measures.**

5.1 Indirect Measures – Indirect measures are those which, although not directly confronting the causal factors of fire environment, reduce the fire risk by containing the factors. Examples of indirect measures are –

- **Cooperation of forest fringe villagers** – Since most of the forest fires are man-made, either by way of carelessness or by deliberate actions, the foremost measure is to sensitize the fringe villagers to the danger of forest fire and obtain their cooperation in prevention of accidental or deliberate fires caused by humans. Cooperation of the

villagers can be best obtained by deliberating the issue of forest fire in JFMC meetings. JFMC can take an effective role in making the fringe population aware of the destructive potential of forest fires, and of their responsibility in prevention of man-made fires.

- **Education of people in general** – Besides the forest fringe population, people in general need be educated. They should be convinced that uncontrolled or repeated forest fires deplete the potential of ecosystem services of forests. In other words, fires cause a decline in the ability of forests to produce timber, non-wood forest produce, and other benefits. People should be educated that it is their responsibility to protect forests from all damaging factors including fires. Such education can be imparted through press, radio, television, workshops and educational institutions. One of the effective means will be to involve the students of schools and colleges and spread through them the importance of conserving forests and the role they play for human existence.
- **Regulatory provisions** – If considered necessary, there could be appropriate regulatory provisions in the Acts, Rules, executive orders or resolutions relating to JFMC prescribing –
  - Disincentive or enhanced punishment to those who willfully cause a fire, or do not assist in preventing or extinguishing fire;
  - Regulations in intrusion to forests, carrying fire in forests, and collection of minor forest produce, particularly in dry season.
- **System of incentive and disincentive** – There may be in place a system of incentive and disincentive for forest personnel in the matter of detection and prevention of forest fires. Forest personnel who do a good job in this regard may be suitably rewarded. The system of reward may also include as beneficiary the villagers. At the same time, there should be provision of suitable punishment for forest functionaries for dereliction of duty.

5.2 Direct preventive measures – these are those measures which directly address the factors of fire environment. Following are some examples.

- **Forecast of forest fire** - In developed countries, prediction of fire is done from studies of temperature, humidity, wind etc. and weather analysis by sophisticated equipments. Forecast of fire can alert the forest personnel and help them take precautionary measures.
- **Reduction of risk** – Risk of forest fires can be reduced by limiting the exposure of forests to fire. This can be done by the following measures –

- **Controlled burning** – The objective is to burn the inflammable materials such as grass, shrubs, fallen leaves and wood in identified blocks or strips under controlled conditions and thus reduce the risk of later fire damage. Ideally, such controlled burning should be done before the advent of dry season. The blocks or strips which undergo controlled burning are less likely to catch fire during the dry season and they restrict fires from spreading across them. Controlled burning is done patch by patch beginning from the patch which has most of the grass dry. Control is exercised so that fire does not spread beyond the boundary of the patch taken up for burning.

  Controlled burning is done to protect plantations, natural regeneration areas, timber depots and other valuable forest resources. A belt of sufficient width round such areas is subjected to controlled burning so that fire, caused accidentally or otherwise, cannot cross this belt and damage the plantations, depots etc. inside.

  It is advisable to take up controlled burning after the dusk because the flame in the dark is easily visible and it is much easier to control the extent of burning within the envisaged boundary. In bright sunlight flame of fire is often not visible and there is risk that fire may spread beyond the limits without getting detected.

- **Fireline** – Fireline is defined as a cleared permanent fire break (a barrier from which all or most of the inflammable materials have been removed) intended to prevent fires from crossing from one area to another. In other words, It is a permanently clear-felled strip in a forest which is burnt every year before the commencement of hot weather to destroy all inflammable materials so that it may prevent the spread of an accidental fire (L S Khanna, 1998). Firelines are carefully aligned so as to divide the forest into small blocks. Thus fire, even if originated at a block accidentally, remains localized within the block and does not spread to other blocks easily. Even when fire is intense enough to spread across fireline, it permits time to start fire fighting operations and contain the damage.

  Firelines 3 to 5 metre wide are optimum. Firelines should be maintained motorable so as to permit easy and quick movement of fire-fighting squads.

Source of Lesson materials:

1. Burton V Burnes et al 1998 Forest Ecology John Wiley & Sons, Inc
2. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun

Lesson 3

1 hour

Lesson Plan

Objective:

- To study combative measures to put out Forest Fires
  - Detection of forest fire
  - Fire combat operations
  - Post- suppression operations
- To know about -
  - Fire Reports
  - Legal Provisions

Backward Linkage: Forest fires dealt with in Lesson 2.

Forward Linkage:

- To observe, during tour, firelines, their use and maintenance, and if possible, know the account of recent fire combat operations. It would be a good experience if the trainees can participate in a fire combat operation

Training Materials Required:

- Copy of lesson 3 to be circulated beforehand

Allocation of time:

- Combative measures - Introduction – 5 mts
- Detection of forest fire – 10 mts
- Fire combat operations – 10 mts
- Post-suppression operations – 5 mts
- Fire Reports – 10 mts
- Legal provisions - 10 mts
- Discussion/ Miscellaneous – 10 mts.

Forest Fires (Continued)

1. **Combative measures** –

Combative measures are those which are taken to put out a fire after it has broken out despite taking the preventive measures. Needless to say that more we delay to start the combative operations, larger is the area that comes in the grip of fire and more is the damage. Thus time factor is very crucial in the matter of detection of fire and launching operations to suppress it. The entire process of combating measures that starts from detection and involves, in stages, communication to proper quarters, mobilization of force and logistics and launching of operations on ground should be accomplished with precision and with minimum wastage of time.

2. Detection of forest fire

A prerequisite for effective fire combat is early detection of forest fire. The traditional practice for detection of forest fire is engagement of fire watchers during the fire season. The fire watchers are required to make ground patrol and man watch towers to detect forest fire. Ground patrol by forest personnel and watchers of course forms an indispensable part of forest protection measures. However, given large forest tracts and limited strength of forest personnel/watchers, ground patrol alone may not be an effective method of fire detection. Watching atop towers may command a larger view but has its limitation in detecting ground fires at early stage. Further, number of watch towers is few and again it is not economically feasible to erect as many watch towers as satisfactory view of entire forest areas would demand. Measures therefore should focus on –

- Identifying suitable locations for watch towers;
- Judicious utilization of limited forest watchers/staff;
- Strengthening patrol in fire seasons;
- Frequent patrol along roads and in those areas frequented by villagers and graziers.

2.1 Despite proper employment of staff/watchers and available resources, the traditional method of fire detection by ground patrol and vigilance atop watch towers is not very satisfactory. Sophisticated methods of remote sensing and GIS are therefore now employed to detect outbreak of fires.

• The GIS cell at Aranya Bhavan (office of PCCF HoFF, WB) downloads information from university of maryland website (http://maps.geog.umd.edu/firms/).

• The said website provides everyday locations (lat/long) of points worldwide where outbreak of fires has occurred in the last 24 hours.

- The lat/long of points of our interest are then overlayed on existing forest boundary layers, and locations of fire points in our forests are found out.
- The locations are quckly communicated to the concerned forest divisions for field verification and necessary combative measures.

(Courtesy Information: Shri Amitabh Misra, IFS)

3. Fire combat Operations

- **Arrangement of labour** – Depending on the extent of area being affected and intensity of fire, labour in appropriate strength is arranged. Labourers are normally engaged from the local villages and the JFMC members.
- **Arrangement for tools, food, water, lighting etc**. – The tools that are normally required are sickles (for cutting grass and shrubs), axes (for cutting down large shrubs or small trees), spades (for digging earth), iron rakes (for moving wood, leaves etc.) etc. Fire fighting is a continuous operation and may continue for hours. Therefore, adequate arrangement for food and water should be made for those who are involved in the operation. Further, appropriate lighting arrangement should be with the personnel to help them move and conduct the operation smoothly.
- **Arrangement for transport** - The effectiveness of the combative measures depends much on how quickly the men and materials are gathered at the affected site. So suitable vehicle of transport should be available. Further, the forest roads and the firelines should be in good and motorable condition to facilitate easy and quick transport.
- **Methods of extinguishing fire** – While water and earth are considered to be effective extinguishing materials, they are of little or limited use in practice. Water in adequate quantity is normally not available at forest sites. Whatever little water is available is rather fruitfully used to put out burning stumps and by the labourers. Putting out fire by earth is also not feasible, as digging earth is a time consuming process. Like water, earth can be used in extinguishing smouldering stumps.

  The effective methods of extinguishing fire are –

  - **By beating** – This is the best and most common method to put out mild surface fires. Brooms required for beating down fire are made by cutting branches of shrubs. Fire is put out by beating back the fire with the green brooms.
  - **By counterfiring** – The method of beating is possible in case of mid fire when men fighting the fire can stand close to fire. However, when fire is intense and going close to fire is not possible, the method of counterfiring is employed. In this method the advancement of fire is stopped by deliberately burning the forest from the opposite direction. A secondary fire is started at

some distance from the advancing fire and is made to proceed towards the main primary fire. The two fires eventually meet and get extinguished.

4. Post- suppression operations

The job of foresters does not end in control or suppression of fire. After the fire is controlled by beating or counter-firing, the affected area still may contain smouldering wood pieces and stumps, and burning dry woods and cones. These remnants may be source of new fire in the area. Therefore after the fire has been suppressed, following operations are required to be done as extra protection against outbreak of new fire.

- All smouldering wood and stumps are completely extinguished with the help of water or earth;
- The burning dry trees are felled and extinguished;
- All traces of fire are completely extinguished.

5. Fire reports

After the combat operation is over, it is necessary to prepare a fire report and submit to the higher authority. The report should, among other things, include map of the affected area, and information on extent of burnt area, cause of fire, assessment of damage etc.

5.1 The circular issued by WB forest directorate and the format of fire report may be seen in Appendix 1 and 2 (Courtesy: Shri Amitabh Mishra, IFS).

6. Legal Provisions

Legal provisions in dealing with forest fires are mentioned below. It is recommended to go through the texts of the relevant Acts in this regard.

6.1 Indian Forest Act 1927

6.1.1 Provisions for Reserved Forest

(a) Any person who sets fire to a reserved forest, or, in contravention of any rules made by the State Government in this behalf, kindles any fire, or leaves any fire burning, in such manner as to endanger such a forest can be charged with offence under sec 26(1)(b) of IFA, 1927.

(b) or who, in a reserved forest kindles, keeps or carries any fire except at such seasons as the Forest- officer may notify in this behalf, may be charged with offence under sec 26(1)(c) of IFA, 1927.

To charge an offender under sec 26(1)(b) of IFA –

It may be noted that setting fire to a reserved forest from outside is an act, the commission of which has to be proved. But in case of kindling fire or leaving a fire

burning outside so as to endanger a reserved forest, the existence of rules made by the government contravening such act has also to be proved in addition to commission of the act itself.

To charge an offender under sec 26(1)(c) of IFA –

It has to be proved that the forest Officer has notified a season and that the act has been committed in contravention of such order of the Forest Officer.

6.1.2 Provisions for Protected Forest

(a) Any person who sets fire to a protected forest, or kindles a fire without taking all reasonable precautions to prevent its spreading to any tree reserved under section 30, whether standing, fallen or felled, or to any closed portion of such forest is punishable under **section 33(1)(d) of IFA, 1927**.

(b) or who leaves burning any fire kindled by him in the vicinity of any such tree or closed portion is punishable under **section 33(1)(e) of IFA, 1927**.

It may be noted that in order to charge an offender under **section 33(1)(d) or 33(1)(e) of IFA, 1927, it would be necessary to prove the existence of notification under section 30 and of rules under section 32 prohibiting commission of such acts.**

6.1.3 Miscellaneous Provisions

According to section **79(1) of IFA,**

- **e**very person who exercises any right in a reserved or protected forest,
- or who is permitted to take any forest-produce from, or to cut and remove timber or to pasture cattle in, such forest, and every person who is employed by any such person in such forest, and
- every person in any village contiguous to such forest who is employed by the Government or who receives emoluments from the Government for services to be performed to the community,

shall be bound to furnish without unnecessary delay to the nearest Forest-officer or Police officer any information he may possess respecting the commission of, or intention to commit, any forest-offence; and

such person shall be bound to take steps forthwith, whether so required by any Forest-officer or Police officer or not, among other things, to extinguish any forest fire in such forest of which he has knowledge or information;

6.2 The Wildlife (Protection) Act, 1972

6.2.1 Provisions for Sanctuary and National Park

Any person who sets fire to a sanctuary or a national park, or kindle any fire, or leave any fire burning, in a sanctuary or national park, in such manner as to endanger such

sanctuary or national park can be charged with offence under **section 30** of the Wildlife (Protection) Act.1972.

Source of Lesson materials:

1. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun
2. Appendix 1 and 2 (Courtesy: Shri Amitabh Mishra IFS)
3. Lessons of Forest Law.

Appendix 1

URGENT

Government of West Bengal
Directorate of Forests
Office of the Principal Chief Conservator of Forests, West Bengal
"Aranya Bhawan", Block – LA-10A, Sector-III, Salt Lake City
Kolkata – 700 098

No. 1969/5TG /RWPM/2M-642/06 Dated : 19 .05. 2006

To

Sub : Contingency Plan for Forest Fires.
Ref : This office letter No. /RWPM/2M-642/06, dt. 4.4.2006.

Detailed instructions were given to you vide this office letter No. under reference for submission of fire reports. I am now enclosing a copy of letter No. 3-6/2006-FPD, dt. 9.5.2006 from the Ministry of Environment & Forests containing a protocol regarding submission of reports and other allied matters. The following revised instructions are, therefore, being issued for your information and necessary action :

1. (A) Starting from 1.6.2006 all the territorial DFOs should submit a First Information Report in respect of the following categories of forest fires **within 24 hours** :

   (a) Forest fires in Darjeeling district (Darjeeling, Kurseong and Kalimpong Sub-divisions) affecting 100 ha of area or more and burning for more than 2 days.
   (b) Forest fires in Darjeeling district (Siliguri Sub-division) and other districts of West Bengal affecting 500 ha of area or more.
   (c) All cases of forest fires, howsoever small, in National Parks, Sanctuaries and tourist areas.

   (B) The above report should contain the following details :

   (a) Date & time of fire.
   (b) Location (Block/Compartment/Mouza).
   (c) Name of Division/National Park/Sanctuary.
   (d) Approximate area affected by fire (in ha).
   (e) Type of fire (Crown/Ground).

   (C) The report should be sent to the Fire Monitoring Unit (Attn. : Shri S. C. Pal, ADFO) through e-mail (wbforestfire@yahoo.co.in) or fax (033-2335 5147).

pto

2. (A) The territorial DFOs should submit a consolidated fortnightly fire report by speed post/fax/e-mail to the Fire Monitoring Unit in respect of **all cases of forest fires** in the Division (including those covered by Para-1(A) above) in the format given in Annexure – A.

(B) The fortnightly report should be submitted according to the following schedule.

(a) Report for the 1st fortnight ⇨ by 22nd of the same month.
(b) Report for the 2nd fortnight ⇨ by 7th of the following month.

(C) Even a 'Nil' report should be sent in case there is no incident of fire during the fortnight.

3. (A) Please recall that you were requested to submit a consolidated report of forest fires in you Divisions for the period from 1.1.06 to 31.3.2006 in the prescribed format by 22.4.2006. Please submit the same urgently, if it is still pending.

(B) The same information may also please be compiled and submitted for the months of April, 2006 and May, 2006 to the Fire Monitoring Unit **by 15.06.2006 positively.**

4. Action in respect of Paras 3, 4, & 5 of the protocol will be taken at the Directorate level.

Please treat it as most urgent.

(S. S. Bist)
Addl. Principal Chief Conservator of Forests,
Research, Working Plan & Monitoring,
West Bengal

Encl : As above.

No...../RWPM/2M-642/06 Dated : 19 .05. 2006

Copy forwarded for information & necessary action to :

(S. S. Bist)
Addl. Principal Chief Conservator of Forests,
Research, Working Plan & Monitoring,
West Bengal

Appendix 2

Annexure-A

Forest Division:_____ District:_____

Fortnightly Summary of the Forest Fires during the Month _____ Fortnight: First / Second (From___ to_____)

Date of Fire	Duration of Fire (Hours)	Location (Forest Block & Comptt / Revenue Block & Mouza)	Latitude - Longitude* & Altitude	Type of Fire (Crown / Ground)	Area Burnt (ha)	Nature[1] of the Burnt Area	Legal Status[2] of the Burnt Area	Cause of Fire (Deliberate / Accidental)	Legal Action[3] (if any)	Name of FPC / EDC	Estimated Loss (Rs. in Lakh)	Remark (if any)

DFO
(Signature & Seal)

* In case latitude & longitude can not be ascertained, please include a GIS map showing the location of the fire.
[1] Mention whether High Forest or Plantation or Nursery or Depot or Forest Village or Forest Establishment, etc.
[2] Mention whether RF or PF or Unclassed State Forest or Sanctuary or National Park, etc.
[3] Include reference about persons arrested and FIR/ POR / COR / UDOR if any.

Lesson 4

1 hour

Lesson Plan

Objective:

- To study injuries to forests by animals
  - ➢ Introduction
  - ➢ Domestic animals
    - Classification
    - Damage by grazing animals, preventive and remedial measures
    - Damage by browsing animals, preventive measures

Backward Linkage: Nil

Forward Linkage:

- To observe, during tour, some of the measures.

Training Materials Required:

- Copy of lesson 4 to be circulated beforehand

Allocation of time:

- Injuries by animals - Introduction – 3 mts
- Domestic animals – classification – 3 mts
- Grazing animals
  - Damage – 5 mts
  - Preventive measures – 12 mts
  - Remedial measures - 12 mts
- Browsing animals
  - Damage – 5 mts
  - Preventive measures – 10 mts
- Discussion/ Miscellaneous – 10 mts.

Injuries by animals

1. Introduction

Increase in the population of herbivores has a serious impact on forest ecosystem. The herbivores may be domestic or wild. Herbivores in the wild may increase in number through reduction of predators. The domestic animals again grow in number as they are considered as assets or property by men who rear them. The wild herbivores almost totally depend on forest plants for their food. Further, a large portion of domestic herbivores belonging to the villages adjoining to forests graze and browse in the forest lands. Thus the dependence of herbivores, wild and domestic, on forests for food lead to considerable pressure on the forest ecosystem and may turn to be quite destructive of forest regeneration.

1.1 Among domestic stock, goats are by far the most destructive of forest regeneration, followed by pigs, sheep, and cattle, in approximately that order. Long-continued overgrazing by livestock will result in the elimination of palatable species from the ground up to the browse line, compaction of forest soil, and eventual conversion of the forest to an open scrub of unpalatable species or grassland (Burton V Barnes et. al, 1998 Forest Ecology John Wiley & Sons, Inc.).

1.2 This lesson deals with the domestic animals.

2. Domestic animals.

As stated before, domestic animals form a part of asset to humans and men, by way of their natural instinct to add to their property, would like to own more number of domestic animals. This is the major reason for increase in the population of domestic animals. It is important to note that even as the livestock population has increased over time, the number of cattle grazing in the forest has risen at a higher rate, since extent of pasture land has decreased. Thus adverse impact of domestic animals on forests has been growing due to following factors –

- Increasing population of livestock in the forest fringe villages;
- Paucity of grazing land outside forests;
- Traditional practice of grazing the cattle in the forest land;
- Lack of awareness about the damage being caused by the animals to the growing plants;
- Forest resources are considered as nobody's property and as such forest protection still now receives low priority in rural development.

2.1 Classification of domestic animals

On the basis of food the domestic animals are classified into following two classes.

- **Grazing animals** – are those which feed mostly on grass and herbage. Examples are cow, bullock, buffalo, horse etc.
- **Browsing animals** – are those which feed on twigs or shoots, with or without leaves, of shrubs, trees and woody climbers. Examples are goat, camel, elephants etc.

3. Damage caused by grazing animals

Light controlled grazing does rather good to forests. As grass and herbs are removed, the fire risk goes down. In temperate forests light grazing disintegrates the thick layers of undecomposed needles and facilitates germination of conifers. However, uncontrolled grazing causes the following damage to forests.

- Seedlings of desired species are also grazed along with grass. So regeneration of important tree species is hampered.
- Grazing animals deliver physical damage to desired seedlings by trampling, crushing to earth and dislodging the roots from the soil by their hooves. This leads to mortality of the seedlings.
- Soil becomes compacted and porosity is reduced. This also results in poor aeration in the soil. Under the hooves of heavy animals the soil aggregates break down leading to poor structure of the soil.
- Compaction of clayey soil due to grazing leads to increased runoff. Again, sandy soil under the hooves becomes loose. Thus both in clayey and sandy soil, soil erosion is increased due to grazing.
- Heavy uncontrolled grazing causes depletion of nutritive palatable grasses and in their place unpalatable, less-nutritive, thorny grasses do emerge. The grazing capacity of forests is considerably reduced.
- Adaptive character of nature also helps establishment of grazing-resistant inferior species in place of valuable crop which are mostly grazing prone.

3.1 Measures in management

Grazing in forests cannot be eliminated altogether by enforcement of law or by persuasion of the villagers. Complete stoppage of grazing as an object of forest management is not desirable either. Light controlled grazing, as stated earlier, is beneficial to regeneration. And when management practice, without compromising the object of development of forests, provides for grazing under certain regulations, it achieves one major input for forest enrichment. The input is support and active cooperation of the fringe population, which is the basis of joint forest management. The management measures to address the problem of grazing should

therefore strike a balance between control measures necessary for scientific forestry and providing options for grazing to livestock of nearby villages. All measures, preventive or remedial, should flow from this principle.

3.1.1 Preventive measures

Following are some examples of preventive measures that can prove to be helpful.

- **Discourage to keep large number of cattle** – People keep large herds for supply of milk, agricultural works and more importantly for dung which is used for manuring and burning. The villagers in the outskirts of forests need be explained that breed and quality of cattle are more important than the number. All the objects of keeping cattle are better served by less number of healthy cattle of good breed than a larger number of emaciated stock. It is also easier to manage and feed a fewer stock. They can be fed at home or put through regulated regime of grazing without much hassle. If the villagers are convinced and number of ill-fed cattle is reduced, the pressure on forests will automatically lessen.
- **Inclusion of grazing in forest function where compatible –** Forests are classified according to their most important functions. For example, there are reserved forests, protected forests, village forests, wildlife sanctuaries, tiger reserves etc. Unclassified forests also form a class. If grazing is not incompatible with the most important function of a forest, it may be allowed. And even if incompatible, grazing may be allowed in restricted time and zone if it helps to achieve the most important function of the forest.
- **Closure or regulation of grazing –** Some parts of the forest, called vulnerable **areas**, may be closed to grazing altogether. **These vulnerable areas constitute concentrated regeneration areas, areas under active erosion, catchments of river valley projects, and other degraded areas**.

  The **concentrated regenerations areas** – young plantations etc- are not large and therefore can be closed without much problem. As soon as the plants cross a stage when they are longer liable to be damaged, the areas in question may be opened to grazing subject to grazing capacity.

  Areas which have become highly **eroded or degraded** owing to, among other things, heavy uncontrolled grazing, the same should be closed until remedial measures are taken and such areas become rehabilitated.

  In areas other than vulnerable areas, grazing may be regulated, that is, allowed in a restricted manner, depending on the grazing capacity of the area. There is a limit to the maximum number of cattle that a forest area can allow for grazing and still regenerate

fodder necessary to sustain grazing by the said number of cattle. **Grazing capacity** of an area is defined as the amount of grazing that the area can afford to sustain, and is expressed as the number of animals or equivalent cow-units per acre/hectare. Grazing capacity of forest areas is determined by various factors like forest type, canopy density, climatic and edaphic factors, slope, amount and quality of grass etc.

Limitation to grazing incidence to the grazing capacity may be effected by taking the following steps.

- Intensive discussion with the JFMC members or villagers, convincing them to appreciate the need to enforce the regulation;
- Issue of a circular or executive order following above discussion; the circular may, among other things, clearly indicate the number of cattle units permitted to graze over a specified area.
- Introduction of disincentive by levying grazing fee on an appropriate scale.

- **Social forestry outside forests**

  Social forestry schemes which were launched in 1980s in the state have done a great service to create a commendable bio-resource outside forest lands. The objective of social and farm forestry has been, among other things, to make the fringe villages self reliant for timber, fuel and fodder, or, in the least, make such villages less dependent on forests for the said resources. There is perhaps no other measure more befitting than social forestry to deal with the grazing issue.

  In this connection it is required to create plantations containing fodder species in government non-forest lands, community lands, and lands belonging to institutions or individuals. Forest department may provide following inputs in such projects –

  - Formulate and design action plan and schedule;
  - Supply or facilitate production of planting materials;
  - Create some plantations in government lands as demonstration plots;
  - Provide technical knowhow to the villagers with regard to creation, maintenance and harvest of such plantations;
  - To finalize, with the concurrence of the appropriate authority, the mode and quantity of distribution of benefits among the beneficiaries, in case of harvest from lands other than those belonging to individuals.

- **Silage, hay making and stall feeding** – Theoretically, stall feeding is the answer to eliminate grazing in forests. In developed countries where animal farming is a major

industrial activity, stall feeding is taken resort to. In our country, it is not possible to bring all cattle population under stall feeding. However, for the sake of health of the cattle and beneficial effects on agriculture and forests, stall feeding should be encouraged and started in the villages. The villagers may however, be provided with facilities to cut and collect fodder from forests, particularly during rainy seasons, to make silage and hay for consumption during the dry months. The work can be organized through the JFMCs.

- **Improvement of forest lands** – With the object to alleviate pressure on prime forests, all grasslands and open forests suitable for fodder grass may be taken up for plantation of fodder grass and maintained as grass production areas.

3.1.2 Remedial measures

Despite taking preventive measures, such measures may not prove to be enough, and the damage due to grazing may continue. Foresters also often come across areas which have been damaged in the past due to grazing. Regulation of grazing, that is, allowing limited numbers of cattle to graze will not be appropriate measure in those areas. Remedial measures need to be taken in such case. Remedial measures are normally of two types –

- **Periodic or Rotational grazing** – When the damage is not serious, further deterioration is arrested by taking recourse to these measures.

a) **Periodic grazing** is defined as grazing by limited number of cattle for a definite number of years or months followed by closure (L.S Khanna 1998, Forest Protection).
   - The object is to allow time (during the period of closure) for the grasses to regenerate and develop so as to afford grazing pressure again for some time;
   - Repetitive periodic closure and opening of an area enables the area to regenerate palatable grasses and bear the impact of grazing during the periods it remains open for grazing.
   - It is different from complete closure of regeneration or eroded areas for a period of 5 to 10 years or for longer periods. While the object of periodic closure, which is of shorter duration, is to allow time for grasses to regenerate, the object of complete closure, of a much longer duration, is to allow time necessary for establishment of tree species.

b) **Rotational Grazing** is defined as grazing of a limited number of cattle in the different parts of the grazing area in a predetermined sequence (L.S Khanna 1998, Forest Protection).
   - **In rotational grazing** the forest area is divided into a number of blocks. The blocks, one at a time, are opened to grazing for a specified period in a sequence. Thus one block or the other of the forest remains open to grazing by limited

number of cattle throughout the year, except may be for the rainy season (July – August);

- The cattle number is limited to the grazing capacity of the forest.
- For example, a forest of 1000 ha of grazing capacity 1.25 cow-units per ha is put to rotational grazing. It means that 1250 cow units can graze in the said forest. The said forest is divided into, say, 5 blocks. It is also planned that the forest will remain closed to grazing during the rains, that is, for the 2-month period of July and August. So under rotational grazing, during the 10-month period of the year each block will be opened for 2 months to grazing by cattle of number not exceeding 1250. The idea is that when grasses in a block are grazed up in 2 months, the cattle are moved to another block and the process repeats itself. Thus each block of 200 ha gets a respite time to regenerate itself. In order that a particular block does not open for a fixed grazing period of two months every year, the grazing period of a block is moved in successive rotations or cycles. It is illustrated below.

Grazing Period	First rotation or cycle	Second rotation or cycle	Third rotation or cycle
January- February	Block I	Block II	Block III
March-April	Block II	Block III	Block IV
May-June	Block III	Block IV	Block V
September-October	Block IV	Block V	Block I
November-December	Block V	Block I	Block II

(Source: L.S Khanna 1998, Forest Protection).

- In order to ensure that grazing is done in the prescribed block, it becomes necessary to fence each grazing block.

- **Artificial regeneration of grasses** – When the damage due to grazing is serious and the land hardly provides any grass for grazing, the rotational grazing may not be adequate to regenerate the area and the option left is to go for artificial regeneration of grasses. Artificial regeneration is, however, feasible only in degraded forests or pastures. The open degraded forest is taken up for planting with superior grasses after suitable soil work.

4. Damage caused by browsing animals

Browsing animals cause more damage to plants than grazing animals. And among the browsing animals, the goat is the most destructive and damage inflicted by goat is most common. The goat eats up almost any plant including the thorny ones. In the process of browsing the leaves,

the shoots are chewed and damaged to such an extent that they cannot re-grow. Adding to the potential for damage is the fact that the goat stands on its hind legs to reach leaves or shoots located at heights which it cannot reach in normal posture. Thus the browsing reach of a goat is more than its height. The sheep is, however, less destructive. Considerable damage is caused by the camel. Since it is a tall animal, the camel is capable of causing damage to a height of about 4 metre. The camel is, of course, found in some specific areas and therefore the damage caused by it is localized and limited to such areas.

4.1 Preventive Measures for browsing

Rearing of goats and sheep forms a means, sometimes the only means, of income of some villagers in the outskirts of forests. These villagers leave their livestock free to browse in the forests. Forests thereby become the major source of fodder for these browsing animals and have to bear the damaging impact of browsing. When the herds are large, the degree of destruction is considerable, and often young plantations and other regeneration areas are damaged to such an extent that it becomes necessary to plant up the area afresh. It has been realized since long that admission of browsing animals into the forest is incompatible with the aims of forest management, and should be stopped as far as possible. The measures that merit consideration are –

- To stop, or contain as far as possible, entry of browsing animals into the forests;
- To meet the feeding requirement of these animals by allowing the villagers to collect from forests fodder of optimum quantity; a suitable arrangement should be in operation to allow collection of fodder by the villagers.
- To include in the regeneration plan of forests planting or growing of fodder plants;
- To raise fodder plants reserve as part of social forestry project;
- To educate the villagers on the necessity of adopting these measures.

Source of lesson materials:

a) Burton V Burnes et al 1998 Forest Ecology John Wiley & Sons, Inc
b) L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun

Lesson 5

1 hour

Lesson Plan

Objective:

- To study Human Interfaces and their Control
  - Introduction
  - Damage caused through human interface
    - Deforestation
      - Diversion of forest land
      - Shifting cultivation

Backward Linkage: Forest fire dealt with in lesson 2 and 3.

Forward Linkage:

- To observe, during tour, some of the cases of diversion of forest land for non-forestry purpose.

Training Materials Required:

- Copy of lesson 5 to be circulated beforehand

Allocation of time:

- Introduction – 3 mts
- Damage caused through human interface – 3 mts
- Deforestation – definition – 2 mts

  Diversion of forest land
  - Introduction - 3 mts
  - Factors leading to diversion – 4 mts
  - Extent of diversion - 5 mts
  - Preventive and remedial measures – 10 mts

  Shifting cultivation
  - Introduction – 3 mts
  - Technique - 4 mts
  - Adverse effects – 3 mts
  - Measures to control - 10 mts
- Discussion/ Miscellaneous – 10 mts.

Human Interfaces and their control

1. Introduction

Man has inherited forests as a gift from nature. It has been man's responsibility to preserve, develop, and utilize this bountiful resource with its large varieties of life forms. For food, clothes and shelter man has ever remained dependent on forests. In all developing countries forests have formed one of the potent factors of economy. Growing population and simultaneous growth of demand of forest produce, typical of a developing economy, have thus resulted in severe damage to forests in our country through human interfaces. In a word, we have consumed more of forests than they could regenerate. The issue of conservation of forests and their biodiversity has therefore assumed great significance and importance in the context of development. The National Forest Policy 1988 has explained that the term 'conservation' includes preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment. All the damage inflicted through human interface has to be addressed and controlled by measures which are compatible with the above aims of conservation.

2. Damage caused through human interface

Following kinds of damage are caused by man.

- Deforestation
- Illicit felling
- Forest fire
- Faulty management
- Miscellaneous other damage

Forest fire has been dealt with in detail in Lesson 2 and 3. The other types of damage are now described separately.

3. Deforestation

Deforestation means removal of forest crop from a piece of land without any plan or intention to reforest the land. The major factors that are responsible for deforestation are (i) **Diversion of forest land for non-forestry purpose, (ii) Shifting Cultivation, (iii) Mining, and (iv) Encroachment**

3.1 Diversion of forest land for non-forestry purpose

Large areas of forest lands have been diverted to other uses over the years. Extension of agriculture and industrial development have both taken their toll on forests. In fact forests have been the first charge to meet the demands of land for any land based economic activity. In our country, until the middle of 20^{th} century, diversion of forest lands to other uses was considered only natural and there had been little concern for the devastating consequence such indiscriminate deforestation process could lead to. Since the middle of last century, the realization that forests are necessary for the survival of humans seems to have found reflection in our forest policies and legislations. There has been awakening that any proposal for deforestation should go through a stringent process of examination and scrutiny and should be

allowed only if diversion of forest land is unavoidable. It has also been realized that such diversion of forest land should be subject to regulatory conditions that will more or less try to compensate the loss apparent due to diversion.

3.1.1 Factors leading to diversion of forest lands

Normally following factors or circumstances lead to diversion or excision of forest lands.

- Relinquishment of forests for agricultural purpose – Throughout the world the agriculture has been the greatest driver for deforestation. India has been no exception. The Forest Policy of 1894 had clearly favoured diversion of forest land for agricultural purposes. It said that "whenever an effective demand for cultivable land exists and can only be supplied from forest area, the land should ordinarily be relinquished without hesitation;…" Thus the growing demand of agricultural land had been met at the expense of forests. Destruction of forest had been accentuated by adoption of agricultural practices which had often been non-scientific. Instead of improving land productivity, more and more forest lands had been put to tilling as forest lands were easily available.
- Relinquishment of forests for development projects – The 1952 national forest Policy stated that the role of forests in the national economy entitles forests to lay claim to an adequate share of land, and envisaged a bar on relinquishment of forest land for agricultural purposes. However, the said policy did not recommend any regulation or bar on diversion of forest land for development projects. Deforestation continued for agriculture and various development works. It is noteworthy that the central government had little regulatory role in this regard as the forest was a state subject. It was through the 42nd amendment of the Constitution in 1976 that forest was brought under concurrent list and thus empowered the parliament to make laws in respect of forests. This led to enactment of the Forest Conservation Act 1980. Under the provisions of this Act, no state government can divert forest land for non-forestry purpose without prior approval of the central government. This Act and the rules made thereunder also lay down several regulatory provisions for according approval for diversion of forest land.
    - Forest lands have been excised for various non-forestry purposes over the years, and continue to be excised notwithstanding promulgation of the Forest (Conservation) Act, 1980. The development projects that are mainly responsible for excision of forest lands are –
        - River valley projects (RVP) and their reservoirs;
        - Rehabilitation of people displaced by RVPs.
        - Construction/extension/widening of roads;
        - Laying/widening of railway lines;
        - Erection of electric transmission lines;
        - Construction of irrigation canals;
        - Establishment of power projects, thermal and hydroelectric.
        - Other industrial projects

3.1.2 Extent of diversion of forest lands.

- River valley projects alone have taken a heavy toll on forest lands. During the period 1951-52 to 1975-76 (prior to promulgation of FCA, 1980), the quantum of lands deforested for river valley projects are as follows-

State	Area in ha
West Bengal	1,700
All India Total	4,79,000

(Source: L S Khanna 1998 Forest Protection)

- The following table shows extent of forest lands deforested during the period 1951-52 to 1975-76 (prior to promulgation of FCA, 1980) for various development projects other than RVPs.

State	Agricultural purposes (ha)	Establishment of industries (ha)	Miscellaneous purposes (ha)	Total (ha)
West Bengal	3,13,700	2,900	6,200	3,22,800
All India Total	24,55,700	1,20,100	9,83,000	35,58,800

(Source: L S Khanna 1998 Forest Protection)

- In West Bengal, following promulgation of FCA, 1980, forest area of 2352.6173 ha has been diverted in the State for different non-forestry purposes till March 2014 (Source: Annual Report 2013-14 of W.B. Forest Directorate). The said area diverted does not include area meant for surface collection of boulders.

3.1.3 Preventive and Remedial measures

It is natural that socio-economic advancement would be accompanied by economic activities that would demand availability of land. Inevitably forests have to bear the pressure to meet a part of this demand. Given the circumstances that land is required to meet the growing demands of food, energy, infrastructure etc., it becomes expedient to take measures to prevent and contain the exercise of the easy option of relinquishing forest lands to meet the requirement. And in case diversion of forest lands for development works becomes unavoidable, we need to undertake remedial measures to neutralize or minimize the ill effects of diversion. The measures – both preventive and remedial – to contain diversion of forest land flow from the FCA, 1980, the rules made under this Act and the guidelines issued by the MoEF, GoI in this regard. Some of the measures are mentioned below.

1) **Strict compliance of FCA** – The Forest (Conservation) Act should be strictly complied with. Section 2 of the Act prohibits use of forest land for non-forestry purpose except with the prior approval of the central government. Any proposal or move for diversion of forest land for non-forestry purpose should be brought under scrutiny and examination under the Forest (Conservation) Act. The issue whether any particular use of forest land constitutes non-forest purpose and thus attracts section 2 should be determined upon examination of whether such use or activity is essential for or relating to conservation of forests and wildlife.
2) **Consideration of other alternatives** - While considering or recommending any proposal for diversion of forest land, a forest officer should satisfy himself that all other alternatives have been considered and that no other alternative is feasible, and the required area is the minimum needed for the purpose;
3) **Undertaking for compensatory afforestation on equivalent area** – Any proposal for diversion of forest land must accompany the undertaking by the concerned authority to provide at its cost acquisition of land of equivalent area and afforestation thereof.
4) **Examination of equivalent land proposed for compensatory afforestation** – Making provision for equivalent non-forest land is not enough. It needs to be satisfied that–
    - The non-forest lands to be provided for compensatory afforestation are consolidated as far as possible, and not fragmented in too small parcels; and if such non-forest land constitutes of discreet blocks, afforestation and conservation of such blocks is feasible and viable under normal forest management practices;
    - The non-forest lands provided are suitable for planting and raising forest species.
    - The non-forest lands provided should be as close to original forest lands being diverted as possible.
5) **Mutation of equivalent non-forest land** – When diversion of forest land is approved and given effect to in terms FCA, equivalent non-forest lands identified for compensatory afforestation are to be transferred and mutated in favour of the State Forest Department, and declared as reserved / protected forests. The transfer must take prior to the commencement of the project.
6) **Compensatory Afforestation** –
    - Should include all phases necessary for creation and establishment of the plantation spanning over a number of years;
    - Nature of plantation, mode of planting including selection of species should be in keeping with the prescriptions of working plan;
    - Species planned for regeneration should be, as far as possible, indigenous, covering large varieties. If the area identified for compensatory afforestation is located adjoining or close to the forest areas being relinquished, the list of select species for regeneration should include as many of the species of the forest area as possible.

3.2 Shifting Cultivation

Considering the country-wide landscape, shifting cultivation turns out to be one of the serious causes of deforestation, though it is not a menace in the context of West Bengal forests. Shifting cultivation is defined as a method of cyclical cultivation, where the cultivators cut the tree crop, burn the area, and raise field crops for one or more years before moving on to another forest site and repeating the process (L S Khanna 1998 Forest Protection). This method of cultivation is known as 'taungya' in Myanmar (Burma), as 'jhum' in Assam, Tripura and Arunachal Pradesh, and by different names in different states of the country. It is a serious problem in the hilly tracts of the north eastern states of our country. It is also noteworthy that quite a large population of tribals depends on shifting cultivation for their livelihood.

3.2.1 Technique of shifting cultivation – While the technique practiced in different states may vary in certain details, by and large it consists of the following steps.

- Cutting down trees and other vegetation on the site during the period from January to March;
- Burning the debris as it dries up in the month of April;
- Ash is mixed in the soil and seeds are broadcast during pre-monsoon shower;
- Crop is harvested during September-October.
- The process is repeated on the same site for 2 to 4 years, after which the site becomes thoroughly infertile for any cultivation; the site loses fertility because of repeated cultivation without manure and due to soil erosion.
- Thereafter a new forest patch next to the previous one is taken up and the same cycle of operation is repeated;
- The process continues until the forest within the limits of cultivation of a village is exhausted and cultivation comes back to the area in which it was started, after a period known as jhumming cycle. The jhumming cycle that is the interval after which the same area is cultivated again gradually shortens due to rise in population and decrease in fertility. After every cycle the land becomes poorer and, after a stage, is abandoned as unfit for cultivation.

3.2.2 Adverse effects of shifting cultivation

- It reduces soil fertility and ultimately makes the land unfit for cultivation.
- It leads to soil erosion which continues unchecked.
- It operates on a low productivity level, that is, production per unit area remains low.
- Considering the hard work and low productivity, the practice of shifting cultivation is actually uneconomic and undoubtedly unscientific.
- In hilly terrains it is a source of increased run off and may lead to floods causing damage to life and property.

3.2.3 Measures to control shifting cultivation

- **Awareness among the fringe population –** The villagers living in the fringe areas, particularly the tribal population, who practice shifting cultivation, should be made aware of the adverse effects of shifting cultivation and of those damage which are irreversible.
- **Induce to settled and scientific cultivation –** The shifting cultivators may be induced and encouraged to switch over to settled cultivation under scientific methods. The primary requirement to do this is to provide land. Implementation of the Forest Rights Act (FRA) 2006 may come in good stead in this connection. The right to hold and live in the forest land vested in forest dwelling scheduled tribes and other traditional forest dwellers under the FRA for self cultivation may be suitably made use of to induce such dwellers to adopt settled and scientific cultivation. Any such move would also require proper counseling, appropriate training and supply of farming inputs and technical knowhow.
- **Proper Land Use –** It is necessary to make the forest and fringe dwellers understand that all available lands should not be ploughed indiscriminately and brought under settled cultivation. It would not only result in gradual diminishing return from the land but also may cause irreparable damage to the land in question. The scientific approach would be to use a piece of land according to its capability. Thus depending on the slope and soil depth, lands may be put to appropriate use. For example, some lands (e.g. land in the valleys) may be suitable for settled cultivation for agriculture, while some other lands may be kept for horticulture, some for cash crop, and some for forests and pastures.
- **Alternative means of livelihood –** In order to reduce pressure of shifting cultivation on forest land, the cultivators should be provided with alternative means of livelihood. These may include –
    - Development of animal husbandry and dairy farming
    - Vocational training and development of handicrafts
    - Value addition to and marketing of non-wood forest produce
    - Distribution of usufruct share in forest produce
    - Employment in forestry works and forest based industries.
- **Making beneficial use of shifting cultivation** – Taungiya method of cultivation has been successfully used and adopted in Sal regeneration in North Bengal forests. Artificial regeneration in Sal Working Circles in North Bengal is done by sowing, and the seedlings that sprout from the seeds need clear space over and all around for growth and survival. However, the forests of North Bengal are characterized with heavy and vigorous growth of weeds that invade any clear space in no time and suppress the young plants. In fact, regular cleaning and weeding, at least 5 times in the first year of plantation, is a crucial

operation in the afforestation programme. Invasive weeds is not only a menace to young plantations, their removal is a labour intensive operation that increases the cost of the plantation. Taungiya system of cultivation comes in good stead to contain and suppress the weeds and help the Sal seedlings grow healthy in profuse numbers. The procedure is to allow the dwellers to raise agricultural crop or vegetables in the intervening spaces between the strips of Sal in the first year. Regular weeding and cleaning undertaken by the villagers to raise the agricultural crop automatically keep the weeds away from the forest crop. This turns out to be highly beneficial for the Sal seedlings as they are saved from invasion of weeds which otherwise would have denied them light, moisture and soil nutrients. Taungiya employed in the intervening spaces between lines of Sal associates also help those seedlings, particularly those which are slow growing, establish easily. Thus Taungiya method becomes beneficial for a sal plantation as a whole. Depending on the growth of the forest crops, taungiya cultivation in plantation sites may be done in the second year, thus reducing the number of cleaning- weeding of forest crop which would have been otherwise necessary. When the forest crops become tall and do not permit enough light and space for taungiya cultivation in the intervening spaces, cultivation is shifted to other sites of new plantations. The cycle thus continues.

- **Legal measures** – While the above measures, as deemed appropriate in a case, can be considered for adoption to contain shifting cultivation or make it beneficial, there will be cases where shifting cultivation should not be allowed or at least should be fairly regulated. Under such situations, shifting cultivation should be regulated and, if necessary, stopped altogether by taking recourse to legal measures. For example, shifting cultivation should not be allowed in wildlife protected areas, around water springs and close to hill roads.

Source of Lesson materials:

1. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun
2. Annual Report 2013-14 of W.B. Forest Directorate

Lesson 6

1 hour

Lesson Plan

Objective:

- To continue study of Human Interfaces and their Control
  - ➢ Deforestation (continued)
    - Mining
      - Introduction
      - Damage caused
      - Preventive measure
      - Remedial measure
    - Encroachment
      - Introduction
      - Factors responsible
      - Preventive measure
      - Remedial measure

Backward Linkage: Human interface dealt with in lesson 5.

Forward Linkage:

- To observe, during tour, some of the cases relating to diversion of forest land for mining, and be aware of measures taken to control/evict encroachment in some cases.

Training Materials Required:

- Copy of lesson 6 to be circulated beforehand

Allocation of time:

Mining

- Introduction – 3 mts
- Damage caused – 4 mts
- Preventive measure – 7 mts
- Remedial measure – 8 mts

Encroachment

- Introduction – 3 mts
- Factors responsible – 5 mts
- Preventive measure – 8 mts
- Remedial measure – 12 mts

Discussion/ Miscellaneous – 10 mts.

Deforestation (Continued)

1. Mining

Mining is a potential cause for destruction of forests. The irony is that with increasing population and industrialization, social demand for materials and energy has been on the rise and mining has been a major economic activity in our country. Like other land based development projects, mining has also taken its share of forest land. Being an important economic activity, mining at the cost of forest resource will continue and the issue to be addressed is how mining can be done causing least damage to forests and environment. According to Forest (Conservation) Act (FCA) 1980,

- ***Mining including underground mining is a non-forest activity and requires prior approval of the central government; and***
- ***Renewal of an existing mining lease requires prior approval of Central Govt.***

Therefore, mining should not be allowed in forest lands without prior approval of the central government. Following promulgation of the FCA, five mining proposals (cases) have been approved in West Bengal till March 2014 (Source: Annual Report 2013-14 of W.B. Forest Directorate).

1.1 Damage caused by mining

Mining causes destruction of forests in the following ways.

- Destroys vegetation while prospecting for the mineral.
- In underground mining, vegetation and soil are lost while digging pits for shaft and dumping the subsoil and the rocks in the surrounding areas.
- In open or surface mining, the entire vegetation and soil of the mined area is lost.
- Construction of roads for transportation occupies forest lands and in hilly terrain, such roads, if constructed on steep slopes, accelerate soil erosion.

1.2 Preventive measures

Following preventive measures may be taken to minimize the damage due to mining.

- First and foremost, a forest manager should enforce strict watch over the forests to ensure that no illegal mining takes place. Illegal mining means those mining activities which take place in contravention of the FCA.
- Investigation and survey for mining should not involve felling of trees. If it does, such survey will attract provisions of the FCA and will require prior approval of the central government under the FCA. ***Whether or not felling of trees is involved, such survey***

shall not be carried out in wildlife sanctuaries, national parks and sample plots without prior approval of Central Govt.

- If a proposal for mining in forest land merits approval, the conditions accompanying the approval may stipulate that deforestation should be on the minimum scale and restricted to the area in which mining is actually to take place.
- The dug-up soil should be deposited outside in such a manner that layers of coarse subsoil remain underneath the weathered top soil. The deposited soil thus becomes ready for plantation.

1.3 Remedial measures

Following remedial measures may be taken to ameliorate the damage being caused by mining.

- In terms of approval granted under the FCA, non-forest land, at least equal in area to the forest land being lost to mining, should be made over to the forest department for raising compensatory afforestation. The cost of such non-forest land and that of afforestation should be borne by the mining agency.
- A shelter belt of trees may be raised around the actual mining area to minimize the pollution and such other anti-pollution measures may be taken as the competent authority granting sanction of mining may specify.
- Mining is a temporary form of land use and it causes destruction of natural eco-system and extensive soil damage. Thus it becomes imperative on the part of the mining agency to plan long term land use goals by way of ecological restoration of the mined lands to productive and beneficial use. Ecological Restoration is the management process whose goal is to recreate an eco-system as close as possible to one that existed in the past prior to mining. The restoration technique should follow site specific approaches that normally include revegetation programme coupled with ameliorative and adaptive measures. The detailed steps to undertake and the extent of success would largely depend on the degree of toxicity, salinity and acidity of the mining waste materials of the site.

2. Encroachment

Encroachment in respect of forest land is the act of illegally seizing possession of some forest land. Generally it is caused by people living in the outskirts of forests or in hamlets /villages honey-combing government forests. The root cause of encroachment of forest land lies in the socio-economic fabric of our society. People who are landless or having marginal land holdings would have a tendency to encroach forest land which lies open apparently without any owner. They are driven by poverty, hunger and lack of means of livelihood. While this may be the most common scenario of encroachment, there have been also instances where people indulge in

encroachment due to land-greed and availability of easy option to enhance land assets. Encroachment of forest land, wherever it takes place, is also indicative of lax attitude of forest managers towards forest protection.

2.1 Extent of Encroachment

In West Bengal, the total forest area under encroachment as on 31 March 2014 stands at 10,040.73 ha. Large shares of encroachment are in the districts of Bankura (2948.357 ha), Paschim Medinipur (3092.516 ha), Purulia (1347.540 ha), Burdwan (1188.69 ha) and Coochbehar (947.090 ha) (Source: Annual Report 2013-14 of W.B. Forest Directorate).

2.2 Factors responsible for encroachment

Some common factors that lead to encroachment of forest lands are mentioned below.

- **No clear demarcation of forest boundary** – If the boundary of forest is not clearly demarcated on the ground, there is every possibility that owners of adjoining lands will encroach into forest land. It is advisable that –
  - Boundary pillars are in place and visible from a distance.
  - The boundary between consecutive pillars is a straight line
  - Ideally, the consecutive boundary pillars should be visible from each other.
- **Lack of field inspection –** Inspection of forest areas and forest boundary is the primary job of a forester. In fact inspection and patrol on foot should form a part of daily job of the frontline staff. It is only through regular patrol that occurrence of encroachment can be prevented or can be noticed by a forester.
- **Leaving forest land barren –** When a forest land is left barren without any forest crop for a long time, encroachers are tempted and they find it easy to encroach.
- **Lack of prompt action –** Delay in detection of encroachment or in taking legal measures to remove the existing encroachment (those which do not come under FRA) encourage new encroachment and continuance of encroachment.
- **Socio-economic condition of the fringe population** – As already stated, the socio-economic condition of the villagers living in the fringe area of forests is primarily responsible for encroachment of forest land. Factors like poverty, living with little or no land, no adequate means of livelihood etc drive some of the villagers to take recourse to the illegal act of encroachment.

2.3 Preventive Measures

Following preventive measures may be taken to reduce the chances of encroachment.

- **Clear demarcation of forest boundary and complete records** – In hilly terrain, boundary of forest block/compartment is generally made by ridges, nalas or rivers. In absence of prominent physical features and generally in plains, boundary may be demarcated by

maintaining a clear strip of suitable width. On natural or artificial boundary, concrete/masonry pillars are erected. Generally, it is the responsibility of the Working Plan Division to erect the forest boundary pillars. While fixing boundary pillars, following guidelines may be observed –

- Each boundary pillar should bear (i) a unique serial number, and (ii) latitude and longitude (lat-long) to be determined by GPS, indicating the location of the pillar.
- Bearings and distances from pillar to pillar should also be recorded, so that locations of pillars may be exactly determined by ground survey.
- The locations of the pillars should appear on the compartment/mouza map of appropriate scale. Lat-long of each pillar and, bearings and distances between consecutive pillars should appear on the map.
- Locations of the pillars should be so decided that the boundary between consecutive pillars remains a straight line, and two consecutive pillars remain visible from each other.
- Record indicating numbers and locations (lat-long of individual pillar and bearing-distance between successive pillars) of boundary pillars should be maintained at Beat/Range/ Division level and should reflect appropriately in the Working Plan document.

- **Regular inspection of boundary –** Needless to say that distinct boundary defined by boundary pillars properly erected will not be enough to prevent encroachment unless the boundary is inspected properly on a regular basis. The frontline forest personnel should be assigned the duty of making regular inspection of the boundary of forests under their respective jurisdiction. A work schedule may be drawn stipulating which part of the boundary should be inspected by a forest personnel at what interval. After every inspection the concerned personnel should make a report on what he has observed in respect of the boundary and the pillars. In the event of detection of any encroachment or if it is found that any pillar has been removed or damaged or shifted, the matter should be reported forthwith to the superior authority for taking immediate action.
- **Strengthening JFM committees** – The villagers living in the outskirts of forests are mostly small and marginal farmers or agricultural labourers. In view of low land productivity and having few options of livelihood, the villagers get inclined to encroach forest land. Thus one important measure to prevent them from falling prey to such allurement is to provide them with employment opportunities in forestry or other development projects and increase their level of income. This can be done by strengthening the JFM committees, and utilizing their collective efforts in fruitful economic activities.

2.4 Remedial measures

Adoption of all preventive measures notwithstanding, there may still be some cases of encroachment. Obviously, the land found encroached should be got vacated as early as possible. Following measures may be taken to remove encroachment.

- **Prompt detection of encroachment –** The prerequisite for remedial measure against encroachment is quick detection of offence and prompt reporting to the superior authority. The more one delays in detection and report, more is the encouragement to the offenders to continue and expand the encroachment. Further, with passage of time it becomes more difficult to evict the encroacher. Therefore, as soon as any case of encroachment is noticed, the forest guard or the officer in charge of Beat should promptly report the matter to the Range Officer, who in turn should report it to the Divisional Forest Officer.
- **Legal actions**

  (1) If the encroachment is of petty nature and does not involve alteration of boundary marks, and the offender vacates the land, the case may be compounded as per provisions of IFA (section 68).

  (2) However, if the offender does not compound the case and refuses to vacate the land, the case should be sent to court immediately.

  (3) **In reserved forest –**

  - Encroachment in the form of clearing or breaking of land, but without any damage or alteration of boundary marks, can be prosecuted under sec 26(1)(h) of IFA.
  - It is noteworthy that notwithstanding any penalty that the court may impose, the WB Amendment Act XXII of 1988 of IFA empowers the Forest Officer to evict the person who has made the encroachment, and to demolish any building erected or construction made by such person on forest land. Further, according to the said amendment act, any agricultural or other crop or any illegal construction shall be liable to confiscation by an order of DFO.
  - It is also important to note that according to sec 65A of IFA (inserted by WB Amendment Act XXII of 1988), clearing or breaking up of any land in reserved forest for cultivation or any other purpose is a non-bailable offence.

  (4) In a protected forest –

  - Encroachment in the form of clearing or breaking of land, but without any damage or alteration of boundary marks, can be prosecuted under sec 33(1)(c) of IFA, if such encroachment is contrary to any prohibition under section 30.
  - It means that the accused can be prosecuted if he has committed the offence in contravention of notification under section 30. Thus to prove the guilt of the

accused, the existence of a notification under section 30 prohibiting such encroachment and wide circulation of such notification by the Collector has to be established before the court.

- It is noteworthy that notwithstanding any penalty that the court may impose, the WB Amendment Act XXII of 1988 of IFA empowers the Forest Officer to evict the person who, contrary to any prohibition under section 30, clears or breaks forest land for cultivation or any other purpose.
- **In protected forest too**, according to sec 65A of IFA (inserted by WB Amendment Act XXII of 1988), clearing or breaking of any land, in contrary to any prohibition under section 30, for cultivation or any other purpose is a non-bailable offence.

(5) In case of altering boundary marks – If the encroachment also involves alteration of the boundary marks by the offender, that is, if the offender alters, moves, destroys or defaces any boundary-mark of any forest, the offence will also attract section 63 of IFA. Therefore in such case the prosecution should be under sec 26(1)(h) or sec 33(1)(c), as the case may be, as well as sec 63 of IFA. It may be noted that according to sec 65A of IFA (inserted by WB Amendment Act XXII of 1988), offence punishable under section 63 is a non-bailable offence.

Reference materials

1. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun
2. Lesson materials on Forest Law.
3. Annual Report 2013-14 of W.B. Forest Directorate

Lesson 7

1 hour

Lesson Plan

Objective:

- To continue study of Human Interfaces and their Control
  - Illicit Felling and Illicit Removal of Forest Produce
    - Introduction
    - Factors responsible
    - Preventive measure
    - Remedial measure

Backward Linkage: Human interface dealt with in lesson 5 and 6.

Forward Linkage:

- To be briefed, during tour, about forest offences involving illicit felling and control measures.

Training Materials Required:

- Copy of lesson 7 to be circulated beforehand

Allocation of time:

Illicit Felling and Illicit Removal of Forest Produce

- Introduction – 3 mts
- Factors responsible – 6 mts
- Preventive measure
  - Forest patrolling / field visits - 6 mts
  - Checking in transit – 5 mts
  - Meeting reasonable demands – 5 mts
  - Creation of alternative means of livelihood – 5 mts
- Remedial measure
  - Powers that a forest officer may exercise - 10 mts
  - Offence reports – 10 mts
- Discussion/ Miscellaneous – 10 mts.

Illicit felling and illicit removal of forest produce

1. Introduction

Illicit felling and removal of forest produce constitute the most frequent and common damage to forests. It is also the most frequent among all forest offences. Of the various forest produce, trees of commercially valuable timber are highly vulnerable to damage in the process. By way of indiscriminate felling and clandestine removal of the produce, the forests lose, in varying extent, their valuable assets, biodiversity and capacity to regenerate. Any measure of forest protection would not be meaningful, unless forests are protected from illicit felling.

Forest officer accords sanction to felling in terms of approved working plan. Illicit felling means those which are caused without express sanction or permission of forest officer. Needless to say, illicit felling is done without any regard to public or national interest and to regeneration of forests. Damage due to illicit felling occurs mostly in the forests lying in the neighbourhood of villages and towns, that is, in areas close to human habitation.

2. Factors responsible for illicit felling

Factors that generally cause illicit felling are described below.

- **The household requirement of the villagers** - Villagers living in the areas adjoining to the forests depend very much on forests to meet their regular household requirements. In their day-to-day life the villagers need timber for making huts/building, small timber for agricultural implements, bamboos and posts for various constructions, and firewood for fuel . When these requirements are not fully met through legal means or rights, they are constrained to indulge in illicit felling and removal of forest produce. In particular, collection of firewood which they need daily takes a heavy toll on forest resources. Their demand for fuel is fulfilled, to some extent, by fallen branches, twigs and leaves which they collect from the forest floor. However, with increasing population pressure, when supply of fuel from forest floor becomes inadequate, the villagers get inclined to make illicit felling of small trees or cutting live branches, which they carry as head loads.
- **Villagers earning a livelihood –** When forests lie close to large human habitations like small towns or cities, use of firewood as fuel becomes popular, and a great demand for firewood is automatically generated in the markets of such habitations. In view of the potential of easy income that markets in such towns/cities do provide, the villagers living in the forest fringe are tempted to make a living through sale of firewood in the markets of those town/cities. The villagers are then prompted to do illicit felling of trees and make firewood billets to sell in the market. Thus while providing a good option of livelihood to the villagers, the forests get impoverished. The effect may be disastrous in forests which bear only small trees/ pole crops, and large chunks of such forest may get barren within a short period.

- **By unscrupulous contractors /Timber merchants –** There is no reason to believe that illicit felling is caused by the villagers alone. Working of forest coupes by contractors has been long discontinued in west Bengal. Harvesting of forest produce from annual coupes or thinning areas is now done departmentally and produce is transported to government depots. Contractors /timber merchants buy timber and firewood lots from the depots. Thus access of contractors/timber merchants to forests is now largely restricted. However, departmental timber operation also involves engagement of contractors and labours from outside. The contractors and timber merchants or their accomplice thus still get opportunities to enter forests. A section of them, who are unscrupulous, sometimes tempt the labours with easy money to make illicit felling of trees, particularly those timber species whose timber is commercially valuable. High price of timber in the market acts as a catalyst to illicit timber trade. While the local villagers may be got engaged as labours in the process, the illicit trade is primarily engineered by the timber merchants/contractors who provide money, transport and other logistics.
- **Activities of miscreants –** Forests are huge resource of wood that lie open in the nature. It is neither possible nor advisable to have protective fencing for the entire forest areas. The protection force at the disposal of forest department is also limited. As against this, special quality timber is a high priced commodity in the market. Given the circumstances, a section of people, mostly from the towns, find forests an easy target to make quick money. They organize illicit felling and clandestine removal of timber. These miscreants also exploit the poor villagers by engaging them in the illegal operations.

3. Preventive Measures – Illicit felling and illicit removal of produce from forest can be contained by taking the following preventive measures.

- **Forest patrolling, field visits/inspection** – Central to forest protection measures is forest patrolling, field visits and inspection on a regular basis by the foresters working at various levels. In fact there is no alternative to intensive forest patrolling for control of forest offense. The prerequisite for an effective patrolling arrangement is availability of adequate field staff who can be assigned forest areas of reasonable extent for regular field visit. The idea is that the forest frontline staff, particularly the forest guard should be able to thoroughly inspect the forest compartment /areas placed in their charge at least once or twice a week. Depending on the vulnerability of the forest areas in question, the frequency of patrol may be increased and suitably adjusted. The forest areas which need intensive and careful inspection are the following –
    - **Forest blocks / compartments adjoining to human habitation**.
    - **Clear felling coupes , thinning coupes and areas adjoining to these coupes**

- In North Bengal forests, trees to be felled in annual coupes/thinning coupes are marked and numbered and they form the marking list of a coupe. In south Bengal forests, the marking list of a felling coupe is made otherwise. Here, the trees which are to be retained are marked and numbered and they appear in the marking list. Thus in North Bengal coupes, it is necessary to verify that trees which are not numbered are not being felled, whereas in south Bengal coupes it is necessary to ensure that that the trees in the marking list are not felled.

- It should be ensured that trees felled and logged are immediately recorded in the Timber Measurement Note Book (TMNB) and produce duly passed transported to government timber depots as early as possible.

- Felling coupes are hubs of various forestry operations involving movement of lot many people. As such, forest blocks adjoining to felling coupes become very vulnerable, since such blocks provide easy access to many, while foresters' attention remain more focused to the operations of the felling coupes.

- **Checking in transit –** Prevention of illicit felling is definitely the first and foremost preventive measure to control forest offence. Illicit felling may still occur despite rigorous patrol and inspection. So checking of forest produce in transit should be made to prevent illicit removal of forest produce. It also acts as a deterrent to illicit felling. Forest produce in transit, except minor produce given free of cost to JFMC members, must always be accompanied by some challan or pass duly issued by forest officer authorized in this regard. Following are the types of common challan or pass that are in use for transport of timber/firewood/poles etc.
  - **Intermediate Transit Challan (ITC) -** ITCs are issues by the passing officers, generally of the rank of Dy Ranger/Forester, to transport frost produce from felling coups to timber depots, while the harvesting operation is in progress.
  - **Transit Pass -** transit pass are issued by officers of the rank Dy Ranger/Forester Range officer, authorized in this regard, to allow **movement** of timber or other forest product from any place within the state to the destination.

  Thus while ITCs are Internal pass for movement of timber mostly within forests, from one forest location to another forest location, the transit passes (TP) are documents authorizing movement of forest product from any place to any

destination, mostly within the state. Both ITC and TP contain, among other things, (i) description of the produce, (ii) place of origin and destination and (iii) facsimile of the hammer mark used for passing /sale-marking the produce. While checking the produce in transit, the forest personal should verify whether the produce actually in transit match with the description given in the ITC/TP, and whether such produce bear the hammer mark matching with the facsimile shown in the challan/TP.

Sec 52 (3) of IFA (amendment by WB Act XXII of 1988) empowers a forest officer or police officer to stop a vehicle, cause it to remain stationary, and examine the contents of the vehicle, including inspection of all records. The West Bengal Forest Produce Transit Rules, 1959 also provide that any vehicle, cart, boat, or other vessel carrying forest produce shall be liable to stoppage by any forest officer for the propose of examination and check.

- **Meeting reasonable demands of the villages** - when villagers living in the outskirts of forest are found to be involved in theft of forest produce for there daily needs, it indicates that the existing arrangement does not meet their reasonable demand. In order to address the reasonable expectation of the villagers living in forest fringe areas , the concept of Joint Forest Management (JFM) has been put in practice in West Bengal since long. The government resolutions issued in this regards provide a share of forest produce to the JFMC members subject to certain terms and conditions. Forest Management should ensure –
  - That forest is duly protected with joint participation and that such forest sustains growing stock harvestable at specified intervals;
  - Produce out of intermediate and final harvest is duly shared with the JFMC members at regular intervals in a manner prescribed by the government resolutions.

  In short, one of the major objectives of forest management should be fulfillment of reasonable demand of the fringe villagers. As they appreciate that the management practice by the department is geared towards meeting their demands, the villagers will seldom indulge in felling or removal of forest produce.
- **Creation of alternative means of livelihood** - The villagers who have adopted illicit collection and sale of forest produce as their means of living need to be prevented from indulging in forest offence and provided alternative means of livelihood. As has been stated, the villagers get inclined to forest offence due to poverty. The management practice therefore should try to ensure –
  - That forestry operations generate employment opportunities for the villagers as much as possible;
  - That the forests afford collection of minor forest produce on a sustainable basis.

- That forest management includes undertaking of development projects enhancing rural employment and economy.
- That the department also makes arrangement for vocational training in various disciplines, including non-forestry ones, to reduce the dependence of the villagers on forest to earn their livelihood.

4. Remedial Measures – Despite making all preventive measures it is difficult to have foolproof arrangement against illicit forest felling. Even in the best possible management, some offences relating to forest felling and removal of produce may occur. In such cases the remedial measures to be taken are legal course of actions to deal with the offences. It is also very important to remember that legal actions are to be taken promptly. In connection with remedial measures, it would be useful to go through the Sections in Chapter IX of IFA, relevant provisions of CrPC and the Human Rights issues. It is advised to go through Lesson 15 of Forest Law.

4.1 Powers that a forest Officer may exercise

In order to combat illicit felling, the forest officer can exercise the following powers vested by the IFA, 1927.

- **Power to seize** – Section 52 of IFA coupled with WB Amendment Act XXII of 1988 empowers a Forest Officer or Police Officer to **seize any forest produce together with all tools, ropes, chains, boats, vehicles or cattle**, if there are reasons to believe that forest offence has been committed.

  Procedure to follow

  - While making seizure, the officer must **place the mark of seizure hammer**, issued in his name for the purpose of seizure, on the property being seized and the receptacle containing the property, and
  - Record the act of seizure including the description of seized articles in the Timber Measurement Notebook (TMNB);
  - The officer who has made a seizure will draw a seizure report. **Details of what a seizure report should contain have been described in Lesson 15 of Forest Law.**
  - The officer has to make, as soon as may be, a report of seizure to the Magistrate. However, **making a report to the Magistrate will not be necessary**, if (a) the forest produce is the property of the state government, and the offender is unknown, or (b) if the offence falls under the purview of section 59A, or (c) if the offender agrees in writing to compound the offence. In case (a), the officer making seizure will make a report of the circumstances to his superior; such report is known as UDOR (Undetected Offence Report), which is described later. In case (b), the officer will make a seizure report and produce the seized articles before the Authorized officer for proceeding under section 59A. In case (c), If the offence is compoundable and merits compounding, a forest officer not below the rank of a forester, may compound the offence in terms of section 68 of IFA,

and make a report, known as COR (Compounding Offence Report), to his superior. The COR has been described further later.

- **Power to arrest without warrant – Section 64 of IFA empowers** a forest officer **to arrest** a person without warrant or without orders from a Magistrate, if there is **reasonable suspicion** that the person is involved in a forest offence which attracts **punishment of imprisonment of at least one month.**
  - Thus before making arrest under section 64, the forest officer should be certain of 'reasonable suspicion' against the offender, and also of the fact that the offence for which arrest is made is serious enough to attract punishment of imprisonment of at least one month.
  - It should be borne in mind that a forest officer **cannot make arrest under section 64 for any offence committed in a Protected Forest**, unless such act is prohibited under section 30(c). Therefore, for making arrest in an offence in a Protected Forest, following conditions have to be satisfied –
    - That there exists a notification issued under section 30(c); and
    - That such notification prohibits the said act.
  - **Procedure on arrest** – The officer making arrest will have to take or send the person, without unnecessary delay, and within 24 hours, before the Magistrate or the officer in charge of the nearest Police Station. In terms of section 65 and 65A (included by WB Amendment Act XXII of 1988), the Forest Officer, not below the rank of Range Officer, may release the arrested officer on execution of a bond.

    It is advised to go through Lesson 15 of Forest Law to know the stipulations under CrPC and Human Rights in connection with arrest.
- **Power to Compound Offences** – Section 68 of IFA read with WB Amendment Act XIV of 1975 and WB Amendment Act XXII of 1988 empowers a forest officer, not below the rank of a forester, to compound a forest offence except under certain circumstances provided in the said Act.
- **Power to prevent commission of offence** - Under section 66 of IFA, every forest officer is empowered to interfere for the purpose of preventing the commission of forest offence. Thus a forest officer is authorized to take such actions as he thinks are necessary for prevention of forest offence. In essence, the section also vests in the forest officer the responsibility of taking such preventive measures.

4.2 Offence Reports

Forest offences relating to illicit felling and illicit removal of forest produce are dealt with in three different manners and accordingly the offence reports are classified into three different types, which are mentioned below.

1) **Undetected Forest Offence Report (UDOR**) – Offences under the following circumstances come under the purview of UDOR.

- The offender is unknown; and
- The forest produce in respect of which offence has been committed belongs to the State Government

Once such offence is detected, the forest officer, authorized to seize forest produce, will **make seizure of trees/logs/ wood illicitly felled as well as of stumps where trees** have **been illicitly felled,** following the procedure described earlier. Since the produce is the property of the State Government, such produce on seizure may be sent to timber depot of the department to form depot lot. The said lot will add to the depot stock and will be disposed like other lots by the competent authority.

The officer making seizure will draw a **UDOR which should contain the following information** –

- Place of occurrence of offence;
- Date of detection of offence;
- Names of the officers present and circumstances leading to detection of offence;
- A brief account of offence indicating number of trees species wise that have been felled, Volume of wood, actual or estimated (if part of produce has been illicitly removed), involved in the offence.
- Seizure report (**Details of seizure report may be seen in Lesson 15 of Forest Law.)**

2) **Compounding Offence Report (COR) –** Offences under the following circumstances come under the purview COR.
   - The offender agrees in writing to compound the case.
   - The offence is compoundable. (**Please see Lesson 4 of Forest Law, portion relating to Sec 68 of IFA, to know the cases when the offence cannot be compounded.**)

The officer compounding an offence under sec 68 of IFA will draw a C**OR which should contain** the following information –

- Place and date of detection of offence;
- Names of the officers present and circumstances leading to detection of offence;
- A brief account of the offence; description and measurement of forest produce, if any, in respect of which offence has been committed;
- Name and other particulars of the offender who is suspected to have committed the offence;
- Whether any property has been seized as liable to confiscation, if so, the seizure report (**Details of seizure report may be seen in Lesson 15 of Forest Law.)**;
- Statement of the offender expressing his willingness to compound;
- Amount realized as compensation for the offence;
- Market value of the seized property, if any;

- Amount, if any, realized being double the market value of such property;
- Whether the seized property has been released on payment by the offender of an amount equivalent to double the market value;
- whether the offender was taken in forest custody and discharged on payment of compensation;

(3) Prosecution Offence Report (POR) - It is a complaint made by the Forest Officer to a Magistrate, alleging about an offence committed by some person(s), and praying for issue of process under the law. Offences under the following circumstances come under the purview POR.

- Offences that do not come under UDOR and COR;
- **The offender is known**. There could be following likely situations
  - The offender was arrested under section 64 of IFA and produced before the Magistrate earlier; or
  - The offender was arrested under section 64 and released under section 65 on execution of a bond to appear before the magistrate; or
  - The offender could not be arrested, but on due investigation, there appears reasonable suspicion of his having been concerned in the forest offence, and thus the case merits prosecution under the law.

Details of what a POR should contain have been described in Lesson 15 of Forest Law, which may please be seen.

5. Information regarding illicit felling cases detected during the period from 2009-10 to 2013-14 may be seen in Appendix 1.

Reference materials

1. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun
2. Lesson materials on Forest Law.
3. Annual Report 2013-14 of W.B. Forest Directorate

Appendix 1

Cases of Illicit Felling
(From 2009 – 2010 to 2013 – 2014)

Sl. No.	Particulars	2009-10	2010-11	2011-12	2012-13	2013-14
01	Illicit Felling Cases detected (in Nos)	8382	8756	14080	15900	10447
	No. of POR	156	291	356	301	220
	No. of COR	3298	3486	7743	8497	4798
	No. of UDOR	4928	4979	5981	7102	5029
02	Volume of Timber seized (m^3)	5865.455	6435.535	9236.30	7803.64	5417.742
03	Value of Timber seized (₹ in lakh)	582.70	628.70	1160.21	277.20	629.96
04	No. of vehicles seized					
	a) Truck	89	89	109	84	194
	b) LMV	11	43	18	15	11
	c) Van	888	1118	365	992	421
	d) Boat	35	71	93	47	19
	e) Others	65	192	1480	114	1794
05	No. of vehicles confiscated					
	a) Truck	19	51	25	37	31
	b) LMV	8	0	3	6	9
	c) Van	888	20	---	98	25
	d) Boat	---	4	---	---	17
	e) Others	65	42	5	---	897
06	No. of Persons arrested	604	720	467	404	476
07	No. of Persons convicted in court	33	22	61	38	14
08	No. of forest personnel assaulted	13	18	9	16	8

(Source: Annual Report 2013-14 of W.B. Forest Directorate)

Lesson 8

1 hour

Lesson Plan

Objective:

- **To continue study of Human Interfaces and their Control**
  - **Faulty management**
    - Defects in management plan
    - Defects in execution of plan
  - **Other damage**
- **Injuries by plants**
  - **Damage due to excess number of desired species**
  - **Injuries by unwanted species**
    - Preventive and remedial measures

Backward Linkage: Human interface dealt with in lesson 5, 6 and 7.

Forward Linkage:

- To be briefed, during tour, about salient points of management plan and measures to control injuries by plants.

Training Materials Required:

- Copy of lesson 8 to be circulated beforehand

Allocation of time:

Faulty management

- Introduction – 3 mts
- Defects in management plan – 7 mts
- Defects in execution of plan – 10 mts

Other damage - 5 mts

Injuries by plants

- Introduction - 3 mts
- Damage due to excess number of desired species – 6 mts
- Injuries by unwanted species – 10 mts
  - Preventive and remedial measures – 6 mts
- Discussion/ Miscellaneous – 10 mts.

1. **Faulty Management**

   Through faulty management man does damage to forests. Defects creep in the management practice in two ways. Firstly, prescription in the management plan may be defective, and secondly, execution of working plan may be faulty.

2. **Defects in management plan**

   Forest is a complex and sensitive ecosystem about which human knowledge is insufficient and incomplete. Thus though forest managers may always try to adopt scientific system of management based on their understanding and knowledge, slight error in their judgment may produce adverse effect on the forest ecosystem. The management planner also finds his job quite difficult as he has to judiciously balance people's demands of forest resources with the silvicultural and ecological requirement of forests. It is thus quite likely that prescriptions in one working plan turn out to be not appropriate and put to revision in the next plan. Making management plan to ensure sustainable eco system services from forests becomes more difficult with increasing population and rising dependence on forests whose capacity to produce is limited.

2.1 Some salient points in a management plan

- **Defect in the perception**- Wrong perception about objective of forest management may invite defects in management. For example, if aim of management is over-influenced by the idea of earning quick revenue in a short term by intensive production of raw materials to meet the demands of industry and household, forests may be subjected to over-exploitation and their potential of supplying ecosystem services may suffer in the long run. Conversely, if the forests are preserved with little exploitation so much so that they do not supply even the legitimate demands of the JFMC members, particularly in respect of the non-wood products, the management prescription will be counter-productive, and participatory forest protection may lose its significance.
- **Bias towards Timber management** - Working plan or management plan often turns out to be timber or wood management plan. Focus is on trees, particularly on trees of commercial value. However, non-wood forest products, though known as minor forest produce, are an important component of forest resources. People's dependence on forests in terms of their daily needs and livelihood is more through non-wood forest products than timber. Even in terms of money value which the villagers (JFMC members) may earn as usufruct share, the non-wood forest products are by no means inferior to timber products. A good working plan should therefore provide prescriptions for regeneration and harvest of non- timber species, including medicinal plants, that can supply non-wood products sustainably.

- **Perfunctory treatment of soil and moisture conservation measures** - Working Plan often deals with soil and moisture conservation works perfunctorily. A sound plan for soil and moisture conservation is a prerequisite for supporting a healthy forest crop.
- **Focus on fast growing and commercially valuable species** - The regeneration plan is sometimes biased towards commercially important species, or those trees which are fast growing and easy to establish. While those species are definitely important constituents of planting stock, we cannot exclude from regeneration plan those species which are slow-growing and difficult to raise, especially when they are important members of the indigenous group of species of the locality and whose existence is threatened. A good management plan will identify the spectrum of indigenous species and those which are already threatened locally or in the region. Among other species, plantation programme should have mandatory obligation to establish the threatened indigenous species.
- **Rotation age** - The rotation age or frequency of harvest should not be guided by silvicultural consideration alone. Areas of a forest division are distributed in different working circles which may be worked, depending on their objective of management, on different rotations. Different from silvicultural rotation, they may be of shorter duration to meet local demands or industrial demands. While fixing shorter rotations for local or industrial demands, the limiting factor is not to allow much compromise on production potential and to ensure that frequency of harvest does not affect the sustainability of production.
- **Harvest in eco-fragile zones** - Driven by the concern to enhance production level, the management plan should not encourage extensive harvest in forests in high altitude, estuarine forests with fragile ecosystem, and forests bearing highly endangered species. Rather in such areas, the plan should regulate, as far as possible, human interference and allow only such management intervention which is necessary for protection against fire, epidemic or natural calamities.

3. Defects in execution of plan

It is obvious that even though a management plan is faultless, its impact on forests will depend on the quality of execution. Nature of defects in execution may be many. We discuss only some common defects.

- **Harvest not commensurate with regeneration** - Harvesting plan should be commensurate with regeneration. In other words, area harvested every year should be invariably planted in the following planting season. The management plan will definitely prescribe this stipulation. But, it will be a gross defect in execution, if area successfully planted falls short of area harvested, which may happen due to many reasons like, paucity of fund, shortage of staff, faulty regeneration plan, natural calamities etc. If for any reason, plantation in a year falls short of harvest which had immediately

preceded such plantation, area of succeeding harvest should be reduced by the area of deficiency in plantation. For example-

Suppose according to prescription, in a working circle, area of annual harvest and annual plantation is 100 ha each. However, against harvest in 2014-15 (October 2014-March 2015) over 100 ha, plantation in 2015-16 (April 2015 – Sept 2015) could be done on 80 ha, leaving a deficiency of 20 ha in plantation. In such circumstances following adjustment in succeeding harvest area may be done.

In Year 2015-16

Area of Harvest (October 2015 – March 2016) should be 80 ha.

The plantation to be done in 2016-17 (April 2016 – September 2016) will be again as per Plan prescription, that is, over 100 ha, comprising land of 80 ha harvested in 2015-16 and part of land of 20 ha which was harvested in 2014-15 but left unplanted.

- **Harvest without due regard to illicit removal of timber** – Area or extent of harvest prescribed also needs to be adjusted against illicit removal of produce. Otherwise, effective harvest will exceed the prescribed felling. It is explained below.

  Suppose in 2014-15, the annual harvest as per plan in a working circle is 100 ha, and illicit removal of produce recorded in the previous year (2013-14) in the same working circle is equivalent to produce over 10 ha area. Then harvest in 2014-15 should be undertaken over an area of 90 (=100-10) ha. It would ensure that felling including illicit felling will not exceed the annual felling prescribed in the Working Plan.

- **Easy option to raise mono-crop and only fast growing species** - Keeping species diversity in view, the plan normally prescribes planting/sowing of planting materials of varieties of species compatible with the local environment. However, during execution, a forest manager may take an easy option of planting mono-crop or a few species which are easy to grow, not prone to grazing damage, and which do not need much care and protection. The purpose of greening may be served by such strategy, but it is a poor quality forest that will be raised. Going for mono-crop or a few numbers of easy-to-grow species is a serious defect in execution.

- **Introduction of exotic species or plants of new provenance without trial** – Forest managers are sometimes inclined to introduce in plantation exotic species (species of foreign origin) or individuals of native species of new provenance without trial, though such introduction is not permitted in the working plan. If it is considered worthwhile to explore new species or new provenances, it is necessary to conduct field trial and assess the performance of such planting materials in the areas under afforestation. It is the

responsibility of the Research Wing to conduct such trial and communicate their observation to the Working Plan wing.

- **Omission of soil and moisture conservation works** – The working plan normally recommends, as part of an afforestation programme, soil works for the purpose of soil and moisture conservation. However, quite often such conservation works are either omitted or done very casually. The quality of plantation and the object of eco-conservation are thereby adversely affected.

4. Other Damage

Humans cause damage to forests in many other ways. We describe some of this damage.

- **Lopping** – Some of the forest trees are regularly lopped to provide fodder. It was observed in the past in south West Bengal forests that young Sal trees were being lopped to serve as tusser host. Repeated lopping weakens the trees, retard their growth and render such trees prone to attack by insects.
- **Removal of leaf litter** – In certain forest areas the villagers remove leaf litter from the forest floor on a regular basis for fuel. It is a common scene in the forests of *Acacia auriculiformis* (Akashmoni) in south West Bengal that forest floors are swept clean of Akashmoni leaves, as these leaves are excellent fuel and of good use by the villagers. It is well known that leaf litter on decomposition improves the physical characters of the soil, and adds to the soil nutrients. Leaf litter also reduces runoff and checks to some extent soil erosion. The practice of removing leaf litter thus causes damage to forests on all these counts. However, if it is a practice of the villagers to collect leaf litter for fuel or some other purpose, it is not advisable to try to stop the practice altogether, because trees are saved as much as leaf litter serves as fuel. It is rather desirable to try to control and regulate collection of leaf litter from the forest floor.
- **Poaching** – Fauna and flora together constitute the biotic components of forest ecosystem. Both flora and fauna discharge important functions in maintaining the dynamic equilibrium of the ecosystem. Their existence and role are interdependent. It is thus natural that destruction of forest fauna by poaching or otherwise will upset the food chain and ecological balance resulting in damage to the forests. Therefore protection of wildlife should form a major task in forest management. Protection measures should include (1) creation of awareness among people, (2) intensive patrol and field visit, and (3) legal measures in wildlife offences.
- **Environmental Pollution** – Environmental pollution is increasing due to growing population, increasing demand of energy and rapid industrialization.

Pollution badly affects the three major components of environment, namely, soil, water and air. As these components get polluted, their capacity and quality to support life degenerate. Consequently, pollution creates an adverse impact on the varieties of life borne by forests.

Injuries by Plants

5. Introduction

A well managed forest is one which is stocked with healthy plants of a number of desired species occupying various storey of the forest. In order that the desired species grow without undue competition for space and nutrients, and do not suffer casualty due to suppression by unwanted species, they should be protected from damage caused by (1) excessive congestion of the desired species and (2) presence of unwanted species.

6. Damage due to excessive number of desired species

At the initial stage, number of plants per unit area of a forest – natural or plantation– remains quite high. For example, a plantation normally starts with 1500 to 2500 plants per ha. Transplanting in large number per unit area is done to take care of natural mortality that will take place. However, excessive crop density even of the desired species is not sustainable or desirable for the forest to grow healthy. Each plant, for its survival and growth, demands space, food, water and light, which are all limited in a given site. As the plants grow, the demand of each plant increases and soon a stage is reached when the site cannot afford to meet the increasing demand. The plants therefore enter into competition for the essentials and with time the competition becomes fiercer. The dominant individuals which suppress the weaker ones are also denied of optimum growth because the weaker plants still continue to share the limited food and water the site can afford. If the situation is not intervened, the resulting crop of the desired species will consist of under-nourished, under-sized and disease prone trees/plants with little utility.

6.1 The management intervention that is necessary is to progressively reduce the number of plants per unit area, as the demand of each plant for food and water increases with its age. The objective is to restrict the total demand of the entire stock for essentials within the limit that the site can provide. It is done by carrying out cleanings in the sapling stage and regular thinning at pole stage and thereafter. This will result in a mature crop of the desired species which would consist of healthy individuals of optimum growth and vigour.

7. Injuries by unwanted species

Forests are damaged by the following unwanted species.

- **Weeds** – Weeds are undesirable and troublesome plants that grow profusely in forest floor, particularly in the blanks, cleared lands and in young plantations.

The weeds may be shrubs, herbs or grass. If left unchecked, the weeds will suppress the seedlings of the desired species, retard their growth and, in extreme circumstances, can annihilate them. Certain weeds also act as host to insect pests and rust diseases. When weeds infest open areas and blanks of forests and plantations in their infancy, regeneration of desired species becomes extremely difficult. In the process of creation of plantations, shoots that come up from seeds sown get suppressed before they attain the height and vigour to steer up clear from the reach of weeds. The transplants of species which are slow-growing are also easy victims. In North Bengal forests, the normal method of artificial regeneration of Sal is by sowing, and one major problem being faced is the vigorous attack by weeds. Some of the common weeds that invade forests are *Clerodendron, Mikania, Ageratum conyzoides, Eupatorium, Lantana* etc.

Grasses are equally harmful as shrub/herbaceous weeds. The effect is very menacing when the root system forms a mat on the forest floor. It prevents germination of seeds and kills most of those which manage to germinate. Moreover, it remains a permanent source of fire hazard, particularly in dry season.

- **Climbers –** Climbers by their nature use other plants (forest trees) as support and climb up, and cause damage to desired plants. At any stage of their growth the plants can be harmed by the climbers. Sometimes the slender climbers get on to the top of young saplings, enclose them and either kill those saplings or badly affect their growth. When thicker climbers twine round the pole crop, they get grooved into the tender bark as the poles grow in diameter. Woody climbers (example: *Bauhinia vahlii*), by their sheer weight, bend the trees and may even kill them by total suppression.
- **Parasites -** In some parasitic plants like species of Cuscuta (Swarnalata), small adventitious root-like structures, i.e rootlets called haustoria or sucking roots develop from stems of the parasites. These roots penetrate the tissues of the host plant and suck the latter. The parasite thus lives by sucking the host plant with the help of sucking roots**.** They weaken the host plant, cut into the stem of host plant as they twine up and may even kill the host plant.
  Given below is an extract of tour note of A Basu Ray Chaudhuri, IFS (Retd) relating to his inspection as CCF Research and Monitoring of an experimental 2001 Sal plantation at Beliatore (Bankura) in November 2006.

  "…..more than anything what attracts my attention is the serious infestation of the plantation by *Cuscuta reflexa* (Swarnalata). Invading from north, the weed has attacked a large number of Sal saplings climbing and twining up to the crown. It has created a kind of mesh on the floor suppressing medicinal plants

that were planted as intercrop in 2004. The weed is known for its power of vigorous growth and habit of killing its hosts. …"

7.1 Preventive and remedial measures

Preventive measure against the unwanted species, in man-made forests, is to deny these species space to emerge and establish. It is the open space between sowing strips and transplant lines where the weeds/unwanted species easily emerge fast and profusely. As they get established they spread and try to cover the young seedlings of the forest crop lines. Thus an effective preventive measure is to grow some crop, generally annuals or short-lived perennials, in the interspaces and thus prevent the emergence of the unwanted species in such space. Leguminous agricultural crop like *Cajanus cajan* (Arhar) or suitable vegetable crop may be raised in the interspaces during the first couple of years since creation of a plantation. In fact, Taungiya system of cultivation adopted in Sal regeneration in North Bengal comes in good stead to contain and suppress the weeds in the interspaces and help the Sal seedlings grow healthy in profuse numbers. The procedure is to allow the dwellers to raise agricultural crop or vegetables in the intervening spaces between the strips of Sal in the first year. Regular weeding and cleaning undertaken by the villagers to raise the agricultural crop automatically keep the weeds away from the forest crop.

7.1.1 Preventive measure described above applies to man-made forests. In primary forests, such measure of raising agricultural or vegetable crop cannot be adopted and is not permissible. Even in plantations, despite taking all good preventive measures, emergence of weeds or unwanted species cannot be stopped altogether. The remedial measure upon emergence of unwanted species is to remove them physically as early as possible. This is done by carrying out cutting, weeding, cleaning in the infested area as deemed necessary. These should also be done while carrying out routine cultural operations like marking, thinning etc. In case of plantations, during the first few years the plantation block should be subjected to thorough weeding –cleaning a number of times every year. In an afforestation programme. a plantation generally undergoes four to five cleanings in the first year, that is, year of creation, and further cleanings, fewer in number, in the next few years as part of creation of the plantation. In weed infested areas - most of the forest blocks in North Bengal - the schedule of cleaning followed is often found to be inadequate. The Taungiya system of cultivation turns out to be very essential in such cases.

7.1.2 A number of weedicides are available in the market. There are also reports that some of the weedicides have been found to be quite effective in annihilating weeds like *Clerodendron, Mikania* etc. and liana like *Bauhinia vahlii*. However, one has to be very careful while applying chemical weedicides because of their toxic effects. Besides weedicides, they may also kill desired species and many other life forms

beneficial for the forest eco-system. It is thus better to avoid application of chemical weedicides. It is rather worthwhile to explore for suitable organic weedicides. But before deciding to use any particular organic weedicide, it is necessary to assess its efficacy and economics by conducting trial over sample plots.

Reference materials

1. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun
2. Lesson materials on Forest Botany

Lesson 9

1 hour

Lesson Plan

Objective:

To study

- Injuries by wild animals
  - Introduction
  - Role played by carnivores
  - Injury by herbivores
  - Protection measures
- Injuries by insects
  - Pests in nurseries
  - Pests of important forest trees
- Injuries due to diseases
  - Vulnerability of plantations and exotics
  - categories of disease
  - progress - what is expected of forest manager
  - Common symptoms
  - Disease in forest trees

Backward Linkage: Nil

Forward Linkage:

- To be briefed, during tour, about salient points of management plan and measures to control injuries by wild animals, pests and diseases.

Training Materials Required:

- Copy of lesson 9 to be circulated beforehand

Allocation of time:

- Injuries by wild animals
  - Introduction - 3 mts
  - Role played by carnivores - 2 mts
  - Injury by herbivores - 7 mts
  - Protection measures - 5 mts
- Injuries by insects
  - Pests in nurseries - 5 mts
  - Pests of important forest trees - 9 mts
- Injuries due to diseases
  - Vulnerability of plantations and exotics – 3 mts
  - categories of disease - 2 mts
  - progress - what is expected of forest manager – 3 mts
  - Common symptoms - 7 mts
  - Disease in forest trees - 10 mts
  - Discussion/ Miscellaneous – 4 mts.

Injuries by wild animals

1. **Introduction**

   Wild animals are an integral part of the forest ecosystem. In an ideal condition they should remain in a dynamic equilibrium among themselves and with the vegetation. That is, in an ideal scenario, the vegetation of a forest, while supplying food for the herbivores, gets time, space and nutrients to regenerate and sustain in terms of quantity and diversity. However, when the balance is upset, the trouble starts and damage to forest flora becomes manifest. Damage caused by wild animals depends on the animals, their size and feeding habit, and also on the plants, their age and the species concerned. Normally, mature trees can escape the risk of damage, and of course, the young plants are the worst victims.

2. **Important role played by the carnivores**

   It is obvious that the herbivores are the agents of destruction of forest vegetation. In that respect, the carnivores play an important role to contain the damage. Carnivores feed on other animals. To the extent the carnivores feed on herbivorous animals, they keep the population of herbivores in check and thus restrict the damage potential of the herbivores.

3. **Injury by Herbivores**

   Herbivores feed on grass, leaves, branches of shrubs and small trees, and other vegetative parts like flowers, fruits, bark etc. So as they thrive in the forests, the herbivores cause injury to the plants. The nature of damage caused by some of the herbivores is described below.

   - **Damage by wild elephants** – Elephants are the largest herbivore in our forests and are most destructive by virtue of their size and quantity of food they need to survive. It is estimated that an adult elephant eats daily about 1.5 quintals of forage in the form of grasses, leaves, small plants, branches, roots, fruits and bark of trees. Tree bark is a favourite food source for elephants. It contains calcium and roughage, which aids digestion. Tusks are used to carve into the trunk and tear off strips of bark. (http://seaworld.org/animal-info/animal-infobooks/elephants/diet-and-eating-habits/). They damage Sal and Teak trees, particularly when young, by removing bark. Bark and leaves of *Ficus* species, *Artocarpus chaplasha* are favourite food. The elephants also like to feed on bamboo, which is destroyed extensively in forests. Besides, consuming forage in large quantities, the elephants playfully cause damage by breaking or uprooting small trees.

     The elephant population is on the rise. They cause damage not only to forests, but also agricultural crops, vegetable crops and human habitation.

Elephant depredation is now very common phenomenon in West Bengal and has become one major problem in wildlife management. Indirect method of containing their ravage by capturing them by kheddah or pit method or by chemically immobilising some select individuals has not been found to be very effective. Following direct methods have been found to yield result in varying extent.

- Scaring them away – Elephants are scared away from young plantations and human habitations, desired to be protected, by beating drums, firing crackers and lighting torches.
- Elephant proof trench – This method is employed to protect young plantations or villages adjacent to forests. Trench, 2 metre wide at the top and 1.2 m at the bottom, and 2 metre deep is dug all around the plantation, or along the boundary between forest and village to keep away the elephants. However, this is a costly method and the trenches require maintenance.
- Power fencing – Entry of elephants to forests or human habitation can be checked quite effectively by installing power fencing. Mild shock as they come in contact with the energized fencing keeps the elephants off from the plantations or village boundary. However, on account of cost and need for maintenance, power fencing cannot be employed to protect large areas for a long time.

- **Damage by Indian Bison or Gaur** – Gaur diet consists of grasses, herbs, shrubs and trees, with high preference for leaves. Some recent studies have reported that gaur feeds on a much wider variety of plants than any other ungulate species of India, with a preference for upper portions of plants, such as leaf blades, stems, seeds and flowers of grass species. Some early studies had however concluded that gaurs are primarily grass eaters. (http://www.threatenedtaxa.org/ZooPrintJournal/2009/February/o158926ii09128-130.pdf)

  As they feed on grass and forest seedlings, the gaurs damage the regeneration of forests. They also cause mechanical damage to young trees.
- **Damage by wild boar** – While being omnivorous the wild boar's favourite food is roots and tubers. As they look for roots and tubers, the boars dig the forest soil and kill the young seedlings of forest species. In North Bengal, damage of germinating Sal seeds and Sal seedlings by wild boar is very common. The wild boars are also very fond of bamboo rhizomes, and thus bamboo crop in forests is highly vulnerable to damage by the wild boars.
- **Damage by Spotted Deer and Sambhar Deer –** These herbivores cause considerable damage to seedlings and saplings of forests. Young sal seedlings are heavily grazed by these animals. They also browse leaves and tender shoots of many species namely, *Pterocarpus marsupium* (Peasal), *Alibizzia lebe*k (Kalo Siris), *Artocarpus chaplasha (*Lathar*)*, *Chukrasia tabularis* (Chikrasi) etc.

3.1 Protection measures

Protection measures against damage by elephants have been described above. A general preventive measure against the damage by herbivores is to fence out the regeneration area. Wire fencing or vegetative fencing around young plantations for the first two years saves a lot of damage from the herbivores. However, fencing is not an effective measure against large herbivores like elephants and animals like monkeys. If a plantation of sapling/pole size crop is heavily damaged by browsing, and if the main crop is a coppicer, then the stems can be cut back to allow coppice shoots to emerge, and the coppiced area can be fenced.

Injuries due to pests and diseases

4. Injuries by Insects

Insects bring about severe damage to the plants. The risk of damage due to insect prevails throughout the life span of the plants. In other words, the insects can attack at any stage of growth of the plants.

- **In nurseries** – The seedlings may be damaged by leaf eaters like cutworms and crickets or root-sucking insects like cockchafers.
- **At sapling/ pole stage** – The plants may be damaged by defoliators, bark-borers, cambium insects and sap-sucking insects
- **At maturity** – The trees are more vulnerable to attack by insects
- **After death or felling**- Even after the trees die or are felled, they become victim of attack by various beetles and the wood gets deteriorated.

4.1 Pests in nurseries

A prerequisite for good plantation is preparation of healthy planting stock in the nursery. It is therefore necessary to control the pest attack on nursery seedlings. Some common nursery pests and their control are described below.

- **Cutworms –** These are surface caterpillars (larvae) of several species of night-flying moths. The larvae are called cutworms because they cut down young plants as they feed on stems at or below the soil surface. (www.extension.umn.edu)
  - **Control measures** - The silvicultural method is to remove weeds and plant residue to help reduce egg-laying sites and seedling weeds that nourish small cutworms. The mechanical method that can also be adopted is to catch the larvae and kill them. Although there are chemical insecticides that have been reported to be effective against cutworms, use of chemical insecticides should be avoided as far as possible.
- **Cockchafers –** Grubs of cockchafer beetle are root feeders. They consume rootlets and feed on tap roots and thus kill the seedlings. There are several

species of cockchafer beetle, and depending on their habits, specific control measures need to be employed. Some general measures are given below.

- **Control measures –** The cockchafer beetles lay eggs in summer or beginning of monsoon. So, one silvicultural control method will be to avoid preparing seed beds during this period, as soil working invites ovipositing. Sowing may also be avoided during this time. If it is unavoidable to do soil working and sowing during oviposition period, the worked soil in the bed may be covered with a layer of charcoal, sand or sulphur; sowing may be done after removing the covering in lines, and the covering material may be put back after sowing. The mechanical method of control is to capture the grubs during the preparation of beds, and destroy them. The chemical method of control, if unavoidable, may be used over small areas where seedlings are found to be affected. In this method, toxic material like carbon disulphide, CACN, acetic acid, or BHC is applied to beds in the prescribed manner.

4.2 Pests of important forest trees

The pest of important forest trees belong to following classes

- Defoliators – They destroy the tree foliage by eating up, or rolling the leaf, or boring the leaf tissue or by cutting and carrying the leaf for purposes other than food.
- Feeders - They feed on shoot, cambium or wood.

Pests relating to two important trees are described below.

4.2.1 Teak Defoliators

Hyblaea puera is commonly known as the **teak defoliator. It** is the most widespread and serious pest in both plantations and natural forests, with as many as 14 generations per year. Defoliation does not kill the trees, but does lead to substantial timber loss. Defoliation by *H. puera* in plantations four to nine years old has been reported to cause about 44% volume increment loss of the trunk. The larvae directly retard girth increment, reduce timber quality by forking, cause death of the leading shoot and result in formation of epicormic branches.
(Source: http://www.atree.org/sites/default/files/articles/Hyblaea_paper.pdf)

- **Control measures** - The teak defoliator is present the year round in teak plantations, but in varying population densities. Natural control of this pest to some extent takes place due to a number of parasitoids, predators including wasps, spiders, birds etc., and some pathogens (disease producing agents) that include certain bacteria and fungi. These agents cause mortality to Teak defoliators. (http://en.wikipedia.org/wiki/Hyblaea_puera). Silvicultural method to contain the Teak defoliators is a preventive one. It is advised that Teak

plantation **should not be created pure over a large area**. The maximum size recommended is about 15 to 16 ha. Teak plantations should be separated by strips of natural vegetation. (L S khanna 1998 Forest Protection)

4.2.2 Sal Borer

Shorea robusta, is one of the most important timber species of India. The heartwood borer, *Hoplocerambyx spinicornis*, is the most serious pest of Sal throughout its range. Its beetles emerge soon after a few showers of monsoon rains from the third week of June to the end of August. They are attracted to the odour of freshly cut bast and sapwood of sal. Soon after mating, the beetle oviposit white, cream coloured eggs in cracks on the bark. After 3-7 days of egg period, the hatching takes place. The freshly hatched grubs bore the bark and reach to the sapwood, where they form tunnels. After feeding the sapwood, the grub move to heartwood where they form a wider pupal chamber, the grubs start pupation from December onwards, develop to immature beetles between April to May and emerge out from middle June onwards during monsoon. The male has long antennae than their body while the female has short antennae. The incidence of attacked sal trees due to heartwood borer goes upto 24.33 per cent during epidemics. The borer killed more than 26 lakhs of sal trees during the sal borer epidemics in Madhya Pradesh between 1996-02.

(Source: *K. C. Joshi, N. Roychoudhury, N. Kulkarni, S. Sambath 2006,* Sal Heartwood Borer in Madhya Pradesh *at* http://www.indianforester. co.in/ index.php/ indianforester/article/view/4513/0)

Fig. 9.1 Sal Borer (Source: http://www.forestrynepal.org/article/1918/5000)

- **Control measures** – This pest is immune to all known forms of control measures as most of its year-long life cycle passes in the tree, except for 20-30 days of adult beetle stage. (Source: http://www.fao.org/docrep/ARTICLE/WFC/XII/0739-B1.HTM)

However, following control measures are generally recommended.

(a) **Silvicultural control** – Sal crop should not be grown dense. It should be regularly thinned. Felling should be restricted between October and March. (L S Khanna 1998 Forest Protection)

(b) Mechanical control

(Source: http://www.fao.org/docrep/ARTICLE/WFC/XII/0739-B1.HTM)

In some epidemics in the past following control measures had been adopted.

(i) Catching and killing of insects through Trap-Tree method. In this Operation, one to two trees ha^{-1} of 60-90 cm girth are felled, cut into 2-3 m long logs and the bark near cut ends is beaten up to provide shelter for the beetle. The beetles get attracted to the smell of sap, get intoxicated after consuming it and become sluggish, rendering their collection and killing easier. Beetles are collected from traps every morning and evening. The heads of beetles are severed and counted for record of daily catches. Trap tree operation starts on the onset of monsoon and that continued till the day the insect catches are nil.

(ii) Felling and removal of affected trees away from the sal forests.

(iii) Burning of debris and stumps after harvesting of trees.

(iii) Stacking of infested timber in depots five km away from sal forests in order to prevent the beetles from flying back to forests.

4.2.3 Galls in Eucalyptus

Plant galls are abnormal outgrowths of plant tissues and can be caused by various parasites, from fungi and bacteria, to insects and mites. Insect galls are more common. In south West Bengal Eucalyptus plantations, on a large scale, were infected by galls in recent past. Galls are also often found in plantations of *Emblica officinalis* (Amlaki). Insect galls are formed by some herbivorous insects as their own microhabitats. They are plant tissue which is controlled by the insect. Galls act as both the habitat and food source for the insect. (http://en.wikipedia.org/wiki/Gall).

Leptocybe invasa, Fisher & La Salle, commonly called Blue Gum Chalcid, is a newly described gall-inducing wasp species currently spreading in many countries and causing damage to young eucalypt plantations and nurseries. Galls induced by this wasp can cause serious injuries to trees, thereby weakening them.

Control Measures - No effective control measures are currently available. The following interim measures are recommended to manage the wasp problem:

1) periodic monitoring of infestation in nurseries and plantations;

2) mechanical removal of affected plant parts and subsequent burning; and

3) avoid production and planting of highly susceptible clones.

Application of systemic insecticides like Rogor or Metacid 50 (@ 2ml/1 litre water) on foliage at fortnightly intervals is effective.
(http://www.fao.org/forestry/22072-0e774d1f27c87fa48a76b498a3b4bd3b4.pdf)

Fig. 9.2 Galls in Eucalyptus (Source:http://en.wikipedia.org/wiki/Gall).

5. Injury due to diseases

Disease in plants has been defined as sustained physiological and resulting structural disturbances of living tissues and organs, ending sometimes into death. (Source: L S Khanna 1998 Forest Protection). Thus when affected by disease, plant tissues cannot perform their normal physiological functions and when such condition is sustained over a period, the plants may suffer structural deformation. Diseases and insects influence and eventually determine the productivity of forests. Unless controlled, they offset the efforts of the foresters to increase wood production.

5.1 Plantations are more disease prone

In plantations, preferred species are raised usually as a pure crop in even-aged stands intensively managed toward increased productivity by reducing genetic variation, eliminating competing vegetation, maintaining optimum stand density and practicing other cultural operations. All these operations may change the ecosystem drastically and expose plantations to the risk of diseases and insect pests (http://www.fao.org/docrep/h2575e/h2575e04.htm). Thus the plantations are more susceptible to disease and the damaging effect of disease is more pronounced in plantations.

5.2 Exotics may be vulnerable

To increase productivity, foresters sometimes intend to introduce exotic species. However, performance of an exotic over a short period may not guarantee that it

will have disease-free life cycles in the long run, because pathogens and pests take time to build up.

5.2.1 (http://www.fao.org/docrep/h2575e/h2575e04.htm)

Exotics are exposed to two hazards: they may be attacked by an indigenous parasite against which they may not possess any resistance or by an inadvertently introduced foreign pathogen. An example of the first hazard is *Eucalyptus*, which, planted extensively in India, is seriously affected over 40000 hectares owing to attack by the pink disease that occurs on a wide range of indigenous hosts. *Celosterna scrabrator*, the root and shoot borer of indigenous *Acacia*, has found a suitable host in *Eucalyptus*, on which the pest has become serious in dry areas.

5.3. Two categories of disease

Diseases in trees are classified into two categories.

1) Pathogenic – means diseases caused by pathogens like fungi, bacteria, virus etc.
2) Physiological – they are non-pathogenic and caused by environmental factors.

5.4 Progress of disease

If the growth of a plant is affected by some adverse factor, the plant becomes weak and becomes predisposed or susceptible to attack by some of the parasites which it hosts. The disease progresses gradually within a tree and, if not checked, may spread to many a tree resulting in an epidemic.

5.5 What is expected of a forest manager

A forest manger should have knowledge of common diseases. He should be able to identify symptoms of such diseases. Early detection of disease symptom is very important and helpful in taking timely control measures. It may be beyond the capacity of a forest manager to adopt suitable measures on all occasions, but timely detection of symptom will enable him to seek expert's help in the early stage of the disease.

5.6 Some common symptoms

Common symptoms fall into three categories.

1) **Necrotic symptoms -** Necrosis is the symptom of death of plant tissues or organs that results from pathogen infection. This symptom can occur in any plant tissues, such as the leaves, petioles, stems, branches, roots, flowers, fruits or tubers. Necrosis may appear in small areas or cover a large area of the plant tissues (http://www.acdiainc.com/symptoms.htm). Some necrotic symptoms are described below.

- Plant Wilting and Death - Infection of pathogens in root system, vascular system or main stem may cause wilting or death of the whole plant. Generally, the infected plant starts to wilt during the early stage of infection, and then the whole plant slowly dies. In a few cases, the wilted plant may be recovered partially or completely (http://www.acdiainc.com/symptoms.htm). If the wilt is temporary and attributable to physiological factors like deficiency of moisture due to excess transpiration, it may disappear when the moisture level is restored during night.
- Canker - Canker diseases are common, widespread, and destructive to a wide range of trees and shrubs. A 'canker' is really a symptom of an injury often associated with an open wound that has become infected by a fungal or bacterial pathogen. It is an injury primarily of the bark and cambium. Canker diseases frequently kill branches or structurally weaken a plant until the infected area breaks free, often in a wind or ice storm. (http://www.mortonarb.org/trees-plants/plant-clinic/help-diseases/canker-diseases; L S Khanna 1998 Forest Protection).

Fig.9.3 Stem Canker (Source: http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath) Plant Disease Symptoms, P.N. Sharma Department of Plant Pathology,CSK HPKV, Palampur (H.P.))

- Decay – It means decomposition of wood substance by fungi. Both living and dead tissues of a plant may be attacked by fungi. Attack on living tissue may cause mortality of the tree. Whereas attack on dead wood, say, heartwood, may cause heart rot.

2) **Atrophic symptoms –** Atrophy means dwarfing or stunting of growth resulting from subnormal cell division. One example is Chlorosis: The loss of chlorophyll from the tissues of a plant, resulting from microbial infection. Chlorotic tissues commonly appear yellowish.

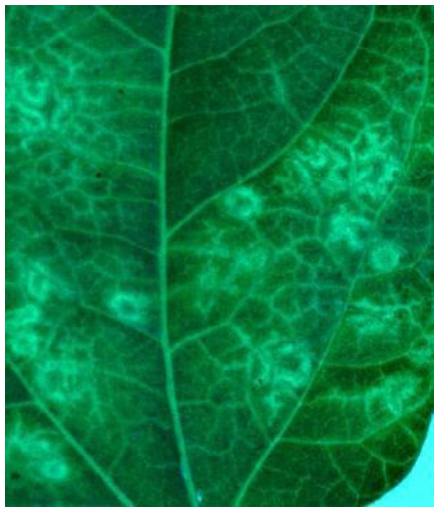

Fig.9.4 Chlorosis (Source: http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath) Plant Disease Symptoms, P.N. Sharma Department of Plant Pathology,CSK HPKV, Palampur (H.P.))

3) **Hypertrophic symptom –** It means a plant overgrowth due to abnormal cell enlargement. The symptoms may manifest in the following forms.
   - Wound tumors – an uncontrolled growth of tissue (s)
   - Galls - An abnormal plant structure formed in response to parasitic attack by certain microorganisms (bacteria, fungi, viruses) or insects.
   - Witches Broom - An abnormal form of plant growth characterized by profuse outgrowth of lateral buds to give a broom like appearance.
   - Enations - A symptom caused by certain plant viruses in which there are small outgrowths on the plant.

(Source: http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath) Plant Disease Symptoms, P.N. Sharma Department of Plant Pathology,CSK HPKV, Palampur (H.P.))

5.7 Disease in Forest Trees

Diseases seen in forest trees may be classified in two broad types.

1) **Root Diseases –** Root diseases are caused by fungi which may be soil-inhabiting or root-inhabiting. The soil-inhabiting fungi cause wilt, e.g *Fusarium solani* causing wilt in Sissoo. On the other hand, root-inhabiting fungi cause root-rot, e.g *Ganoderma lucidum* causing root-rot in Sissoo (Source: L S khanna 1998 Forest Protection).

   Control measures –
   - In general, it is difficult to control root disease, because the root, the affected part, is not accessible, and fungicide, being toxic, should not be applied to soil.

- Some general silvicultural guidelines may, however, be followed. **In wet Sal forests, some controlled burning** may be done to contain the moisture level resulting in reduction of weed growth (Source: L S khanna 1998 Forest Protection). Excess moisture and profuse weed growth favour *Polyporus shorea* (the fungus causing root rot in Sal) to become epidemic. Then in a plantation programme the **site selected should be suitable for the plants**. For example, Sissoo is known to grow well in well-drained sandy loam site. If planted in waterlogged or clayey soil Sissoo does not grow well and becomes predisposed to root diseases. While doing advance soil work for afforestation programme, old srumps, if affected by fungi, should be removed. Selection of species is also very important. If **resistant species form the major component** of planting stock, the risk of root disease is reduced.
- Biological control of soil-inhabiting fungi is difficult. However, some root-inhabiting fungi like *Armillaria mellea* and *Fomes annosus* are reported to have been successfully controlled.

2) Heart rot

Heart rot in living trees is caused by fungi which have entered the tree through open wounds and exposed bare wood. The presence of fruiting bodies of the heart rot fungi, punk knots, swollen knots, dry branch stubs sticking out of bole, and swollen boles are indications of heart rots in trees (L S Khanna 1998 Forest Protection). Heart rot causes decomposition of wood resulting in substantial loss of timber.

As long as a tree is growing vigorously, rot will be confined to a small central core. This is called compartmentalization. If the tree is weakened and fresh wood exposed by severe pruning or storm damage, decay fungi can advance to more and more wood.
(http://forestry.about.com/od/forestdiseases/p/dis_com_hr.htm.)

Control measures - (*B. K. Bakshi* Heart-rots in Relation to Management of Sal; http://www.indianforester.co.in/index.php/indianforester/article /view/24303)

To control or reduce the incidence of heart-rot in high forests, the crop should be nursed during the critical period of susceptibility by sound silviculture. The silvicultural measures include –

- Protection from fire injury by control burning;
- Manipulation of the overhead canopy to prevent frost and suppression.

- Thinnings and selection fellings should be carried out with a view to stand-improvement.
- All diseased trees should be removed during felling to prevent further loss in net volume recovery and spread of decay to the residual crop. A second marking may be necessary after felling is completed when trees with hidden decay become evident. Such trees and also those damaged during fellings should be removed.
- During felling, injury to the standing crop from falling trees should be prevented by lopping the side branches of the latter if they are many, thick and spreading.
- Infected stumps should not be coppiced.
- Standards should be selected from healthy trees free from any symptoms of heart-rot.
- In moribund sal, dry felling at short intervals is desirable. Felling age in forests containing high incidence of heart-rot should be lowered.

The forest pathological considerations for the management of coppice sal forests in the south West Bengal are different. Sal forests in this part are worked on short rotation. Due to continued maltreatment to which these forests were subjected in the past, the incidence of decayed stumps is high. According to some experts, attempt to raise the rotation of these forests is fraught with the risk that the decay will progress from the stump into the tree when the heartwood develops. High forests in these areas should therefore be raised from seeds/ seedlings.

Reference materials

1. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun
2. Lesson materials on Forest Botany
3. Websites cited in the lesson.

Lesson 10

Time 1 hour

Lesson Plan

Objective:

To study

- Injuries due to natural calamities
  - Flood and landslide
  - Drought
  - Frost
  - Snow

Backward Linkage: Nil

Forward Linkage:

- To be briefed, during tour, about salient points of management plan and measures to control injuries due to natural calamities.

Training Materials Required:

- Copy of lesson 10 to be circulated beforehand

Allocation of time:

- Injuries due to natural calamities
  - Introduction - 3 mts
  - Flood - 8 mts
  - Landslides - 10 mts
  - Drought - 10 mts
  - Frost - 12 mts
  - Snow - 7 mts
- Discussion/ Miscellaneous – 10 mts.

Injuries due to natural calamities

1. Introduction

It has been long recognized that there is a general correspondence between the geographic distribution of plants and climate. In other words, climate is a major factor that influences and sustains typical vegetation and forests of a place. The earth's climate arises from the interaction of solar radiation and atmosphere that surrounds the earth (Burton V barnes et. al . 1998 Forest Ecology). Climate includes unusual and extreme events as well as those that occur with regularity. When the extreme events lead to natural calamities, the forests are subjected to unfavourable climatic and environmental factors, and they suffer damage. Described below are some unfavourable or adverse climatic and environmental factors accompanying natural calamities and causing injuries to forests.

2. Flood

(http://www.extension.umn.edu/environment/trees-woodlands/flooding-effects-on-trees/)

- **Direct damage** - Flooding may cause direct damage to trees by
  - changing soil conditions;
    - water covering the soil reduces oxygen supply to roots. Flooding changes pH of the soil, which may not be favourable to the crop. Flood waters may carry to the soil chemicals or other toxic materials from urban areas or agricultural fields, which are harmful to plants.
  - interrupting normal gas exchange between trees and their environment;
  - Sedimentation
    - Sedimentation on tree roots also tends to cut off supply of oxygen and cause root injury.
  - Physical damage.
    - When floods are accompanied with strong currents, waves, or suspended particles they may wash away the soil from the base of the trees and expose their roots. Exposed roots can stress trees and make them more vulnerable to be fallen by wind. Ice flows and debris carried by rushing waters can remove bark and damage tissues. Flood waters that cover foliage on lower branches will interfere with photosynthesis and gas exchange, leading to death of those branches.
- **Indirect damage** - Flooding also may weaken trees, thus making them more susceptible to indirect damage from insects and diseases. The degree and likelihood of indirect damage depends upon the severity of the flood, the tree species and tree health
- **Symptoms of flood stress** - Trees that are flood stressed exhibit a range of symptoms that may include
  - leaf chlorosis and subsequent defoliation;
  - reduced leaf size;
  - development of epicormic shoots; and
  - crown dieback.

3. Landslides

(http://www.fao.org/docrep/016/ba0126e/ba0126e00.htm)

Landslides cause environmental damage to forests and agricultural resources by

- removing topsoil,
- blocking rivers and
- Increasing downstream sedimentation.

All the above occurrences are detrimental to growth and establishment of forests. Removal of topsoil would adversely affect the availability of water and nutrients. Blocking of rivers, depending on scale, may cause overflowing of water over forest lands resulting in environmental and physical damage of plants in varying degrees. Increased downstream sedimentation also can cause physical damage besides root injury. In case of heavy landslides, the physical damage becomes very conspicuous as chunks of forest blocks carrying mature trees get uprooted and moved down the slope.

3.1 Silviculture measures

(http://gis.fs.fed.us/psw/publications/rice/RiceFAO.pdf)

As far as landslides are concerned, clear-felling is the least desirable silvicultural system, as in this system the anchorage strength of trees in the soil is reduced simultaneously over the whole harvest area. Another reason for avoiding clear-felling where landslide risk exists is the effect on slope strength of any delay in achieving prompt regeneration. Landslide risks resulting from even-aged management can be reduced by turning from a clear-felling system to a shelterwood system. With any silvicultural system, a species which coppices well can probably maintain slope strength at a high enough level so that the removal of trees during the harvest will cause only a trivial increase in landslide risk. This would be true only if management of the stand is prudent and maintains high levels of growing stock.

3.1.1 Scientific studies confirm the crucial role of trees and forests in preventing landslides not only by reinforcing and drying soils, but also in directly obstructing smaller slides and rock falls. However, the role of trees and forests in the case of deep-seated landslides or in extreme events is unlikely to have any effect (http://www.fao.org/docrep /016/ba0126e/ba0126e00.htm).

4. Drought

Drought can be defined as a prolonged and abnormal water deficiency extensive in time and space (Burton V Barnes 1998 forest Ecology). Though not always the case, droughts are usually accompanied by unusually warm conditions. A typical example is what we observe in south West Bengal. A major part of this region is what we call drought prone area, as it normally suffers from water deficiency during the period from December onwards till onset of monsoon in middle of June. Drought or near-drought situation occurs in this region during summer between April and June before the advent of monsoon – a period when atmospheric temperature soars high.

4.1 Drought affects forest trees both directly and indirectly. One direct impact is reduction in growth of the trees during growing season. The productive functions of the trees like flowering, seed production, seed germination etc. are also greatly reduced. Regeneration process is badly affected, as seedling survival rate drops down. Among the indirect effects, the most obvious is the incidence of fire the probability of which goes high during drought. Fire also burns more and spread faster in dry conditions. Drought may also be associated with attack by insects and diseases and thus result in severe damage to forests. Recurrence of drought may increase the probability of disease.

4.2 Recurrence of drought puts the forest soil under moisture stress and therefore favours regeneration of drought-resistant species. Thus under drought condition in successive summers, species diversity in forests will undergo change and reduce on account of mortality of water demanding species and survival of less demanding ones.

4.3 Measures

Forest management has little to do relating to prevention of drought, but has lot to contribute in taking remedial measures and ameliorating the effects of drought.

- **Soil and water conservation work** – The forest managers may undertake suitable soil and engineering works to prevent soil erosion and conserve soil moisture. The objective of such works is to reduce run off and recharge ground water reserve as far as possible. In undulating terrain, any afforestation programme should include, as mandatory steps, soil-moisture conservation works like contour trenches, checking gully erosion, digging suitable planting pits etc.
- **Choice of species** – In plantation programmes in drought-prone areas, priority in selection of species should be on those species which are drought-resistant, that is, those which can survive under soil-moisture stress. In south West Bengal forests, though Sal is the major species, it needs adequate moisture at the initial stage of establishment. Left rain-fed, Sal regeneration from seeds/seedlings has been found to have failed quite often. However, once Sal seedlings get established with a little irrigation, they can bear the drought condition and grow into tall trees. Again the south west Bengal forests contain a number of species that are drought-bearers. Examples are Peasal, Haritaki, Bahera, Neem, Mahul, Kend. One example of an exotic (from Australia) which has naturalized in this tract and has found to be perfectly suitable under drought conditions is *Acacia auriculiformis* (Akashmoni). Forests suitably planted with drought-resistant species will produce good vegetation cover that will make optimum use of limited water available, and in the long run, enhance soil moisture.
- **Mulching –** In order to lessen the effect of drought, mulching is done in the post-transplanting stage. This is a common and routine measure in all plantations in south West Bengal. It consists of the following steps.
    - Soil working around the base of the plants to keep the soil loose; it removes the compactness of the soil, enhances water infiltration into the soil, and

improves aeration of the soil; and

- Covering the soil around the base of the plants with some mulching material in order to conserve moisture, reduce run-off and erosion, and check weed growth. Mulching materials are usually cut grass, foliage or straw, and may include compost, wood chips, saw dust etc.

5. Frost

Frost means chilling of air below the freezing point (0 degree Celsius) (L S Khanna 1998 Forest protection). On the basis of mode of formation, frost is classified into following categories.

- **Radiation frost** – It occurs at night on account of loss of heat by radiation. On clear winter nights air near the ground undergoes rapid cooling and when temperature falls below freezing point, water vapour gets transformed into ice crystals that form on soil, ground vegetation or other object surfaces near the ground. It is called **ground frost** or **hoar frost**. It is not only the surface air but also soil air that gets chilled.
- **Pool frost** – It occurs in a place when convection current of cold air of considerable depth flows into natural depressions from adjoining areas. It is more damaging than ground frost as cooling effect extends to a considerable height of the vegetation.
- **Advection frost** – Advection frosts occur when cold air blows into an area to replace warmer air that was present before the weather change. It is associated with cloudy conditions, moderate to strong winds, **no temperature inversion**[1] and low humidity. Often temperatures will drop below the melting point (0 °C) and will stay there all day (http://www.fao.org/docrep/008/y7223e/y7223e07.htm).

  ([1] Temperature inversion means temperature increasing with height above the ground)

  This frost occurs in northern parts of India due to cold waves coming from outside.

5.1 Frost pocket

Frost pocket or **Frost hollow** is the name for low-lying area (e.g. a valley bottom or a smaller hollow) where a frost occurs more frequently than in the surrounding area. (http://www.weatheronline.in/reports/wxfacts/Frost-hollow.htm)

5.2 Injuries due to frost

- **Injury to young plants –** Ground frost which occurs at night freezes the soil moisture. In the morning young plants get exposed to sunlight and undergo heavy transpiration. The loss of water in the plant body due to transpiration is not replenished as the roots cannot supply water from the soil moisture which is frozen. As a result, the young seedlings suffer mortality.
- **Cell Injury (http://www.fao.org/docrep/008/y7223e/y7223e0a.htm) -** Direct frost damage occurs when ice crystals form inside the protoplasm of cells (intracellular freezing), whereas indirect damage can occur when ice forms inside the plants but outside of the cells (i.e. extracellular freezing). It is not cold temperature but ice

formation that actually injures the plants. It is believed that intracellular ice formation causes a "mechanical disruption of the protoplasmic structure". The extent of damage due to intracellular freezing depends mainly on how fast the temperature drops and to what level it supercools before freezing.

As a result of extracellular ice formation, water will evaporate from the liquid water inside the cells and will pass through the semipermeable cell membranes and deposit on the ice crystals outside of the cells. As ice continues to grow, the cells become more desiccated. Typically, in injured plants, the extracellular ice crystals are much larger than the surrounding dead cells, which have collapsed because of desiccation. Therefore, the main cause of frost damage to plants in nature is extracellular ice crystal formation that causes secondary water stress to the surrounding cells.

- **Injury to crown** – The pool frost or the cold waves generally kill back saplings and poles to the ground level (L S Khanna 1998 Forest protection).
- **Frost cracks** – Under frost attack, stems of the trees develop longitudinal cracks, called frost cracks. These fissures close later and get covered with growth of callus.
- **Canker** – When a branch dies due to frost, callus forms at the base of the branch. The callus gets killed due to subsequent frost attack. As the process recurs the wound point becomes vulnerable to attack by fungi resulting in formation of canker.

5.3 Protection Measures

The measures are preventive and described below. Depending on the circumstances, following measures may be taken.

5.3.1 In Nursery

- **Shades at night** – The nursery beds may be covered with shades at night. The shades should be slanted so that leaves of the seedlings do not get exposed to direct sunlight in the morning. When during the day the soil temperature has risen up, the shades may be removed so that soil receives direct sunlight.
- **Watering** – Watering the nursery beds in the morning during frosty season is advised. Watering melts the ice crystals formed on the ground, provides water to the roots and thus lessens the chilling effect of frost.
- **Smoking** – Sometimes brushwood and grass are burnt around nursery at night to create a smoke screen over the nursery. This prevents radiation frost in the night.

5.3.2 In Plantation

- **Nurse crop – R**aising of nurse crop [example: *Cajanus* (Arahar)*, Ricinus communis* (castor oil plant)] in the interspaces reduces the frost damage to the desired species.
- **Retention of frost protection shelterwood –** When planting of frost tender species is planned in frosty localities, the area in question is clear felled except that healthy, a number of young and middle aged trees, evenly distributed, are suitably selected from the existing stock and retained as shelterwood as a frost cover.
- **Regulation of weeding –** It is advisable not to do weeding during winter so that weeds may act as frost cover to the plants.

5.3.3 In natural Regeneration Areas

- Shelerwood or Selection System – While trying to obtain natural regeneration in frosty localities, it is advisable to avoid clear felling system. Shelterwood or selection system will be an appropriate option to provide frost cover to regeneration.

6. Snow

In temperate areas much of the annual precipitation falls as snow. In western and central Himalayas, snow normally stays above 2000 m, and in the eastern Himalayas the altitude of snowfall is higher (L S Khanna 1998, Forest Protection).

6.1 Injuries due to Snow

- **Water stress** - Distinct from rain, snowfall is characterised by the fact that frozen water is unavailable to plants. On warm days in early spring when the soil is still frozen, trees with transpiring foliage may experience water stress (Burton. V. Barnes et al, 1998 forest Ecology).
- **Physical injuries –** The young trees and saplings get buried under snow and are broken under physical pressure. Even when snow is not deep enough to bury sapling or poles, it settles on the uphill side at the base of the saplings and causes the stems to bend outward. The bending of stem becomes permanent and is observed on the mature trees. As this bending occurs at the high-girth portion of the stem, much of valuable timber gets lost. When snow accumulates on the crown of the trees, there are chances that tree branches or tops may break under snow pressure. As snow slides down the slope, it causes soil erosion and, in extreme cases, may wipe out strips of forest along its course. Hill slopes down which snow slides regularly often become bare. Persistent snow cover may also prevent establishment of vegetation.

Reference materials

1. L.S Khanna 1998, Forest Protection, Khanna Bandhu, Dehradun
2. Burton V Barnes et al 1998, Forest Ecology, John Wiley & Sons, Inc.
3. Lesson materials on Soil and Water Conservation
4. Websites cited in the lesson.