

**Review of Silvicultural practices adopted in India: its  
implication on Participatory Forest Management**

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## **Introduction**

Silviculture has been widely accepted as the art and science of forest farming. The three basic operations contained are regeneration, tending and harvesting of the forest. A series of treatments along the tree life is regarded as a silvicultural system. A silvicultural system may be defined as the process by which the crop constituting a forest are tended, removed and replaced by new crop, resulting in the production of wood of distinctive form (Troup 1996). In the traditional context, silviculture refers only to the methods of raising forest crops and their care up to the time of harvest. However, in ideal situations silvicultural practices such as nursery development, land preparation, soil and water conservation etc., form a part of a more complete forest management system.

In case of community forestry, the silvicultural systems are highly variable due to local perceptions, and unique indigenous applications. The effective integration of two domains of knowledge such as adaptive and indigenous, in order to formulate an ideal silvicultural system is required to meet the diverse local, regional and global expectations from the forest. The whole system, is however, to be looked in the context of the objective of sustainable forest management.

### **PART – I: Review of silvicultural system in India and participatory silvicultural approach**

Silvicultural systems have been classified in many ways but, in India, the most commonly used classification is based primarily on the mode of regeneration, and this is further classified according to the pattern of felling carried out in the crop. According to mode of regeneration, silvicultural systems are broadly classified into high forest systems and coppice systems.

#### **1. High Forests systems:**

In this system the regeneration is normally of seedling origin, either natural or artificial (combination of both) and where the rotation is generally long. These are further classified on the basis of pattern of felling which, in turn affects the concentration or diffusion of regeneration and the form or character of the new crop produced. Many sub systems have been followed under this can broadly group in to two systems such as clear felling systems and shelterwood systems. Details of some of the sub systems practices under high forest systems have been explained here by describing nature of the practices and its advantages and disadvantages to conservation and regeneration of the forest.

##### **1.1. The clear-felling system:**

Under this system equal or equi-productive areas of mature crop are successively clear-felled in one operation to be regenerated, most frequently, artificially but some times naturally also.

The pattern of regeneration followed mostly by departmental plantation or *taungya* system. These systems were extensively applied in West Bengal, Uttara Pradesh, Madya pradesh and Orissa and, *taungya* system were applied not only to teak, sal and miscellaneous species, but also to eucalyptus and to indigenous miscellaneous species in the region of Uttara Pradesh West Bengal and Kerala states in the country.

The regeneration pattern followed under departmental plantation describes following steps:

1. Demarcation of the annual coupe for the clear felling,
2. Preparation of growing stock map of the area
2. Clear felling and burning the felling refuse
3. After the area is cleared, it is inspected and soil maps as well as a treatment or suitability map are prepared
4. Then department will prepare plantation journal, which contains nature of site, area, spacing, and other silvicultural information

Another regeneration system followed under clear filled area was *taungya* system. Which is method of raising forest plantations in combination with field crops. The *taungyas* may be departmental leased or village *taungyas*. In departmental *taungyas*, the department does the work of raising agriculture crops as well as the forest crops. The main object of raising agricultural crops is to keep down weeds and to get additional revenue. But such *taungyas* are seldom successful because the forest staff does not have the requisite technical know-how of agriculture. Further, in order to get better return from agricultural crops, entire attention is concentrated on them resulting in the neglect of the forest crops. Therefore, departmental *taungyas* should be followed only when there is no other method of keeping down weeds and grasses in high forest areas.

Leased *taungyas* are those in which agricultural crops are raised in the inter-spaces of the lines of forest plants by giving the land on lease to the person who offers maximum lease money. In this method, the inter-spaces of each regeneration area are leased immediately after clear felling for raising agricultural crops for two years, before planting forest species and one year after planting forest species.

The clear felling system is a simplest among all high forest systems as it does not require a high degree of skill in carrying out and require less supervision. Further, the yield per unit area is more and consequently the cost of felling and extraction is low. It is also assumed that artificial regeneration is the best method of regulating composition of new crop, increasing the proportion of more valuable species and introducing fast-growing exotics species. If properly tended, the even-aged crop produced by this system has trees with comparatively cleaner and more cylindrical boles because of horizontal competition, than those of trees

produced by other high forest systems. As the regeneration establishes early in this system, the coupe can be opened up for grazing soon. This is one of the important considerations in India as grazing pressures in rural area is high.

However one of the main drawback of this system is that soil remains exposed till the canopy closes, there is great danger of deterioration of soil and the possibility of increase soil erosion. The situation is worsens in case of *taungya* system of regeneration where agriculture crops are raised prior or after planting forest species. This system produces even aged crop which is less resistant to damage by snow and wind and, when it is also pure, it becomes all the more susceptible to damage by insects, pests, and fungi. The devastated appearance of large clear-felled areas particularly in the hills makes the system undesirable from the aesthetic point of view also.

### **1.2 The Uniform system**

It is a kind of shelterwood system (regeneration is obtained under the shelter of over-wood) aiming at concentrated regeneration, in which the canopy is uniformly opened up over the whole area of a compartment to obtain uniform regeneration. It is also called compartment system, implying that the canopy is opened up for uniform regeneration over the whole compartment in one operation. Patterns of felling followed under this system are seeding felling, this is to opening the canopy of a mature stand to provide conditions for securing regeneration from the seeds of trees retained for the purpose. This is the first stage of regeneration felling under a shelterwood system, Second felling, as a regeneration felling carried out between the seeding felling and the final felling under a shelterwood system in order to remove the shelter and admit increasing light to the regenerating crop. Because regeneration under this system requires more sun light and this is achieved by removing some of the seed bearers retained at the time of seeding felling. Further, final felling will be carried out as the removal of the last seed or shelter trees after regeneration has been effected under a shelterwood system. It is carried out when the coupe or regeneration area is more or less completely stocked with established regeneration that no longer requires any shelter.

In this system regeneration has been obtained through clear felling the coupe and regeneration is expected each year as far as possible, so that a normal series of age gradations from one to  $N^{\text{th}}$  year are formed. But under this system, it is not possible as it requires several year to regenerate an area naturally. Therefore, in order to ensure that the entire forest area is felled and regenerated systematically within the rotation, it is necessary to divide the rotation into as many parts (periodic blocks) as the number by which the rotation is divisible by the time taken to regenerate an area naturally.

Some of the advantages of clear felling systems are the soil is not completely denuded so there are less chances of soil deterioration and erosion. The soil is adequately protected. As the regeneration operations are carried out under the shelter of older crop. However there is little danger of invasion of weeds, as happens in the clear-felling system and also protected against adverse climatic factors such as frost, cold winds etc. As the regeneration is obtained from the seeds of the best-selected trees, the new crop is superior from the point of view of hereditary characters

### **1.3 Group system**

It refers to silvicultural system in which regeneration felling, instead of being done uniformly all over the compartment are carried out in scattered groups. This is either because of the presence of advance growth in those groups or to induce regeneration denovo, so that these foci of regeneration can be enlarged centrifugal to merge with each other ultimately. This system has been applied for deodar forest of Himachal Pradesh and sal forest of Orissa, but it was not successful because of heavy invasion of grass in the groups and consequent accidental fires. It was again tried in Uttara Pradesh for deodar forest during 1953 to 1967 but was failed because of advance growth and artificially created gaps could not be mapped due to difficult hilly terrain and therefore regeneration could not be tended properly. Further protection of regeneration from anthropogenic and fire could not be enforced.

The pattern of felling followed under this system is regeneration felling, in which it is necessary to go over the compartment to locate groups of promising advance growth. If these groups require to be freed, all or some over-wood is removed. Then, in order to enable them to spread centrifugal, seeding felling is done on the periphery all round them. If the groups of advance growth are not adequate, some gaps are created by felling trees in small groups to enable regeneration to come up in these gaps. When regeneration appears in these artificially created gaps, secondary felling is done therein as well as in the seeding-felled rings round natural foci. When regeneration appears in these artificially created gaps is established, final felling may be done. Simultaneously, secondary felling is done in the seeding-felled peripheral strips round them, and a fresh seeding felling in rings round them.

This system having an advantage over uniform system, the young crop develops in a more natural way than it does in the uniform system. Because in nature regeneration appears sporadically rather than uniformly all over the area at one time and there is little danger of the seed bearers being uprooted by wind storm as these are surrounded by un-felled forest. However it is noticed that locating, surveying and marking the trees in hilly terrain is extremely difficult and towards the later stages, the few isolated seed bearers are exposed to serious risk of wind blow.

#### 1.4 The irregular shelterwood system

It is defined as silvicultural system in which the crop to be regenerated is opened up irregularly and the resultant crop is uneven-aged. Using this term for the first time, Trevor (1938) described it as a modification of the uniform system, where large quantities of advance growth of various ages and sizes, trees even up to 40cm diameter, are retained as part of the future crop. Pattern of felling of the crop to be regenerated is irregular and does not follow any regular pattern. The irregular opening of the crop is necessitated by one, or a combination, of the following circumstances

**a) The irregular nature of the crop being regenerated:** when the crop to be regenerated is irregular, uniform opening of the crop leaving a few seed bearers, results in unnecessary sacrifice of immature material for a theoretical ideal of uniformity. Though retention of well-grown poles and young immature trees up to 40cm diameter makes the resultant crop irregular, it not only saves the unnecessary sacrifice of immature established crop but also facilitates the completion of regeneration work.

**b) Difficulty in obtaining regeneration at will:** when it is difficult to obtain regeneration at will, on a large scale, all attempts to have uniform even-aged crop are likely to fail. In such circumstances, the removal of over-wood cannot proceed at a uniform rate. It has to follow the regeneration, i.e., the nature of opening depends upon the present condition of regeneration and the prospects of its progress.

**c) Danger of loss of soil fertility:** when uniform heavy felling are likely to affect the fertility of the soil adversely, there is no other alternative but to retain immature trees of the older crop to cover the ground. In the tropical rain forests, which have the richest soils in nature, heavy uniform openings result in leaching of the nutrients under heavy rainfall conditions to such a depth as not to be available to plants and trees. Therefore, if the fertility of the soil is to be maintained, felling should be of an irregular nature, by retaining immature trees up to a certain girth limit.

This system has been applied to deodar and sal forest and also in tropical rain forests such as evergreen and semi-evergreen forests. In the sal forests of Dehradun division of Uttara Pradesh, the development of sal regeneration is so irregular that the application of uniform system failed completely. Further, it was not possible to obtain established regeneration over large areas at will in a reasonable period. The only alternative was to adopt Indian irregular shelterwood system and nurse up regeneration which is found scattered over almost the whole area of the working circle in patches of varying sizes and in all stages, from sub-whippy to the established pole stage.

The all India tropical moist forest symposium (1960) has recommended that, where these forests are managed for the production of timber, they may be worked under irregular shelterwood system. In areas where the number of mature and over-mature trees is proportionately higher, the surplus growing stock of such trees should be removed in the first one or two felling cycle to facilitate the application of irregular shelterwood system. Some of the example are given below where in these application have been adopted

The Andamans evergreen forest was extensively worked under this system, where they have called it as Andamans canopy lifting shelterwood system. All sound trees of commercial species, below the prescribed girth (prescribed girth class are 150 cm girth at breast height for hardwood, 120 cm for softwood and 180 cm for other category) are left as advance growth. Closely following the extraction of timber, canopy lifting is done by a) felling all poles of non-commercial species and under growth up to 10 meter height; b) girdling trees of 10m to 20m height not needed as seed bearers or as a part of the future crop. The area then presents a picture of 'sieve without blanks' so that adequate light is filtered through the canopy. They are carrying out two or three weeding in the first year, one in second and third year. Climber cutting is also done along with weeding.

### **1.5 The selection system and group selection system**

In which feelings and regeneration are distributed over the whole of the area (except in so far as felling cycle introduces a modification) and the resultant crop is so uneven-aged that trees of all ages are found mixed together over every part of the area. So selection system is different from rest of the system explained earlier, are confining to part of the whole area, whereas in selection system, it is distributed over the whole area and completely uneven aged.

The area to be worked under this system is divided into coups after a certain number of years, which is equal to the number of coups. This interval is known as felling cycle, which is defined as the time that elapses between successive main feelings on the same area. The length of the felling cycle affects the silviculture of species, exploitation of forests and the nature of crop produced. The longer the cycle, the smaller will be the area to be worked in a year. This would result in heavier feelings per unit area. If the forest is composed of a mixture of light demanding and shade bearing species, heavier felling would create conditions favorable for the regeneration of light demanders. With heavier felling, the volume of timber removed per unit area would be more and the cost of logging and extraction would be less. This could also adversely affect the uneven-aged and stratified structure of the forest. Simmons (1929) has shown that with a yield assessed at 2% of the growing stock, a felling cycle of 10 years would result in the removal of approximately 20% of the growing stock in

the coupe This may maintain the selection nature of the forest. When felling cycle increased to 30 years, the removal may be approximately 60% of the growing stock and this would be similar to seeding felling and consequently the resultant crop would be even aged. In the ideal or periodic selection system, it is expected that natural regeneration will come up in the gaps created by felling of trees

**Table 1. Regeneration and Type of crop under High forest system adopted in India**

Sub Silvicultural Systems	Mode of Regeneration	Type of crop
<b>I. CLEAR-FELLING SYSTEMS</b>		
a) Clear felling system Clear-felling by compartments or sub compartments	Usually artificial, often by <i>taungya</i> Natural regeneration is sometimes possible from seed from adjoining areas or from seed already on the ground or from coppiced advance growth.	Very even-aged
b) Clear-strip system Clear felling by strips, which progress across the regeneration area.	Usually artificial, though natural regeneration is often possible from adjoining area.	Even-aged
c) Alternative-strip system clear-felled strips alternating with un-felled strips.	Usually natural on the initially cleared strips; natural and/or artificial on the intervening strips when felled	Even-aged
<b>II. SHELTERWOOD SYSTEMS</b>		
a) Uniform system Seedling felling uniform over a compartment or sub-compartment.	Mainly natural, often largely assisted by artificial regeneration	Even-aged as the regeneration interval is short.
b) Group system Seedling felling in groups over compartments, Subsequent felling to enlarge the groups	Mainly natural, though control of the mixture is often assisted by sowing and planting.	Uneven when young, but even aged later if the regeneration interval is short, otherwise somewhat uneven-aged.
c) Shelterwood system Regeneration felling in strips, progressing across the regeneration area. Strips wide and progress rapid.	Mainly natural	Even-aged as the regeneration interval is short.
d) Indian irregular shelterwood system Opening of canopy is irregular depending on the progress of regeneration and all advance growth of various ages and sizes upto specified d b h is retained generally in groups as part of the future crop.	Natural	Uneven-aged as the regeneration interval is long and immature trees of the old crop are retained as part of the future crop.
<b>III. SELECTION SYSTEMS</b>		
a) Selection system Trees removed singly in selection felling	Natural	Uneven-aged with all age classes mixed together on each unit of area.
b) Group selection system Trees removed in small groups	Natural	Uneven-aged

Source: Ramaprahah and Khan 1983

Group selection system is a selection system in which trees are felled in small groups and not as scattered single trees of the typical selection system. These felling may be distributed over the whole area if it is small, otherwise these are carried out only on a part of the whole forest each year under a felling cycle. The crop in this system differs from that of the theoretical selection forest, that in this system groups of trees of the same size are distributed. This

system is suitable for light demanders, as their seedlings can come up and establish satisfactorily in comparatively larger gaps created in this system than in the typical selection system

## **2. Coppice system**

It is defined as those silvicultural systems in which the new crop originates mainly from stool coppice and where the rotation of the coppice is short. This main group is further differentiated or classified on the basis of the pattern of felling. The different systems characteristics are briefly presented below.

### **2.1 Simple coppice system**

It is defined as a silvicultural system based on stool coppice, in which the old crop is clear-felled completely with no reservation for shelterwood, or any other purpose. As already stated, the simple coppice system consists clear-felling a fixed area annually and regenerated by coppice shoots. The best season for coppicing is a little before the growth starts in spring because, at this time, there is a large reserve of food material in roots, which is utilized by the coppice shoots.

The system is simple in application and does not require any skill in marking as required in shelterwood high forest systems. Further, cost of weeding, cleaning and protection is much less than in case of reproduction from seed. But in this system we will get only small-sized timber and its applicability and financial success is limited and the system tends to exhaust minerals in the soil. This system was applied for sal forest of north India and also tropical dry forests of Andhra Pradesh and Tamil Nadu.

### **2.2 Coppice of two rotations system**

The coppice of two rotations system is modification of the simple coppice system in which at the end of the first rotation of coppice, few selected poles are left scattered singly over the coupe in the second rotation to attain bigger size. In the second rotation felling, these poles are felled with the coppice but new poles are selected from among the coppice shoots of one rotation age and left for the second rotation. Thus, the main object of the system is to produce some large-sized timber in addition to the poles of ordinary size.

### **2.3 Shelterwood coppice system**

This is another modification of the simple coppice system. In this system, even in the first clear-felling, some shelterwood (125 to 150 per hectare) is retained for forest protection. The trees selected as frost protection shelterwood are the most promising ones, and are retained till the coppice shoots are fully established. The shelterwood is then removed gradually. This system is applicable to areas where frost is a common occurrence, coppice for larger age and demand for small sized timber.

#### **2.4 Coppice with standards system**

Is defined as silvicultural system based on coppice in which an over-wood of standards, usually of seedling origin and composed of trees of various ages, is kept over coppice for periods. Which may be multiples of coppice rotation and as a permanent feature of the crop throughout its life. Under this system, all trees, except the standards, are clear-felled. This requires selection of standards before felling. The standards should be of the most valuable species of the crop and should have a long clean bole and attenuated light foliage is to produce more large-sized timber than fuel. For Indian conditions (Trevor, 1938) standards should not occupy more than one third of the canopy. When the rotation of standards exceeds two rotations of coppice, the standards consist of several age-classes. In such case, the space allotted to the standards is to be properly uniformly distributed amongst the various age-classes and whole area.

This was introduced in 1934-35 in the working plans of Sagar division in Madya Pradesh and later it was extensively applied to sal forest of Uttara Pradesh, Bihar and West Bengal for a rotation period of 30 years. This system provides greater protection to the soil than simple coppice system. It allows standards to grow in isolation and get the benefit of light increment without exposing the soil, which is protected by the coppice, and it serves the purpose of seed bearers and provides seedling regeneration. However it is difficult to apply in practice. It need great skill in maintaining correct balance between standards and coppice, and correct distribution of standard of different classes and normally the species in this yield lesser timber per tree, being more branched and shorter-boled, than in the high forest systems. Felling, conversion and extraction costs are higher in this system than in the high forest systems.

For Indian conditions, Trevor (1938) has recommended that standards should not occupy more than one third of the canopy. When the rotation of standards exceeds two rotations of coppice, the standards consists of several age-classes, for instance, if the space allotted to standards is 0.3 of the entire canopy and there are three age-classes, each should get 0.1 of the canopy space. This means that the number of standards of lower age-classes will be more than the standards of the older classes.

#### **2.5 The coppice-with-reserves system**

The tenth silvicultural conference (Anon 1961) recognizes this system as a definite silvicultural system, recommend its application to dry deciduous forests extensively. It is defined as a silvicultural system in which felling is done only in suitable areas, after reserving all economically important immature growth as well as other valuable miscellaneous species, either singly or in optimally spaced groups. In this system, the

emphasis is not on felling but on conservation. Therefore, the first thing to be done is to distinguish areas which require protection or, at the most, some improvement felling, and areas in which felling can be done. Even in areas in which felling can be done, felling does not conform to any predetermined pattern but is carried out according to the requirements of the crop. Thus felling may vary from clear felling to practically no felling by reserving all trees.

**Table 2. Regeneration and type of crop under Coppice system adopted in India.**

Sub silvicultural System	Regeneration	Type of crop
a) The Simple coppice system Crop removed by compartments by clear fellings, with no reservation of a shelterwood.	Coppice often assisted by artificial regeneration in strips or lines.	Even-aged
b) The coppice of two rotations system Part of the crop reserved for the whole of second rotation to produce larger material	Coppice	Underwood and overwood even-aged but of different ages.
c) The shelterwood coppice system Crop removed by compartment by clear-felling, except that a shelterwood is retained for a short interval	Coppice	Even-aged
d) The coppice with-standards system Part of the crop reserved to form an uneven-aged overwood.	Mainly coppice	Underwood even-aged Overwood uneven-aged
e) The coppice with reserves system The done keeping in view requirements of crop, and may ran from clear-felling in certain portions to practically no felling in others. All financially immature growth reserved either as single trees or as optimally spaced groups of valuable timber trees	Mostly by coppice	Irregular groups of even-aged coppice with uneven-aged reserved cop Considering the entire crop, uneven-aged.
f) The coppice selection system Stems removed as in the selection system but reliance on coppice regeneration.	Mainly coppice	Uneven-aged
g) The pollard system Removable of exploitable material as under the simple coppice system but by periodical pollarding	Pollard	Even-aged

Source: Ramaprabakash and Khan 1983

### 3. Silvicultural practices under different forest management regimes in India

Major forest management systems followed in India are community forest management system, forest management by Forest Department through many interventions such as social forestry, Joint Forest Management apart from territorial management of forest. However in these systems though due importance was not given to complete development of silvicultural practice for sustainable forest management, some of the practices have been followed. In this sections study try to account such practices followed under different forest management regimes and its implication for the future management of forest.

#### 3.1 Community Forest Management

Voluntary forest protection arrangements have evolved in many parts of India, allowing rapid regeneration in protected patches of forests. Self-initiated Forest Protection groups emerged in response to loss of forests, encroachment of forests for cultivation, severe shortage of

biomass for rural communities. The spread of these initiatives is apparent in states such as Bihar, West Bengal, Orissa, Karnataka, and Haryana.

The primary objective of all these forest protection committees was protection of degraded or partially degraded forest patches as well as non-forest areas. Other activities include adoption of silvicultural operations, regulating grazing and extraction, managing vegetation, fire control and grass distribution. Some of the protection systems adopted include social fencing, voluntary patrols and paid guard. The experience of self-initiated Community Forest Management in India provides if communities set up their own institutions, they exhibit exemplary resource use and are able to exert considerable social pressure on the erring members of the group. Further, biodiversity provides a greater assurance of livelihood security than the timber value of forests.

It is broadly describes that under community forest management systems, local residents who have developed institutions, norms, rules, fines and fees to sustain forest resources. These systems characteristically involve one or more communities protecting and using a specific forest area. The approaches followed under community forestry towards forest management in general and silvicultural practices in specific, are very simple and user friendly. These approaches developed over period of time by repeated experimentation and monitoring. Some of the approaches are mentioned in the table-3 and comparison area also made with approaches under conventional forest management, which describes forest management mechanism followed by Forest Department over period of time.

Despite many differences found in approaches of these two Forest Management systems, that some of the practices followed are good and very simple to understand and implement. It needs scientific understanding of these practices for better conservation and regeneration of forest to meet various objectives of forest management such as biodiversity, meeting local biomass needs, employment generation, etc., So it is very important to consider both the approaches as complementary to evolve good participatory forest management. In order to evolve such methodology it is better to look after the some of the specific drawbacks in these approaches from point of community participation, cost effective practices, easy to practice and document and evaluate.

The ecological and silvicultural practices followed under community forest are local specific and traditionally evolved. However guidelines on JFM are not adequately addressed all the practices followed by the community, though commonly practiced by the communities for a longtime. Further poor documentation and scientific understanding also contribute for lesser acceptance and validity of these practices.

**Table 3. Approaches followed under conventional forest management and community forest management in India.**

Features	Conventional Forest Management	Community Forest Management
1 Management objectives	The emphasis of these conventional methods is to quantify an allowable harvest for single products, i.e. to prescribe a sustainable yield or quantity. Interest in artificial regeneration involving mono-cultures and genetically improved planting stock.	The emphasis of simple technical methods is to provide both qualitative and quantitative descriptions of what can be cut and what should be retained i.e. to prescribe a sustainable treatment rather than a sustainable quantity. Interest in natural regeneration supplemented by enrichment planting with preferred species and planting stock.
2 Management options	Management focuses on a few commercial products (primarily timber) or a single land – use	Management focuses on multiple products and services required by local communities as well as external stakeholders, which yields multiple management objective
3 Planning and implementation of forest management	Government agencies are solely responsible for planning and implementing management operations. Under Joint Forest Management, Forest Department along with local community involved in planning process.	Local users drive the planning and implementations process. Role of the other agencies such as forest department and non governmental agencies are minimal
4 Methods and management plans adopted in management of forests	Complex technical methods are used by trained technicians to undertake various activities, such as: undertake inventories, calculate and schedule yields, and monitor operations and their impacts Detailed and complex management plans lacks users into formal agreements for carrying out conventional forestry operations	Simple methods for assessing, regulating and monitoring yields that can be easily understood and applied by local people are used and developed with external support where appropriate. Plans contain simple codes of practice or guidelines describing suitable silvicultural and harvesting approaches that are based on users' needs, the capacity of the users to apply them, and the capacity of the forest to meet user's needs.
5 Harvesting prescriptions/management benefits	Highly specific-harvesting prescriptions based on maximizing the yield and value of a few products over time, within an overall allowable cut.	Simple, adaptive harvesting prescriptions that encourage product diversity and manipulation of forests to produce a locally desired mix of products in the future
6. Cost effectiveness	Complicated, costly and technically intensive approaches for monitoring forest condition and productivity	Simple, cost effective but reliable approaches for rapidly monitoring and evaluating all aspects of forest management (social, ecological and economic).

Source: Modified from Michael and Andrew Barash (2001)

### 3.1.1 Community Forestry: Implication on participatory silvicultural processes

Community forestry as a concept and a practice has understood largely over the past two decades, though such practices existed over 100 years. Concentrating mainly on understanding and developing the institutional aspects of community forest management, it has focused primarily on returning the responsibility for decision making back to the communities living in and around designated forest areas (Poffenberger 1990). With this focus on the socio-political or managerial component, there has been a tendency to ignore the

technical or biological elements of forest management, especially with respect to the natural forest management. Thus aspects such as silviculture, forest protection from natural threats, stand improvements and various aspects of utilization have received relatively little attention as compared to the institutional aspects.

Silviculture systems are developed in the context of ecological relationships and refined through repeated experimentation, monitoring, and readjustment. For the most part, community forestry has made little progress in developing new technologies to enable the natural forest to meet villagers needs of different forest products and services. Villagers themselves are now asking for assistance in developing more productive forest plots, but forests have had difficulty in supplying the technical information they need. In short, forestry, as a science, is failing to deliver as a result, community forestry is falling short of its potential. A better forest management alternative are needed to arrest deforestation and alleviate the threat to natural forest areas increasingly at risk of being stripped of their commercially valuable resources, or of being concerted to alternative land uses (Donovan 1998). All these should result in ensuring participatory process to give respective role, responsibility of forest management and derive benefits out of this in a sustainable manner. The basic information required for participatory silvicultural prescription was given in Appendix IV.

Community forestry must integrate research techniques from forestry, ecology and anthropology. Further Forest Department functionaries need a sound base in the social as well as biological sciences so that they have the skills necessary to work with villagers to devise and test new silvicultural techniques. Foresters must be able to assess local skills and assist community in adapting silvicultural practices. The cooperative research techniques of on-farm experiments developed in farming systems research can and should be adapted to investigate forest manipulation by local communities (Richards 1985). The trained forester should be the link between the scientific community and the *de facto* forest manager. The community working in this manner will contribute both to the advancement of forest science and to assisting community to develop new skills and technology. Thus, the role of the professional forester should be as the midwife and the catalyst to assist local people in developing the knowledge base needed for the refinement of silvicultural prescriptions and enhancement of forest productivity.

### **3.2 Conventional and Participatory Silvicultural approach**

#### **3.2.1 Conventional approach**

Under conventional approach Forest Department adopted several silviculture treatments in reserve forest and other forestlands comes under territorial division. At the division level

Forest department prepare working plan, which is guiding source contains the area to be treated and application of silvicultural practices over period of time of forest management. The working plan known as owing body firstly to clarify and define the objects of management and the consequent policy of action, secondly to organize the administration and treatment of the forest in harmony with the policy (Ostuastron 1984)

Some of the essential elements mentioned in the working plan while adopting any kind of treatment to forest are (1) attainment of a maximum production of the materials or services desired by the objects of management, (2) conservation or improvement of soil and site productivity, (3) the moulding of individual stands and stand types into a composite whole, that provides a steady sequence of maturing timber by a planned progress towards an ideal entity and lastly the satisfaction of the needs of utilization. The above features clearly imply that, in short how to cut and tend the growing stock and faster the site. The extent of a working plan area (synonym in the United State of America is working circle and in Canada sustained yield unit), i.e. the area included in the provisions of one plan, depends on administrative convenience. Accordingly it should ordinarily coincide with an executive charge or with one ownership if an executive charges includes properties of more than one owner since separate owners are unlikely to accept the provisions of a common plan unless they have agreed to close co-operation in the management and use their forest properties,

### **3.2.2 Microplan approach, scope and relevance**

Preparation of microplan is one of the most important aspects of forest management under Joint Forest Management. This programme was adopted by the Government of India during 1991 and emphasis was given to collaborative planning and management by the local communities and Forest Department. Microplan shall aim at sustainable development of degraded forest area for sufficient production of fuelwood, timber and fodder, distribution of forest produce and also the regulation of cattle grazing. The plan shall also prescribe the quantities and modalities for removals of forest produce for procurement and distribution every year. The microplan will be put before the village forest committee and general body of the Village Forest Committee, which is formed at village level by offering membership to all households for its approval and then Deputy Conservator of Forests will give his formal acceptance for the execution of the plan. Once the microplan is accepted, it shall replace the existence working plan/management plan of the region.

Many current provisions in the government orders have also created legally ambiguous situations with respect to microplan and states such as Madhya Pradesh have provisions whereby the microplan would supersede any existing working Plan for the allocated JFM area. This stipulation has several legal ramifications since currently under a Supreme Court

ruling, no forest area can be worked unless it is covered by a working plan duly approved by the Government of India. The Forest (Conservation) Act additionally states that all proposals involving clearing of naturally grown trees in forest land or portion thereof, for the purpose of using it for reforestation, can only be sent in the form of a Working Plan / Management Plan. Provisions for forestry operations therefore, cannot take place at the behest of a microplan. It is advisable that a microplan is prepared in addition to the Working Plan for each Village Forest Committee and ensures that it focuses more on village development activities.

### **3.2.3 Features of Working Plan and Microplan.**

The major difference between the two practices is that almost all-indigenous forestry operations seem to be oriented towards the procurement of current returns, while the scientific concept focuses more on the future returns mainly in terms of timber or perhaps the net present value (Prasad et al. 1998). Some of the features of working plan and microplan are given in the table-4, which have similar stand with respect to some issues and are much different in other cases. The Forest department mostly decides the guiding goals of the working plan however, it is decided in collaboration with the local communities under microplan, which seems to be more participatory in nature. Further working plans are by and large timber or revenue oriented, whereas microplan aimed at multiple products to meet various needs of the community, according to this silvicultural strategies varies between these two approaches.

Working plan have prepared for specific area, again for few principal species. In case of micro plan area focused for the management was much smaller than working plan however focus was given to various species of local use also. Some extent microplan evolved out of traditional knowledge and are planned for short period of five years. Whereas working plan are more methodological oriented than as approach and planned for very long period. Issues related to biodiversity and wild life are inadequately addressed in working plans and forest protection mechanism was not mentioned unlike in microplan protection strategy is clearly mentioned.

**Table 4. Features of microplan and working plan approach.**

Features	Working plan	Microplan
<b>I. Conceptual frame work of working plan and microplan</b>		
1 Guiding goal of forest management	Decided by Forest Department (unilateral)	Decided jointly by the forest department and forest users
2 Decision making processes	Uniform silvicultural strategy - timber and revenue oriented	Varied silvicultural strategies aimed to facilitate derivation of multiple products from a given forest
3 Management strategy	Guiding goal of forest management is forest management for maximum timber production	Guiding goal of forest management is to meet the basic needs of forest dependent community in a sustainable manner.
4 Silvicultural approach	Forest type specific approach: provide treatment according to the silvicultural requirements of a few principal species in the growing stock.	Limited to village level forest by giving due focus on multiple species
<b>II. Prescription related parameters</b>		
1 Use of traditional knowledge	Previous working plan provides the basis for next term's silvicultural prescription: local/indigenous knowledge, social cultural and ethnic values of forest are neglected	Indigenous knowledge is made full use while evolving these innovative systems
2 Planing and implementation	Methodological than a process approach: it does not seek the involvement of field managers while planning and very little scope for incorporating changes during the progress of the plan Silvicultural treatments need considerable technical knowledge for implementation	Process approach than methodological: forest management strategy should have inherent capability to evolve with time and situation. Simple, need based, that match the local capacity to understand and implement
3 Periodicity	Silvicultural treatments form part of long-term (15-30 years) forest management plans, for a large forest area	Silvicultural treatments are incorporated in short term (5 years) forest management plans after deciding the long term management objectives of a given patch of forest demarcated through need based zonation.
4 Applicability	Prescriptions are not relevant for application outside designated forestlands	Prescriptions can be applied after minor modifications to areas outside designated forestlands too.
5 outputs	Timber yielding plantation species are the primary focus	Focus upon multiple forest species
6 Integrity	Inadequate emphasis on biodiversity and wildlife; separate management plans are written for protected areas for conservation and protection of wildlife and biodiversity Inadequate emphasis on forest protection.	Wildlife management and biodiversity conservation is an integral part of forest management. Adequate emphasis given for forest protection (fire, grazing, encroachment etc.

### 3.2.4 Micro plans: step towards participatory approach

Preparation of microplan is one of the most important aspects of forest management in JFM context. In this community have been involved in planning of microplan, some extent local needs and traditional technology has taken in to account. However microplan need to be prepared in much more different passion, so that it should consider traditional knowledge on scientific temperament. It has been observed that the village communities don't manage their respective forests on strict technical lines, it needs to build of scientific thinking among community. The microplan prepared till dates are not technically sound and there is a conflict between the working plan and the micro plan at many places. In Andhra Pradesh review of the

microplan in one of the study area led to the conclusion that most of them override the importance of forest resources inventories (reference). The existing crop composition, the likely achievement of the normalcy of growing stock, likely increase in productivity and realization of revenue, are not addressed properly. The data on forest health has either been omitted/missed out or copied from outdated compartment/block histories

The issue of integration of microplan and working plan could be very controversial. A microplan being functional without the presence of a working plan as in Andhra Pradesh also may be not desirable as this is in contravention to the spirit of the National Forest Policy 1988 which envisages that working in the forest areas has to be detailed in the working plan. Also the Honorable Supreme Court (order dated 12.12.1996) has directed that no felling of trees in the forest areas is to be taken without the approval of working plans by the Central Government. It also stress the need for preparation of working plan within two years for all the areas specially the JFM, under approved management, covered by a working plan. Dr. A. R. Maslekar committee's report also stresses that the new approach of working plans should satisfy the objective of National Forest Policy 1988.

### **3.2.5 Integration of microplan with working plan:**

The new JFM guidelines 2000 issued by the Ministry of Environment and Forestry rightly recognize the importance of synchronization between working plans and micro plans. However, the suggested instrument of linkage should be reconsidered. A better way of facilitating JFM could be to incorporate broad provisions for microplan in all the working circles if JFM is taken up in accordance with prevailing rules and regulation. For making such broad provisions working plan officer needs to consult village organizations, conduct PRA exercise in representative JFM villages as well as take in to consideration the hitherto obtain experiences and lessons from JFM areas. The guideline also emphasizes that deviation can be approved without changing the basic principle of conventional working plan. But most of the people working in JFM in every part of the country felt that there is a need for a separate set of silvicultural design for JFM. In such circumstances, it would be difficult to stick to hitherto timber oriented silvicultural principles. It would be better if these so-called basic principles are clearly spelt out, else the vague statement should be avoided to strengthen the cause of JFM.

### **4. Participatory silviculture approach**

Traditionally, forests of the nation are being managed through scientifically prepared working plans. The concept of sustained yield and silvicultural requirements of prominent species of a forest tract are the prime considerations. A revolutionary development in the arena of forest management in India took place in the late 1990s, when participation of local, forest

dependent communities was sought for the management and protection of state forests under the umbrella of Joint Forest Management (JFM) program. This new approach has been adopted by 27 Indian states and about 14 Mha of forestland has been regenerated by more than 62,800 Forest Protection Committees through indigenous and innovative methods and approaches. Even in Joint Forest Management proper emphasis was not given to develop silvicultural system for participatory practices and some of the aspects of silviculture has been relatively ignored (Bhattacharya and Prasad, 1998). In this section study attempted to conceptualize participatory silviculture practices specially keeping community members, frontline staff of the forest department and NGO functionaries in mind. Further it describes silvicultural treatments for different kind of outputs desired by the forest dependent community. Steps required for participatory silviculture are discussed along with key elements and some of the models and options for designing silviculture practices for participatory process.

#### **4.1 Meaning and scope of the participatory silviculture**

Participatory silviculture is understood that it is for and by the people, that draws prescriptions from existing scientific understanding as well as rich indigenous knowledge, and, thus has strong institutional, ecological and socio-economic basis under pinning the art and science of forest vegetation management. Some of the important features of the participatory silviculture are, evolving simple silvicultural prescriptions, which can be easily assimilated by local forester and village community and it should address multiple outputs like grass, firewood, fodder, bamboo and other NTFPs to meet various needs of the local community. In this context it is required to evolve and implement innovative need based silviculture approach (mix of classical and indigenous silvicultural systems). Further the basic informational requirements for participatory silvicultural prescriptions were given in appendix I.

#### **4.2 Silvicultural treatments, definition and end products**

Some of the common and specific silviculture treatments has been identified keeping the expected outputs of the local community, Forest Department and other stakeholders from the forest. These have been defined for the common understanding and enable to practice under participatory process. Under participatory process it is expected community to execute all the practices to achieve expected outputs and Forest Department and NGO must play their role as facilitators. Several silvicultural prescriptions mentioned under participatory approach, that local forester can work together with village community for maintaining and improving the productivity of the forests. Some of the silvicultural treatments, which have

been commonly practices and some of the specific treatments practiced under different situations are listed in the table-6, along with its definition and expected outputs

**Table 6. Definition and end products of silvicultural options/intervention under participatory approach**

Silvicultural options/interventions	Definition	End Products
1) Selective harvesting	Occasional cutting of trees for special use	Poles, firewood
2) Weeding/cleaning	Removing unwanted vegetation, which is competing with the growth of young regenerated or newly planted seedlings To improve the growth of desirable tree species	Timber, firewood, fodder, grasses
3) Thinning	Removal of selected trees from a pole stage forests to decrease the stocking density	Poles for fencing, building materials, firewood
4) Pruning	Cutting of branches from large or mature trees	Foliage, firewood, materials for hut construction.
5) Lopping	Harvesting of leaves of small branches and twigs	Foliage for livestock bedding and fodder
6) Singling	Reducing the number of stems growing from a cut stump to live a single stem along with thinning	Foliage, firewood, fodder
7) Leaf litter collection	Removal of leaf litter from the forest floor along with germination seeds	Firewood, manure
8) Cut back operations	Dressing of older malformed stumps in order to promote new shoots.	Firewood, fodder, manure
9) Multiple shoot cutting	When repeated cutting is done to remove malformed and damage trees of the coppicer species, a good coppice crop consisting of multiple shoots is produced such shoots are thinned in multiple shoot operation and best shoot is retained.	Firewood, foliage, fodder.
10) Regeneration strategy: gap planting and enrichment planing	Planting local tree species in open patch to improve the canopy cover and growing stock. Of the surrounding natural forest	Improve biodiversity
11) Water course protection	Keeping forest intact in hilly areas and degraded slopes	Maintain water course and to improve the ground water table
12) Coppice and reserve system	Refers to coppicing species like sai and teak belt of MP, Orissa and WB	Timber, firewood, foliage etc.
13) Wildlife improvement	Maintaining the habitats of the flora (which are specially needed for pollination and fruit dispersal agents)	Improve wildlife

#### 4.3 Steps involved in participatory silvicultural approach

The involvement of local community in exercising silvicultural interventions for sustainable forest management is the main crux of participatory Silviculture. Some of the steps mentioned are essential to initiate participation of the all the stakeholders with full understudying of particular practice, its purpose and expected output from the practice. While implementing these practices it is required follow steps one after the another to arrive meaningful participatory process. Further some of the methods required to arrive these steps

under participatory approaches have been described under part II-methods for the participatory silvicultural approach

**4.3.1 Identification of forest patch:** Information about the vegetation type and canopy cover in a given forest management unit can be obtained from the Working plan of the forest division and also from the local communities

**4.3.2 Description of forest condition:** It is a combination of age of the trees, nature of species (whether light demanding or shade loving or intermediate), density of the main canopy, amount of natural regeneration or young seedlings present and identification of disturbances (fire, grazing, illicit cutting, encroachment etc ) These will enable the users to decide on their management objectives and to select the actual forestry operations needed

**4.3.3 Participatory forest resource assessment:** Is a dynamic process comprising of three major components, which are mapping, surveys and inventories. In this, primary step is to identification of problems and opportunities for community forestry in the area and facilitation of sound silvicultural advice and extension Secondly importing skills to and arousing interest among the villagers in forest management for monitoring and managing their own forest

**4.3.4 Forest needs assessment:** It is basically assessing biomass availability and requirements of the local community It is very essential to pay due emphasis upon local resource use pattern and incorporate these concerns in the silvicultural interventions. For this rural appraisal methodology can be employed to collect information from the forest dependent community, which is required to estimate the extent of forest dependence

- demographic details
- identify user group for the given forest patch
- list the product needed from the forest
- search for substitute/alternatives for the forest products.

**4.3.5 Identification of silvicultural interventions:** According to the information generated in the previous stages by participatory silviculture process, possible silvicultural interventions should be discussed with the communities keeping in view of their basic requirements (list of silvicultural interventions are given in Table-6)

**4.3.6 Preparation of site specific plans:** It is comprehensive information of the site where participatory silvicultural treatments have been planed to implement In order to prepare complete site-specific plans some of the information need to be collected for the preparation of the management plan is given below

- (a) Prepare the sketch of the site with baseline information. The baseline information like, contour lines of the site, forest type, growing stock inventory, soil type, topography, rainfall and other site information.
- (b) Information on the growing stock needs to be annualized to know the species composition, basal area, average height, number of trees/ha. the diameter vs number distribution curve for the entire plot normally appears like J shaped curve when there is normal regeneration in the site.

Similarly the site also indicate less perturbation due to any degradation factors. However, any other form of the curve other than J shape will indicate the abnormality in the regenerations status of the site indicating the presence or absence of particular diameter class. Similarly for each species such curves can be plotted to understand the regeneration status and diameter distribution of the species. Further for each species, importance value index (IVI) can be calculated to know the percentage of species of the total growing stock and species diversity of the forest area for understanding the composition structure of the vegetation. Based on the analysis of the growing stock information, we can identify the degradation factor such as fire/grazing/excessive harvest/no coppicing/no seed mother tree/ any other factor.

**4.3.7 Implementation of Silvicultural options** Once the user group has decided which operations it wishes to carry out in each patch of forest during that year, they may need some help in organizing the way in which they actually carry out these operations.

**4.3.8 Participatory monitoring:** After implementation of site specific plan, it is very important to identify at an early stage remedies to problems caused by inappropriate management and modify or devise new silvicultural prescriptions and also to evaluate the performance of the management system to meet multiple needs of the community. Impact assessment and monitoring do not represent a single attempt. So data need to be collected over a long period of time (several years) to assess the impact and monitor the participatory forest management activities.

#### **4.4 Key elements for participatory silviculture**

Some of the important elements need to be considered under participatory approach are listed here. These elements play vital role in deciding particular silvicultural treatment or set of treatments to achieve management objectives set under participatory process.

**4.4.1 Product selection:** At the village level, communities can rank products according to importance. On a national level, export values can be used to rank the most economically important products.

**4.4.2 Harvestable size criteria:** To understand life cycles of particular forest resources, it is important to know the optimal harvest size and age for each product. This knowledge resides

both with traders and village collectors, and can be elicited by semi-structured interviews. The main difficulty is often to combine size, weight and or colour criteria with reliable age estimates.

**4.4.3 Estimating off-take over time:** To estimate off-takes, it is best to begin a source – the village community. In many villages, a kind of land –use mapping has already been done, either by sketch mapping or under the district land allocation programme. This mapping can be used to collect location specific yield data such as,

- A list of all forest and other land use blocks
- A list of the three main NTFPs for each forest
- An estimate of total off-take for each NTFPs for each block in a year
- How the estimate was calculated and specific criteria/calculations
- Calculated estimates of surface area in hectares, based on maps with understood boundaries between the blocks and
- Summarized information in a table.

**4.4.4 Mapping & blocking** Villagers are usually able to sketch a map of various NTFPs collection sites. It is then necessary to translate this into features on a topographical map. Villagers usually express sites in terms of direction, and they find it difficult to view sites as areas with a quantifiable surface area. The translation of sketch map data to a topographic one is probably best done by skilled field officers.

**4.4.5 Regeneration studies:** In order to determine whether yields will be stable over time, it is important to understand how many productive individuals/specimens will grow every year. The best way to estimate future densities of plants is to establish regeneration sample plots.

#### **4.5 Options and models for participatory silviculture approach**

Selection and implementation of silvicultural treatments are primarily depends on the objectives of the forest management. In this context various models have been developed over period time by the different agencies. In case of the participatory process it is required to develop different models keeping community options as well as options of the other stakeholders. In this sections some of the options have been expressed to prepare suitable silvicultural model for participatory approach.

**4.5.1 Biodiversity management:** The biodiversity conservation and management is the primary concern of the community forestry. The conventional silvicultural interventions followed by the forest department aimed at maximizing the timber yield by encouraging only economic species, which ultimately affected the number of species that were considered as weeds or jungle growth. From various studies it is reported that, the biodiversity value of the species may be estimated based on its ever greenness and endemic value or set of species in a

site. The silviculture models need to consider ways and means to protect and promote these species.

**4.5.2 Regeneration strategy:** One of the major silvicultural interventions in the forest management is regeneration operation. The regeneration strategy depends on various factors and ultimately on the overall management objectives. The regeneration strategies were aimed at maximizing the uniformity in the stand structure and promoting the economically important species. Similarly, the artificial regeneration was aimed at creating plantations with only timber species, ignoring the biodiversity aspect. However, with biodiversity being the main theme of the current management policy, the regeneration model needs to be developed by taking both biodiversity and economic objectives into consideration. The species planted in the gaps were mainly fast-growing timber species like teak and in the open degraded areas the exotics like *Acacia auriculiformis*, *Casuarina equisetifolia* have performed well. Due to high density of planting the exotics with their fast-growing nature have suppressed the undergrowth, particularly the grass growth, which is very important for the local community for fodder. The ground flora is also suppressed under the exotic plantations, affecting the biodiversity.

**4.5.3 Natural regeneration model of community forestry:** The area was closed from grazing and fire by digging cattle-proof trenches around the degraded forest area. The old rootstocks in the degraded forest in moist and dry deciduous forests have responded to the protection and the regeneration of native species was found in abundance in the site. These models have been tried elsewhere and the results are very promising. As the natural regeneration takes care of both biodiversity and other NTFPs needs, it would be appropriate to use this approach to reforest the degraded forest. The model is also cost-effective and ecologically very sound.

**4.5.4 Conservation and regeneration of NTFP:** The sustainable forest management success largely depends on the success of the participatory management process. A key element for the success of the participatory process is the economic incentives to the local people. The silvicultural intervention needs to be designed to increase the benefits to the local people. The productivity potential of non-timber forest products has not been fully exploited due to the low priority accorded in the forest management. In the past, the NTFPs resource have been mismanaged due to the lack of sustainable strategy. Some of the valuable NTFPs species have been over-exploited, affecting the regeneration potentials and population structure. Some of the examples are *Persea macrantha*, which is recklessly debarked. The flower and seed collection of many of the NTFP species has affected the regeneration capacity of the species (e.g. *Myristica* flower, *Embllica* and *Garcinia* seeds etc.) The silvicultural

interventions in the natural forest management need to address these problems and develop appropriate stand models. Some of the light demanding NTFPs species comes up well in the open forest and in the closed canopy. The canopy manipulation and stand structures are to be simulated to promote productivity and the regeneration of the species. Rotational harvesting and exclusion for mother trees from harvesting fruits and trees needs to be integrated into the silvicultural management systems.

**4.5.5 Gender role:** It has been noticed in community forestry that, women are interested to get more fruit, fodder, leaf, branches, twigs and grasses for daily subsistence needs, whereas men member are interested about timber which give cash earning for the family. Men is involved in the clear felling and harvesting timber and women in tending operation as multiple shoot cutting, lopping, pruning and thinning in West Bengal and Hills of Nepal (Guhathakurta and Subimal Roy, 2000). Keeping these silvicultural model should address the role of the men and women by looking in to their strength and requirements.

**4.5.6 Agroforestry practices:** In the Western Ghats belt the traditional agroforestry practices are in vogue for a long time. The horticultural plantation activities in the Western Ghats such as, Areca, coffee, cardamom and pepper combines tree cultivation to compliment plantations. Often it is said that the canopy density and biodiversity is equally good in the multi-layer home gardens as in the natural forests. The tree cultivation is also very intensively adopted on the farmlands. The tree species generally preferred by farmers are usufructs yielding types. The green manure is extensively used by the farmers are met from both agroforestry trees and from *betta* lands assigned for the gardens. There is a big opportunity expands agroforestry practice in the participatory approach on the farmlands as well as plantation areas by judiciously mixing the tree cultivation and the farm crops. Some of the good agroforestry species are bamboo, cane (artisans), fruit yielding species such as *Artocarpus heterophyllus* and *Mangifera indica*, and green leaf producing tree species and fodder plants.

## **Part II: Methodology for conducting participatory silviculture**

We have explained the merits and demerits of different silvicultural systems designed and adopted in India in Part I. So it is very important to understand the silvicultural models and practice prescribed and adopted under various externally aided project under Participatory Forest Management system (JFM), in India. For example, the different models adopted and area covered under Western Ghats Forestry Project (WGFP) and Forestry and Environment Project for Eastern Plains (FEPEP) in Karnataka have been given in Appendix II to V. So it is very important to know, how these models/interventions have been implemented and there

impacts on ecology and livelihood of the local community This is additional information to understand the methodology developed for the participatory approach in this section.

In this regard study attempting to develop methodology for participatory silviculture involving all the stakeholders in implementation of the various silvicultural interventions For each objectives we describe methods, possible source of data and interpretation of data to understand the possible impact of silvicultural models and practices adopted. Draft methodology assumes three objectives, which are essential to understand concept, meaning, scope and nature of silvicultural practices. Further simple methods have been developed to collect information, it has been supported by possible source of data also. The key area of this draft method is interpretation of data to understand status of the practices and its impact on forest conservation and regeneration. The general information such as name of the range, village, and initiation of the forest development programmes such as Joint Forest management, Forrest Development Agency, community protection of forest, other related information need to be collected. In this section various steps has presented, to be followed under participatory silvicultural approach with detailed methods to conduct the excise

**Step I: Estimation of biomass needs of the VFC**

Before going into the details of models it is very important to understand the extent of biomass dependency of the village community. This is the first step involved in deciding the nature of models needed for a village. This information will be collected by household survey of the village and also through participatory appraisal by involving the local community and some of the government and non- government functionaries at village such as panchayat member, forest and agricultural department officers. During discussion issues mentioned in the chart I need to be collected

**Chart I: Biomass estimation of the village**

Bio-mass	Current supply (pre JFM)			Future supply (JFM)	
	Source*	Quantity (tones)	Frequency	Source*	Quantity (tons)
Fodder					
Firewood					
Timber					
Poles and Agricultural Implements					
Green foliage and litter					
NTFPs					
Others (specify)					

\*Source: forestland, village common lands, agriculture lands, homestead garden, outside village, others includes adoption of energy saving devices, mechanized agriculture etc ,

Frequency of supply: weekly/monthly/half yearly/yearly/occasionally

From this data we can understand the biomass requirements of village communities, further to understand the gap between current use and future requirement. The extent of dependence for various forest resources will be extracted, it enables to assess the present condition of these area to arrive extent of degradation, its potential to supply future requirements and its sustainable management. Further it enables to plan kind of silvicultural interventions needed to meet various forest management objectives set for the participatory approach.

**Step II. Silvicultural options prescribed and adopted to meet biomass needs at the village level.**

In this step it is essential to understand the silvicultural options already adopted in the study site. Further it is required to collect information about kind of silvicultural intervention prescribed, adopted and its performance in meeting the objective of the forest management in the site. Details regarding extent of area treated and type of silvicultural interventions undertaken over period of time in the study area are essential to record, the format has given in the Chart II. This information can be collected from the forest department records and other agencies involved in the implementation of the programme in the study area.

**Chart-II: Silvicultural options prescribed and adopted in the study area**

Biomass needs	Silvicultural options prescribed		Adopted	
	Area treated (ha)	Option prescribed	Area treated (ha)	Option prescribed
Fodder				
Firewood				
Timber				
Poles and Agricultural Implements				
Green foliage and litter				
NTFPs				

This data helps to understand that is there any silvicultural treatments have under taken in the area and the purpose of undertaking such treatment. So some of the performance of such treatments enables to plan future silvicultural options either by modifying the existing practice on participatory line or to adopt new interventions to meet various forest management objectives.

**Step III: Preparation of participatory forest management plan**

This is very important step under participatory approach. In this step through participatory rural appraisal it is expected to discuss various silvicultural treatments to be undertaken and area to be covered under various silvicultural options. It required to be prepare the management plan for specific period by ensuring the participation village communities, forest

department and NGO functionaries. Information required to discuss and document during preparation of management plan is given in the Chart-III

**Chart-III: issues to be cover under participatory management plan**

<b>Issues</b>	<b>Details to be mentioned in the management plan</b>
Area to be covered under plantations and natural protection	Yes/No and extent of area (ha)
Criteria for selection of site	Yes/No, mention
Species selection	Yes/no, if yes what are the species
Nursery development	Yes/No
Spacing to be followed in plantation	Yes/No, If yes what is Spacing
Site preparation	Yes/No, If yes mention the steps to undertake
Pitting and Planting	Yes/No, If yes mention the type
Cultural practices followed (weeding, watering, mulching, inputs application)	Yes/ No, If yes mention practices
Pruning and lopping	Yes/ No
Harvesting grass	Yes/No, if yes mention the mode of extraction
Replacement of dead seedling (gap filling)	Yes/ No

The management plan prepared under collaborative effort enables to implement the various silvicultural options in the study site. Further it acts as guide for the implementation of the models and helps to monitor the various performances of adopting particular interventions in the study site over a period of time.

**Step IV: Understanding the performance of the various silvicultural treatments adopted**

In this step it needs to understand the performance of the various interventions mentioned in the management plan and which have adopted out of this during participatory approach. Some parameters needs understand in common irrespective to kind of intervention adopted such as density and diversity of the forest, biomass production, status of regeneration etc. However some of the performance such as improvement in the soil fertility, ground water, reduce soil erosion can be measured with respect to objectives to be achieved out of interventions prescribed and adopted in the study site. The size and number of the transacts/quadrates depends on the heterogeneity (extent of variation in soil, topography, vegetation, etc.), forest type and climatic factors and also based on model and silvicultural practices followed in the study area.

**Chart V. Method for measuring different parameters under participatory approach**

Parameter	Methods
Status of plantation/natural plantation	Consultation with records: date of plantation, area of plantation, no of species per hectare planted, spacing followed and other silvicultural related practices
Density, Diversity and Bio-mass of the trees	Lay transact (100 x 10 meters) or quadrat (100 x 100 meters), note all the individual trees in the transact/quadrat, mention name of the individual tree, take girth of the tree at breast height in centimeters and height of the tree in meters
Mortality rate of the trees	Note all the dead pits in quadrat/transacts.
Density, Diversity and Bio-mass of the shrubs	Lay 5x5 m size quadrats within the tree transacts /quadrats, note all the individuals have girth less than 30 cm, measure girth of the tree and mention the name of the species
Density, Diversity and bio mass of the herbs and grass	Lay 1x1 m sized quadrats of five numbers within transacts or quadrats of the shrubs Note all the herbs and grass For biomass, harvest all herb and grass above ground level in the 1x1 meter quadrats, proportion of moisture will be calculated and species will be recorded.
Growth pattern (species adaptability and mode of competition in mixed condition)	Canopy height and length Branching pattern (straight or crooked) Branch and leaf angle should be noted
Flora and Fauna status	By participatory rural appraisal method, gather information related to biodiversity in the study area.

In chart Va format was given to record name of the individual species, its DBH and height from tree, shrub and herb transacts/quadrats.

**Chart Va: Data format for recording the growth of planted and regenerative species (trees, shrubs and herbs)**

*Quadrat size and no.*

Name of the Species	Planted / retained trees during plantations		Natural regeneration			
			Regenerated by seed		Regenerated by coppice (stump)	
	DBH (cm)	Height (mt)	DBH	Height	DBH	Height

**Step V: Gender and social implication of the silvicultural practices adopted under JFM**

In most of the ecological studies gender and social implication of such practices is inadequately addressed, these are very essential to increase community participation in participatory approach. This try to record gender and social implication form the local community to strengthen participatory process in real terms

- Aim is to assess the gender and social implications of the silvicultural practices and participation and their involvement of the women and VFC members in discussion
- Some of the implication considered form the above assessment are: species choice, grass harvested, NTFP collection, fire wood collection, grazing, protection etc.,

**Method; to conduct this excise:**

- Group discussion separately with women, VFC members (MC), forest guard
- open ended interview schedule
- reviewing the management plan

**Chart IV: Guide to group discussion and intervie**

Mention group: (women/artisans/SC/ST/landless and General category)

Silvicultural practices or issue	Choice or perspective of community	Impacts (what they observe)
<b>I. Product expected from the protected/ planted forest</b> 1) Fuel wood 2) Fodder 3) NTFPs 4) Small timber 5) Foliage 6) Others		
<b>II. Species choice for different products</b> 1) Fuel wood 2) NTFPs 3) Fodder 4) Poles & small timber 5) Timber 6) Others		
<b>III. Harvesting practices</b> 1) Pruning & lopping for firewood, fodder & foliage 2) Thinning for poles, small timber & agri Implements 3) Litter collection for manuring & cooking 4) Clear felling to get revenue		
<b>IV. Protection measures</b> 1) Initial years 2) Later years		

This information should be collected through group discussion with key stakeholders of the VFCs

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## Appendix • I

### Basic informational requirement for participatory silvicultural prescriptions

(Detailed basic information about all aspects of a plant's life history, ecological relationships, pollination and seed dispersal is critical for developing silvicultural prescriptions. These details were summarized below)

<p><b>1. Nomenclature knowledge</b> Genus, family Derivation of name Local and trade names</p> <p><b>2. General introduction</b> Number of genera, species, <i>planting</i> Natural range and artificial, extended distribution Special features process Major and minor uses and history of exploitation; access, tenure Market prices, royalties, fees</p> <p><b>3. Identification</b> Dendrologic features Form, height, girth, crown diameter Common associations</p> <p><b>4. Habitat and Site Data</b> Climate preference: rainfall, temperature, humidity Topography: elevation, landscape <i>and</i> Preference Soil preference, pH, texture, drainage, soil type, bedrock Tolerance of shade, drought, flood, salinity, frost, wind, fire, disease, pests Forest type, stage &amp; abundance Distribution &amp; companion species</p> <p><b>5. Life cycle characteristics</b> Phenology: conducive conditions, periodicity, pollination ecology, seed dispersal Silvical features: occurrence, abundance, degree of dominance, gregariousness Natural growth pattern: size, age at maturity, mortality, yield (all products) per tree/ha</p>	<p><b>6. Existing silvicultural</b></p> <p>a) <i>Natural regeneration</i> Site condition preferred relation to mother tree inducements</p> <p>b) <i>Assisted propagation &amp;</i>  Wildling collection Vegetative methods suitable Seed technology: collection, -ing, storage, viability, etc appropriate nursery techniques germination factors shade tolerance pest and pathogen problems age and time of planting site preparation transplanting techniques tending: weeding, thinning, pest control</p> <p>c) <i>Response to various treatments</i>  <i>refinement techniques: weeding, pruning, thinning, tillage, etc</i></p> <p>d) <i>Suitable silvicultural systems</i> e) <i>Growth and yield data</i> f) <i>Pests and pathogens</i> g) <i>Compatibility in mixed systems</i> h) <i>Coppicing ability</i></p> <p><b>7. Seed sources</b> Domestic Regional International</p> <p><b>8. Literature</b></p> <p><b>9. Institutions and scientists prominent in research and development of this species</b></p>
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Source: Wardsworth, 1997

## Appendix II

Some of the silvicultural models developed and adopted under Western Ghats Forestry and Environment Project, implemented by Karnataka Forest Department from 1993 to 2000 in Uttara Kannada and Shimoga forest circles, in which joint forest management programmes was first implemented in the Karnataka state

Model	Zone considered for model	Total area treated (ha)
<p>I Gap planting and enrichment of the natural forest, consists of three models</p> <p>1) Gap A model Canopy cover less than 0.2, assumes replanting with 750 trees/ha</p> <p>2) Gap B model Canopy cover between 0.2 and 0.4, assumes replanting with 500 trees/ha</p> <p>3) Gap C model (enrichment model) canopy cover between 0.4 and 0.6, aimed to increase the proportion of valuable species</p>	<p>Zone 2 - refereed to productive forest, with little human activity</p> <p>Zone 2 or Zone 3 - zone 3 refereed to productive forest, with more human activity</p> <p>Zone 1 or Zone 2 - zone 1 was for the ecologically sensitive, biodiversity - rich area (PA and sacred groves)</p>	28,358
<p>II Small scale industry and artisans plantations (bamboo and cane) Specified as bamboo model to restock and manage a bamboo forested area</p>	Zone 2 or Zone 3	6,015
<p>III Local needs multipurpose forestry management, consisting of four models</p> <p>1) Fuel wood model: with 50% of the area to be planted with fuel wood species which will be removed once the canopy cover is established</p> <p>2) Fodder model: with 50% of the area devoted to fodder</p> <p>3) Green manure model: with 50% of the area devoted to green manure</p> <p>4) Fruit/NTFPs model: with 40% of the area devoted to fruit and NTFPs</p>	Most of the plantations are raised in zone - 4 area, was the degraded fringe, the JFPM area as per the government order (less than 0.25 canopy)	22,225
Total area treated under different models		56,598

### Appendix III

Details regarding ecological zones considered, management plan adopted, land categories considered under Forestry & Environment Project for Eastern Plains (FEPEP) project in Karnataka. This project implemented by the Karnataka forest Department in eastern plain area from 1996 to 2002, in which joint forest management programme was implemented

Zone	Management objective	Treatment model code	Locality	Area (ha)
1) Archeologically important, ecologically sensitive wild life potential area	Ecological	01	Reserved forest	20,000
2) Degraded reserve forests	Ecological and economic	02	Degraded reserved forest	80,000
3) Degraded reserve forests	Economic and local needs	03, 04, 05, 06 & 07	Degraded reserve and minor forest	46,000
4) degraded reserve forest outside reserve forest a) on government lands	Economic and local needs	03, 04, 06, 07, 08, 09, 10, & 12	Govt lands such as C & D, gomal, Tank foreshore, road side, railway line and urban areas.	23,500
4) degraded reserve forest outside reserve forest b) on institutional lands	Economic and local needs	11	Institution lands	1000
5) Private farm lands	Fruit and MFP yielding	13 a	Private farm lands	1,00,000 or 1 crore seedlings
	Fuel, fodder, green manure, small timber and bamboo	13 b	Private farm lands	2,00,000 or 20 crore seedlings

Note: name of the models adopted under FEPEP are:

- 01: Management of ecologically sensitive, archaeologically important and wildlife potential areas
- 02: Natural regeneration (ANR & gap planting)
- 03: Trench mound cum pit plantation
- 04: Mechanized plantation
- 05: Irrigated Bamboo plantation
- 06: Irrigated Bamboo and teak plantations.
- 07: Irrigated Fruit orchard
- 08: Foreshore plantations.
- 09: Strip plantation (Road side, Railway line side and canal sides)
- 10: Urban forestry
- 11: Afforestation in Institutional land
- 12: Development of tanks (man made lakes) parks, and recreation spots in urban areas
- 13a: Farm forestry : Fruit and MFP yielding
- 13b: Farm forestry: Fuel, fodder, manure, small timber and bamboo

**Appendix V**

Some of the silvicultural interventions listed under model-3 (Trench mound cum pit plantation) developed and adopted under FEPEP project in Karnataka state

Model 03	Trench Mound cum pit plantation
Location	All the 17 districts of the state
Type	Better soil
Design	Permanent, long rotation plants at 6mx8m in pits Fuel, fodder species in trenches of size 4m X 0.45mx0.45m. plant density – 1100/ha
Species	In pits – Ficus spp, Tamarind, Neem, Honge, Albizzias, Bamboo, Terminalia. In trenches – Hardwickia, Casuarina, Acacia auriculiformis, Acacia nilotica, Sandal etc.,
Land preparation	Pits of size (0.60)3 at 12mx8x plant to plant in a row 12m; 8m between rows – 100 pits/ha.
Protection	Running trench of 60cmx 40cm along boundary, live hedge of agave. However, the protection issues would be decided after discussing with VFCs and their commitment towards protection. One casual labour for 20 ha.
Planting technique	Well-developed tall seedlings (1 meter in height) raised in polythene bags of size 8" x 12" would be planted 1 pits, 3 plants/trench
Upkeep & Maintenance	One casual labour for 20 ha to take care of upkeep and maintenance. Brushwood fencing by watcher only.
Tending operation	
1 <sup>st</sup> year	One weeding and soil working in trenches, scrapping of grass and hoeing around pits
2 <sup>nd</sup> year	One weeding, one soil working, one scrapping around pits.
Fertilizer	FYM to only miscellaneous plants. One quintal for 40 plants
Harvesting	1) Grasses will be collected from 3 <sup>rd</sup> to 7 <sup>th</sup> year till canopy closes. 2) Fruits will be harvested after 10 <sup>th</sup> year 3) timber and sandal will be harvested after 30 years. 4) Tree fodder will be available after 15 years. 5) Fuel will be harvested by staggering it at 6 <sup>th</sup> , 8 <sup>th</sup> , 10 <sup>th</sup> , 15 <sup>th</sup> , and 20 <sup>th</sup> year.