CHAPTER 3

Impact of State Forestry & Settlement on Forest CPRs

3.1 Approaches in Forestry

Forestry practices evolved in the mid-eighteenth century Germany as a response to growing concern for the impending "wood famine". Forestry has been defined as "the scientific management of forests for the continuous production of goods and services" (Baker[i], 1950 *cf.* Perry[ii], 1998). There are two approaches in forestry: the first refers to "eco-system" based forestry which has a strong ethical foundation, the second approach is generally known as "intensive" forestry. The latter approach developed in Germany and is more like modern agriculture that identifies with individual entity rather than with communities and ecosystems (*ibid*).

Influenced by Adam Smith's classical liberal economic theory, the German foresters formulated an economic approach that came to be known as "soil rent theory". This theory held the view that interest should be earned on land, timber capital, and also for silvicultural expenses. The theory provided the much needed planning tool for calculating the crop with the highest monetary return and the highest financial rotation with the highest rate of interest on a given forest land. Thus pursuing the objective of profit maximisation in forestry no longer faced the ethical dilemma as it was in conformity with the liberal economic principles (Plochmann[iii], 1989). To ensure a high rate of return in forest when interest is charged on land and other capital assets the optimal length of the rotation period needs to be made shorter. Practices such as this resulted in clear-felling of natural vegetation to be replaced by fast-growing highly valued monocultural crop. In Europe, hardwood native species were supplanted mostly by Norway spruce and Scot pine, and in India it was *dhupi* (*Cryptomeria Japonica*).

Over the years, popularly practiced intensive forestry came to be introduced in large number of countries primarily to meet the rising demands of growing economies. To cater to this demand for forest products, realisation of the full potential of the land under forests is essential which is possible only when:

(i) superior quality seedlings are planted, while keeping the land free of other species that may adversely affect the growth of trees; increasing the soil quality by appropriate scientific prescription, and

(ii) subsequently harvesting the crop when the rate of growth of the tree or profit calculated for a series of rotation is maximised.

This required highly specialised knowledge of forests science and hence intensive forestry came to be known as "scientific forestry". It may best be described as an economic model of forestry that uses the service of scientific knowledge. On the contrary, intensive forestry never evolved through scientific analysis of alternative hypothesis rather its genesis laid in uncritical acceptance of the untested hypothesis that maximizing economic efficiency in the short term was the path to maximizing social and economic benefits into the future (Perry, 1998).

However, it will suffice to mention that the main point of contention between the intensive forestry approach and other forestry approaches like the "forest rent" doctrine which is better known in resource economic literature as the Maximum Sustainable Yield (MSY) theory, is identification of the *optimal rotation period.* Unlike the intensive forestry theory, the forest rent theory considers interest payment on land and capital assets to be unjust.

3.2 Rent Capture and its Implication in Forestry Practises

Originally the term 'rent' has been closely associated with land only. But in a broader perspective, the definition of rent has been expanded to include all natural capital. The credit of the concept of rent goes to Ricardo (1817) and Smith (1776) and is referred to as the "Ricardian rent". It implies an additional payment to intra-marginal land due to the differential quality of the land (difference in fertility, better weather etc.). Others like Von Thuenen (1840) considers rent to be solely determined by the location of the land which results in a difference in transport costs of produce brought to the market. He proposes a model to explain the land–use patterns that evolve around a market where land rents diminishes continuously as cost of transport to the market increases. However, in forestry literature two concepts of rents are generally used, namely, *stock* rent and *land productivity* rent (Luckert and Bernard[iv], 1993). They do not represent any new concept of rent but is related to special type of circumstances in forest. The stock rent is the rent that accrues to the old-growth timber and does not represent any previous investment, and so the entire rent is the resource rent. Land productivity rent on the other hand is a combination of resource rents and quasi-rents. Once land is assigned for timber production, the rotation is chosen to maximise the present value[v] of all future harvests. If returns from harvest exceed cost then it generates streams of rents over time (Kooten and Bute[vi], 2000). The capitalised value of this rent is vested with the owner of trees who may also happen to be the owner of land.

Capture of economic rents through nationalisation of resources has been the cornerstone of public policy in economics. Walras therefore argued for nationalisation of land and resources, but when it was not possible to do so, he favoured a tax on rents (*ibid*; p. 66). The goal of rent capture should be achieved without disturbing the economic efficiency of the resource use. In practice, forestry decisions like length rotation period, harvesting and management decisions are not immune to methods of rent capture.

3.3 State Ownership of Forestlands and its Implications for Resource Use

As metioned inthe earlier chapter the nature of ownership of forestlands and the corresponding forest policy has a profound effect on providing environmental amenities related to the non-timber and non-use values of the forests. State ownership of forestland has assumed importance due to the following three reasons:

(i) It is a measure of the degree of control exercised by the government on forestry.

(ii) It determines to some extent the distribution of political power,

(iii) It affects the forest productivity and thus has a bearing on forest policies.

When the ownership of the forest is vested with the state it is expected that priority shall also be given to non-timber values of forest production. If non-timber values are also incorporated to the decision model then what is its implication on forestry? To answer this question we will have to first find what is the optimal rotation period? Optimal rotation per se depends on the criterion chosen for the forestry operations.

From Gaffney (1957), to Samuelson (1976) and later Johansson & Löfgren (1985) there was unanimity as regards to the supremacy of Faustmann's[vii] (1849) formula over the MSY or "forest rent" approach. However, the superiority of the Faustamnn's approach has been seriously challenged by scholars like Judd[viii] (1999). The MSY criterion may result in minor economic loss as compared to the Faustamann's criterion, but from the practical point of view MSY is a better option. Even in Germany where the land rent theory originated, practical forestry now is more guided by silviculture and ecological principle that aim to achieve sustainability instead of economic efficiency (Möhring[ix], 2001).

3.4. MSY and the Optimal Rotation

Generally biologists would prefer to identify the maximum sustainable yield (MSY) to determine the optimal harvest age of trees. MSY is a method of forest management that corresponds to a particular rotation age of trees that ensure maximum possible annual output which can be sustained over time. The interval from planting of seedlings to harvesting of trees is known as the "rotation". Therefore, the amount of timber extracted from forests annually without diminishing the future harvest must be equal to the Mean Annual Increment in timber (MAI). We may begin by enquiring about what would be the optimal rotation age of trees (t^*) when, price of timber remains constant over time and the objective of the forester is to maximise the timber value.

To find solution to the above problem we consider that the growth in timber for the time interval (t) to be $v(t)$. Here $v(t)$ is the total production function and the general arguments of the function, ie, labour and capital has been replaced by (t). So MAI can be expressed as $v(t)/t$, and the Current Annual Increment (CAI[x]) which is defined as the change in volume each year is given as $v'(t)$. Therefore, the objective of the forester has been to maximise the MAI of the trees. If the forest has number of even aged cohorts that equals to their rotation age, then, harvesting a stand each year and replanting that stand will give us the MSY. So our problem is to calculate the time of harvest (t) that will maximise the harvest volume over time.

$$maximise\ W = \frac{v(t)}{t} \dots\dots\dots\dots (3.1)$$

Taking derivative with respect to (T)time to harvest trees we get;

$$\frac{dW}{dT} = \frac{v'(T)}{T} - \frac{v(T)}{T^2} = 0 \dots\dots\dots (3.2)$$

$$or, \frac{v(T)}{T} = v'(T) \dots\dots\dots\dots\dots\dots. (3.3)$$

It is well known that marginal product function intersects the average product function from above where average product is maximum. A common forest management approach to determine the harvest age of trees (t_m) where the MAI is maximum. Maximum MAI is also known as the Culmination of the MAI or in short as CMAI. This is shown with the help of figure 3.1 as given below:

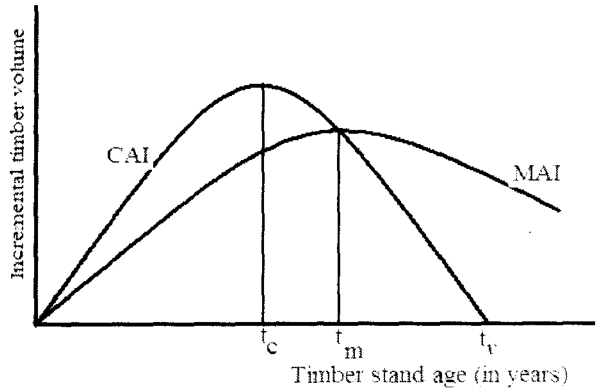

Figure 3.1 Relation between CAI, MAI, and MSY harvesting age

Rearranging equation (3.3) gives us the MSY rotation age;

$$\frac{v'(t)}{v(t_m)} = \frac{1}{t_m} \dots\dots\dots (3.4)$$

where the LHS represents the rate of growth of timber stand and t_c stands for maximum current annual increment of timber and t_m represent the MSY rotation age.

3.4.1 Land Rent Theory of Forestry and Optimal Rotation

The MSY approach to forestry has been criticised primarily because of the fact that it does not take into consideration the financial aspect of forestry. The main focus of the MSY approach has been maximisation of total production. The financial or economic approach on the other hand selects the optimum rotation age for a forest stand which gives the maximum value from harvesting the trees. The later approach is not as simple as it appears, but rather depends on exogenous factors like growth rate of trees, the output that they produce and also on the discount rate (r); besides it also depends on cost of planting and the price of cut timber.

Here price means the "stumpage value" of the trees, i.e., receipts after sell of timber of a tree less the cost of harvesting, sawing and transporting it to the point of sale. So the economic approach is simply a problem maximisation of the present value of the streams of stumpage value in future. Before proceeding any further a few issues need elaboration that are peculiar to forestry economics. First, the rate of growth of the tree follows a logistic function. Initially the growth rate is high but later it slows down and ultimately becomes zero and then negative due to decay and finally death. This is shown by the logistic function as shown in figure 3.2 below:

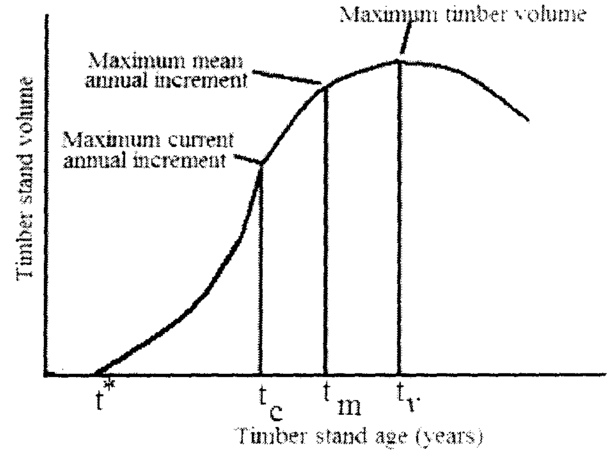

Figure 3.2. Relationship between volume and age of a timber stand.

Second, timber can be sold only after trees attain maturity at a minimum age t*. So far we have not said anything that would demand a departure from the MSY approach. The next point considered in economic approach makes forestry a serious economic issue under the capital theoretic model. If we keep trees on land it involves some cost. Now, as long as this cost is less than the receipts, it adds to profit but a point may be reached when cost exceeds that of receipts and it is no longer profitable to keep trees on land. The cost of keeping the forest not only includes regular management costs such as thinning, cutting, monitoring etc., but involves two more significant costs as mentioned below (Howe[xi], 1979; p.226):

(i) If the cutting of trees is deferred by one period it means that the interest that could be earned from the sale proceeds is lost (earning from alternative use of fund i.e. opportunity cost of capital invested is lost).

(ii) Also when there is a standing forest on a piece of land, it means that the same land cannot be put into any other alternative use and hence the opportunity cost of capital tied up with the land is foregone.

The standing tree (stock of trees) is thus a capital and it will be kept in a particular use as long as it produces a satisfactory rate of return. The second item of the cost as mentioned above needs further discussion. As mentioned, the land can be put into alternative use other than forest and thus involves an opportunity cost. Even when the land is earmarked for forestry only as in case of state forest, the cost would be equivalent to the annual rent that such a piece of land would fetch, had the land been cleared and planted. In forestry literature this is known as "site expectation value" or "soil expectation value".

It will thus be profitable to keep the trees one more additional year if the annual increase in the stumpage value exceeds the interest foregone on the stumpage value plus the rental value of the newly planted land (Howe, 1979; p. 227).

3.4.2 Optimal Rotation Age under Single Harvest: Fisher's Version

If the objective of forest operations is just to maximise the net benefit from a one-time harvest of the forest without any consideration of the future harvests then the optimisation problem is just a maximisation problem in (t).

$$maximise_t \; w = (p - c)v(t)e^{-rt} \;\ldots\ldots\ldots (3.5)$$

where p is constant real price of timber per unit, and c is the cost of harvest and is assumed to be constant. So equation (3.5) gives the net discounted present value of the timber harvested at period (t).

Then the optimal harvest age T_f corresponding to the maximum net present value can be identified by differentiating with respect to t by the product rule and setting it equal to zero we get:

$$maximise_t \; w = pv(t)e^{-rt} - cv(t)e^{-rt}$$

$$\frac{dw}{dT} = pv'(T)e^{-rt} - (r)pv(T)e^{-rt} - cv'(T)e^{-rt} + c(r)v(T)e^{-rt} = 0$$

$$(p - c)v'(T) = (p - c)(r)v(T)$$

$$\frac{(p - c)v'(T)}{(p - c)v(T)} = r$$

$$\frac{v'(T)}{v(T)} = r$$

$$or, \qquad \frac{v'(T_f)}{v(T_f)} = r \;\ldots\ldots\ldots (3.6)$$

where T_f is the age when they are clear felled[xii] and the subscript f denotes Fisher's rotation age. Condition (3.6) shows that as long as the rate of growth of trees (growth in value) exceeds the rate of increase in alternative investments (represented by the factor r), it is profitable to keep the stand. The trees should be harvested when the rate of growth of timber is just equal to the rate of discount.

Both the MSY and Fisher's rotation age determined by the conditions (3.4) and (3.6) respectively are independent of the price. We may without loss of generality assume that the two conditions hold true when the price is unity. Price is an important decision variable at least for one reason: if it is low as a result of which the net revenue from harvesting becomes negative then it is better not to harvest the stand regardless of the rate of growth of the stand (Kooten and Bulte, 2000).

3.4.3 Optimal Rotation Age under Single Stand Continuous Forestry: The Faustmann Principle

If land is assigned to forestry only, having no potential for non-timber source of revenue and all speculative factors do not enter into our calculation then the optimal rotation age is different from what we have derived before. It was Martin Faustamann (1849) who identified this problem and correctly determined the age of harvest to maximise the net present value of a series of future harvest of timber stand on the same site.

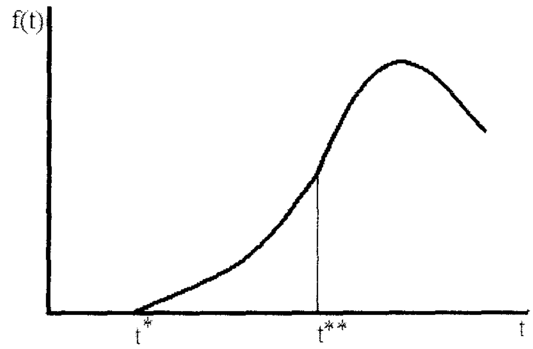

Figure 3.3 Relation between tree growth and age of tree

Here the decision is to cut the trees at a point of time where the present value of returns from felling operations can be maximised. The decision variable here is the *time allowed to lapse* between planting & felling and replantation. The duration of this delay between planting and felling of trees sets forestry management apart as a distinct problem within capital theory.

Profit depends on the volume of timber (the implicit assumption is that the timber price remains constant over time). Timber volume increases initially upto t^{**} years and beyond t^{**} the rate of growth of timber volume declines. So for $t < t^{**}, v'(t) < 0$ and for $t > t^{**}, v''(t) < 0$. If p is a constant real price of timber per unit of volume net of harvest costs, planting costs remain a constant c. Forest revenue is $pV(t)$ and the current value of profit for a single rotation is $pv(T) - c$. If we now consider that plantation cost is incurred at the beginning of the rotation and revenue is received at a deferred date at the time of harvest, the term $pv(T) - c$ is logically inconsistent. Therefore, we have to discount the current revenue realisable at T at a rate r to find the present value of revenue i.e. $e^{-rT}pv(T)$. So the net present value of the profit (Π) is;

$$\Pi = e^{-rT}pv(T) - c \dots\dots\dots (3.7)$$

If we now differentiate the equation (1) with respect to T by applying the product rule and maximising, we obtain:

$$\frac{pv'(T)}{pv(T)} = r \dots\dots\dots (3.8)$$

Here $pv'(T)$ is the return and $pv(T)$ represents the capital tied up in the forest. This shows that felling should be delayed until the return on the forest stand, the RHS of (3.8) equals r. Equation (3.8) is the solution for the single-period forest rotation problem. Now if it is possible to replant on the same land, as in the case of forest land, a set of rotations will take place at $t_1, t_2, \dots, t_\infty$ when the forest is clear-felled and replanted again. Commencing from planting on clear land at $t = 0$, the objective of the forester is then to maximise

$$Z = -c + e^{-rt_1}[pv(t_1) - c] + e^{-rt_2}[pv(t_2) - c] + \dots + e^{-rt_\infty}[pv(t_\infty) - c] \dots\dots\dots (3.9)$$

Now if we consider the fact that for each period, $t_k = kT$ where, $k = 1,2, \dots, \infty$ in equation (3.9) by the sum of a convergent geometric progression, simplifies to

$$Z = \lim_{n \to \infty} \sum_{k=1}^{\infty} e^{-r_k T}[pv(t_1) - c] - c = \frac{pv(T) - c}{e^{rT} - 1} - c \dots\dots\dots (3.10)$$

Differentiating with respect to T and equating to zero, we get

$$\frac{pv'(T)}{pv(T) - c} = \frac{r}{1 - e^{-rT}} \dots\dots\dots\dots\dots\dots\dots (3.11)$$

where, Z is the *site expectation value* and T is the age of the trees when they should be clear-felled. [Here I would like to mention that that the term clear-felled also has an economic interpretation. A plantation of even aged stumpage can be cheaper when clear-felled compared to other methods of felling, like selective felling, improvement felling etc. Selective felling means that in a mixed forest (the mix may be due to uneven age of the trees also) only the matured valuable species are felled. In practice what we find is that in order to remove a valuable tree number of other species are destroyed to make way for the selected tree to be removed easily.]

Faustmann's formula can be readily interpreted in the form:

$$p v'(T) = r(pv(T) - c) + r\frac{(pv(T) - c)}{e^{rT} - 1} \dots\dots\dots\dots\dots\dots (3.12)$$

In equilibrium, the rate of return on the forest stand, $p'v(T)$, should equal to the interest that the net value of the forest generates if it were invested, plus the rate of return of investing the present value of all future rotations at the rate of interest r. The term $\frac{(pv(T)-c)}{e^{rt}-1}$ is the *site* value, and the second RHS term in equation (3.12) is thus the opportunity cost of investment tied up in the trees and the site.

Relaxing the earlier assumption, if the price of timber increases due to increased demand for timber, a producer would naturally like to increase timber supply in order to take advantage of high prices on the timber market. But the supply of timber cannot be increased at will; its supply depends upon decisions taken by previous generations. The natural tendency under this circumstance would be to harvest more now and keep less for future, implying progressive reduction in the length of the rotation period.

The Faustmann relation can be subjected to comparative static analysis. To do this, we trace the effect of changes in r, c and p on the optimal rotation period. If discount rate r is increased (this may happen if under the time-preferences of the forester, the present period is preferred over the current period), the term $\left(\frac{r}{1-e^{-rT}}\right)$ [xiii] is strictly increasing. As $\frac{pv'(T)}{pv(T)-c}$ is strictly decreasing in T, by assumption it means that the length of the optimal rotation is reduced. The effect of changes in timber prices and harvest & planting costs can be considered jointly, as the cost-price ratio. So we rewrite equation (3.11) as $\frac{v'(T)}{\{v(T)-{}^{c}/_{p}\}}$.

Provided all other factors remain the same, the length of the rotation increases as replanting cost increases. Why is this so? This is because as cost increase it reduces the value of forest and thus raises the rate of return on the existing stand. If, on the other hand, timber prices increase due to any change in demand and supply parameters, this would have an effect opposite to that of a change in costs: that is, while a price increase would reduce the length of the optimal rotation, a price decrease would extend it.

3.4.4 Implication of Faustmann's Rotation Age for State Forestry

As long as commercial interest gets priority in State forest management, the maximisation of revenue from forest becomes the desired objective. To realise the maximum revenue as identified by the Faustmann's formula it is assumed that the ownership rights are well defined they are enforceable with zero transaction costs. In other words, it means that there is no loss of the asset due to any leakage caused by illegal extraction or any random factors.

Therefore, the success of commercial forestry under the guise of "scientific forestry" requires a well planned out procedure and steps to ensure that the revenue is maximised. For proper planning it is essential that adequate knowledge about the forest stand is available, a dedicated pool of experts having specialised knowledge about forestry, well defined property rights to safeguard the flow of income from the asset.

The progress of State Forestry in India bears testimony to the points mentioned above. In brief scientific forestry in India can be briefly summarised as follows:

(i) First step for introducing scientific forestry requires an in-depth study of the inventory of stock [e.g. Brandis (1873), Ribbentop (1900), Troup (1940) and others undertook extensive field surveys to take stock of the forest resources in the Indian sub-continent].

(ii) Second step is to establish a separate administrative department for forest management [e.g. Forest Department].

(iii) Third step is the creation of stringent legal codes [e.g. various Indian Forest Acts].

(iv) Finally, it includes a body of scientific practices [like silvicultural practices, creation of botanical gardens to help experiment with exotic species which are quick yielding and will ensure a higher return to the investment and watershed management]

Forest Service came into existence based purely on commercial consideration (Stebbing, 1926). The Forest Survey of India (FSI) was earlier known as Pre-Investment Survey or PIS. In many provinces in India and in other colonies the Forest Service was placed immediately under the Revenue Department, which clearly shows the primary role of forestry as generation of revenue for the exchequer (Sivaramakrishnan, 1995).

Forest in India was a source of huge surplus. By 1920 net revenues from the state forests had increased fourfold to 21 million rupees from the 5.5 million rupees of 1880's. The average profit for the quinquennial period 1864-69 to 1924-29 increased fifteen folds. The average net surplus for the period 1924-29 was £ 1,800,000. Almost 50% of this surplus originated from Burma. But, excessive concern for revenue had in fact been detrimental to the progress of forestry and financial loss in periods to follow (Stebbing, 1922).

Colonial forest policy in India might be said to have evolved through three distinct phases after the state takeover of forests in British India under Lord Canning through the first Indian Forest Act of 1865 [IFA 1865] and its subsequent legislative refinements in 1878, 1894 and 1927. Colonisation of forest was done under the pretext of stopping loss of forests cover due to mismanagement of the local population, for soil conservation and need to preserve for posterity [this last argument meant that the imperial power considered forests to be an asset which could give return in perpetuity]. But in guise of this argument lay the foundation of ecological imperialism. For example in the Himalayan region, sal *(shorea robusta)* and deodar *(cedrus deodara)* were first exploited for railways and also for construction purposes. Latter with development of technology it was chir pine (*pinus longifolia*) that was mercilessly tapped for the chemical industry. So the extensive pine forest of Garhwal and Kumaon was reserved much latter in 1912.

3.5 Issues in Forest Valuation

Forests represent an unusual investment problem where a long time lag exists between the decision to invest in planting seedlings and the decision to harvest. So forestry requires consideration of two simultaneous decisions. First is the decision to invest by planting, and second to disinvest by felling mature trees. But, the second decision depends on investment decisions taken some generations earlier. The value of the forest not only includes the part of produce that is brought to market but also includes the part of the produce that is not transacted through market. While the FD seeks to maximise the return on investment, the local communities on the other hand seek to ensure the uninterrupted flow of those outputs which have direct bearing on their livelihood needs. This difference in state and local community valuation of the natural resource in general and forest in particular set natural resource economics aside from other branches of economics.

Besides a sustainable natural resource management system requires that the values derived from the natural resources not only meet the present period demand but also ensures that the long term development goals are ensured. As mentioned before, market failure makes it impossible to guarantee an efficient intergenerational allocation of resources. It has therefore been suggested that to overcome the problem of market failure involving two generations or more, all transactions of forest produce must be priced through appropriate valuing technique and also making all stake holders including the local community accountable for their actions (Mathur and Sachdeva[xiv], 2003). Intergenerational resource allocation problem involving decision making in prices cannot be satisfactorily studied under a static economic framework.

Measuring the value of benefit that flows from the forest is easier said than done. The nature of benefit that flow from forest located in different agro-climatic regions are not easily comparable, also the benefit from natural forest is different from man-made forest. Moreover, with increase in scientific knowledge it is now well known that the benefit from forest is just not limited to timber and NTFPs. Another aspect in forest benefit valuation is the property right governing the use of the forests. Thus, variation in property right structure demands alternative methods to value the forests.

Closely connected with the concept of market failure is the presence of externality which results in a gross under-valuation of the benefits from forests. Principle of State forestry has evolved considering only the value of timber which is far less than the total economic value of the (TEV) of the forests. Such under-valuation results in smaller allocation from the state exchequer for the maintenance of the forest than what would have otherwise been allocated if TEV of forest was the basis of the forestry principle (Mathur and Sachdeva, 2003). The detailed on various methods of valuation of forests has been given in Table 1.1 of chapter 1.

3.6 Forestry beyond Faustmann

Faustmann defined optimal age at which to harvest the trees at that point of time when the net cumulated discounted value of an infinite sequence of harvests of even aged tree on a given tract of land is maximum. Following this definition standard State forestry prescription was clear felling of the entire cohort and such practices gave rise to the concept of "synchronised" forest (Salo and Tahvonen[xv], 2002). Under "synchronised" forestry system the forest is worked in Circles. Each Circle is sub-divided into Periodic blocks comprising number of compartments which is fixed according to the rotation age prescribed for the cohort. Mitra and Wan[xvi] (1985) showed that both under discrete or continuous time the optimal solution is likely to converge with the Faustmann's periodic solution. Heaps[xvii] (1984) on the other hand used a convex harvesting average cost function, but failed to show that long-run equilibrium coincides with Faustmann's solution. However, the major limitation of these studies was that they considered the cost of planting and harvesting as zero.

In Faustmann's model the price of timber is assumed to be given and constant. Also it considers that the forest produces a single homogeneous output, i.e., timber. These assumptions of the model are almost similar to the assumptions of a competitive market. What happens to the rotation age if the assumptions are relaxed? In other words, will there be any change in the rotation period under different market structures. What this means in practise is whether competitive or monopoly structure of forest-holding would deplete the forest at an accelerated pace. Crabbe and Long[xviii] (1989) concluded that, with a fixed forest area, a uniform forest and with a constant regeneration cost, both monopoly and competitive firms follow an identical Faustmann rotation and have the same output and prices. This conclusion is based on a result proved earlier by Mitra and Wan[xix] (1985).

It is not necessary that the forester may always try to attain optimality based on Faustmann's prescription. In practise a forester may apply various felling methods like selective felling, improvement felling etc. Lands cleared of forest not only has a poor visual impact, they also account for loss of top soil, loss of water retaining capacity of soil etc. Instead of single rotation forestry, state forestry came to adopt double rotation forestry. Under double rotation each forest tract contains two uneven aged cohorts. Selective felling of the mature trees serves the following purposes:

(i) the remaining trees help to stimulate growth of new trees,

(ii) it helps to reduce cost of plantation through natural regeneration,

(iii) it improves the genetic stock of plants,

(iv) it increases the amenity value, and also

(v) it increases the social acceptability of timber exploitation.

The preference for selective felling by the managers of public forests is primarily because it reduces the cost of harvest and thus harvesting cost can be incurred more often. As a result under the selective felling method the rotation age gets shorter as compared with clear felling. Reduction in rotation age has been a conscious policy of the State forestry because it makes possible to ensure adequate supply of timber at regular interval.

3.6.1 Non-Timber Benefits and Forestry: The Hartman's Optimal Rotation Age

The argument in favour of State ownership of forests as mentioned in the earlier chapter was to manage a public good for the welfare of the people. However, it is clear from our above discussion that State forestry has pursued a narrow objective and was exclusively directed towards maximisation of revenue from timber. Such optimal value founded on the basis of Faustmanian principle does not ensure maximisation of the flow of benefits from forests as it does not include value of non-timber benefits. However, if such external values are taken into account then there will be modification in the optimal solution of the commercial State forestry. The major difference between the commercial forestry and social benefit maximising forestry is that, in case of the former the benefit accrues only at the time of harvest, while in case of the latter the benefits accrue continuously (Kooten and Bulte, 2000; p. 391).

There is no well defined relationship between the value of non-timber benefits and the age of the stock. The value of non-timber benefits $\{g(t)\}$ like that of watershed function, scenic amenities, fruits, flowers, mushrooms etc., is highest when the forest is well-established and lowest when the forest is clear-felled. On the other hand the grazing benefit from a forests land decreases as the age of the tree increases. If we include nonmarket value of external or amenity benefit then the solution to the maximisation problem is given by Hartman's[xx] (1976) rotation age (Hanley[xxi] *et. al.*, 1997).

To estimate the optimal rotation age which is inclusive of the NTFP benefits the value of the forest over a single rotation in an open land is given as:

$$b_1 = \int_0^T g(t)e^{-rt}\,dt + pv(T)e^{-rT} - c \,\ldots\ldots\ldots (3.13)$$

where $g(t)$ is the flow of non-timber values from the forest as a function of its age. As usual, $pv(T)$ is the timber value at the end of the rotation net of harvesting costs and c is the cost of the planting. If we now assume further that the forest stand is initially bare and is felled at regular intervals, then the value of the forest over an infinite time horizon would be

$$b_{\infty} = b_1 + e^{-rT}b_2 + e^{-r^2T}b_3 + e^{-r^3T}b_4 + \dots\dots\dots (3.14)$$

Our problem is to maximise the value of (3.14), and to do that the forester has to find the rotation length T, for which the function is maximised. By the same argument as in (3.9), we get

$$M = maximise_T \frac{1}{1-e^{-rT}}\left[\int_0^T g(T)e^{-rT}\,dt + pv(T)e^{-rT} - c\right] \dots\dots\dots (3.15)$$

Differentiating and equating to zero yields, after some rearranging,

$$pv'(T) - rpv(T) + g(T) - rM = 0 \dots\dots\dots (3.16)$$

where M is the value of the site when the socially optimal rotation is followed. Let us compare (3.16) with the original Faustmnann's formula by putting (3.9) into same format:

$$pv'(T) - rpv(T) - rM = 0 \dots\dots\dots (3.17)$$

If $g(T) = 0$, then the forest follows a Faustmannian rotation. The increase in benefit for any delay in harvesting of the trees by a further infinitesimal increment in time not only includes increased volume of timber but also the flow of non-timber outputs $g(T)$. But this delay also involves additional cost elements that include two aspects, namely (i) interest has to be foregone which otherwise would have accrued by selling timber in the current cycle, which is given as $rpv(T)$, and (ii) the loss of interest from delaying timber and non-timber benefits for all future cycles, rM.

The flow of non-timber values $g(t)$ will vary from forest to forest. Also it is not always that this value increases monotonically with increase in the age of the stand. If $g(t)$ increases with age and is sufficiently high then it may be optimal never to harvest. If on the other hand, $g(t)$ is constant over time then it would be optimal to pursue the Faustmann rotation. However, when the $g(t)$ is high initially and later decreases as in case of grazing benefits; Swallow[xxii] *et. al.* (1990) has shown that benefits from grazing can be expressed as the following function:

$$g(t) = \beta_0 te^{-\beta_1 t} \dots\dots\dots\dots (3.18)$$

The value of this function is maximized by differentiating the function (3.18) with respect to t and setting it equal to zero; the maximum value is found at $T = \beta_1$. Their estimated function is shown below.

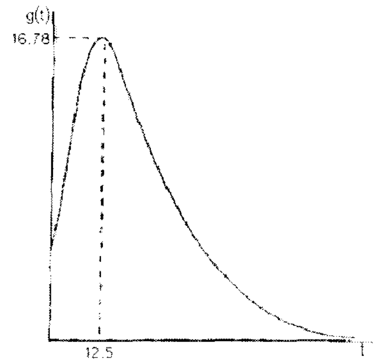

Figure 3.4 Grazing benefit function

The Hartman solution to the rotation age requires that the age of harvest should be chosen at the point where marginal present value of delaying harvest or marginal benefit of delay [MBD $= g(T) + pv'(T)$], equals the marginal opportunity cost of delay [MOC $= rpv(T) + rM$]. Equality between MBD and MOC ensures fulfilment of first-order condition for maximisation. However, for the second-order condition to be satisfied it is essential that the present value function is not flawed by presence of non-convexity[xxiii]. In the presence of non-convexity the myopic policy maker may fail to attain the global optimum.

3.7 NTFP and Forestry

The major drawback of State forestry in India is that it has been traditionally identified with either ecological stability or as a source of industrial raw material, and not with the subsistence needs of the rural poor. As opposed to timber, which is produced only after the tree has been removed; NTFP products like fuelwood, fodder, fruits, nuts, flowers, poles etc. are products of the living tree that can be harvested sustainably without any loss of tree cover. The statutory provision associated with NTFPs since the Forest Act 1865 has been rather anti-poor and discourages local value addition. In rural region of a developing country the insurance market is generally incomplete and people therefore depend on traditional insurance system to mitigate any risk from fluctuations in income. Traditionally, insurance has been provided to rural community in times of poor harvests by natural resources held in common. Thus the dependence of poor community on forest for insurance use affects their decisions related to the land-use choice (Delacote[xxiv], 2009).

For simplicity if we consider that land can be put to two alternative use, either forestry or agriculture. Then land-use decision can be considered if not in a strict sense to approximate a zero-sum game at least for two reasons. First, any expansion of agriculture frontier is possible only through deforestation of the land. Second, while expansion in agriculture is a way to reduce poverty but has corresponding risks, NTFP extraction on the other hand has a low potentiality for poverty alleviation but plays an important means to reduce risk. As a consequence trade-off exists between forest and agriculture. The opportunity costs of forest lands compared with its alternative uses thus play an important role in determining how the land shall be put to use. Any increase in profitability of agriculture will bring more forest lands under agriculture. Also expansion in agricultural land may be a result of the conscious policy of the state determined by revenue considerations of the state. This is exactly what has happened during the colonial rule in India. Large areas of forest lands were diverted for purposes other than forests in North Bengal. However, by 1970s the government gave precedence to the environmental role of the forests and declared that 33% of the total land shall be under forest.

3.8 Land-Use Decision: Forests Agriculture Trade-off

Let us take the total land of the country to be broadly classified as land that can be put to two alternative uses i.e. forests and agriculture (L_1) and the remaining area as those which do not have any potentiality for forests or agriculture (L_2) like riverbeds, wetlands, glaciers, alpine regions, etc. So total land (L) is given as:

$$L = L_1 + L_2 \dots\dots\dots (3.19)$$

L_1 can be further divided into three categories of land given as:

$$L_1 = L_f + L_a + L_d \dots\dots\dots (3.20)$$

where, L_f is the area under forests, L_a is the area under agriculture which also includes human settlement and L_d is the degraded land which is not included under L_f and L_a. There is no trade-off between L_1 and L_2, and therefore we consider L_1 to be an invariant. So we can write equation (3.20) as:

$$\bar{L}_1 = L_f + L_a + L_d \dots\dots\dots (3.21)$$

But change in land-use due to change in opportunity cost or deliberate policy decisions shall alter the proportion of area under L_f, L_a and L_d dynamically over time. Differentiating (3.21) with respect to time (t) and simplifying, we get:

$$-\frac{L_f}{dt} = \frac{dL_a}{dt} + \frac{dL_d}{dt} \dots\dots\dots (3.22)$$

Equation (3.22) shows that the rate of deforestation is equal to the rate of transfer of land for agricultural plus the rate of land being degraded. Loss of forests land due to expansion in area under agriculture can be stabilised either through introduction of technology that has direct impact on agricultural productivity (intensive agricultural technology) or through conscious state policy. However, loss of forests land due to degradation is a matter of serious concern in India. Degradation of forests land has largely been accounted for excessive forest use which resulted in loss of top soil, loss of biological diversity etc.

In countries like India where government plays an important role in forestry, any large scale deforestation is said to have been caused deliberately or inadvertently by state policies (Repetto and Gillis[XXV], 1988; Panayotou[XXVI], 1993). Inappropriate government policy and the corresponding waste of valuable assets results in a loss of welfare, an event generally identified with government failure in natural resource economics literature. Government failure in forestry happens when:

(a) The state overvalues forest for timber and undervalues NTFPs.

(b) Resource prices are deliberately kept low to encourage industrial and agricultural activity, and economic growth.

(c) The role of minor forest products are systematically ignored because the majority economic benefits from them accrue to the powerless social group.

Forest policy pronouncements shift costs and benefits accruing from forest, and this in turn shapes and moulds state forestry practices. *Changes in state forestry that adversely affects the dependent communities give rise to conflict in forest management.* Wide ranging measures are suggested to resolve this conflict in forest management. On the one hand it may include minor changes in management criteria, to rather radical prescription by Milton Friedman that state should not manage forests at all, and instead be left in the hands of private owners, who would acquire the tenure rights of such lands through public auction (Stroup & Baden[XXVII] 1973; p. 305).

As opposed to state ownership, markets cannot function properly without some degree of tenure security (Kooten and Bulte, 2000). Transaction cost increases when rights to land are not clearly defined. Increasing transaction costs drive a wedge between the value of the marginal product of land actually in use and what would be obtained if the land was utilized by a more productive alternative user. With insecure land tenure and low rent capture the forest is over exploited through destructive harvesting. Land tenure thus plays an important role in deforestation.

3.8.1 Agriculture (Land Tenure) and Forests

During 1980-1990, over 15 million hectares (ha) of tropical forest were cleared annually, and the rate of deforestation averaged 0.8% per year (FAO, 1993). Over 1990-2000, global tropical deforestation slowed down to less than 12 million ha per year, or an annual rate of 0.6%, although there were substantial regional differences in deforestation (FAO, 2001). In most of the developing countries the decline in forest area is mainly the result of land conversion, in particular, agricultural expansion for crop production. The initial concern for such loss in forest cover in developing countries came from the natural scientists. Economists got involved as late as in 1980s and their studies can be broadly separated into two phase. The initial focus had been to identify the macroeconomic causes for deforestation. Later, the shift was towards modelling and analyzing economic behaviour of agricultural households and other agents who affect deforestation through their land use decisions. Four distinct analytical frameworks that have evolved to estimate the causes of agricultural land expansion and the corresponding deforestation are given below:

(i) Environmental Kuznets Hypothesis (EKH) model

Environmental Kuznets Hypothesis states that environmental bad (e.g. pollution) initially increases and later falls as per capita income increases. This argument has been applied to a bad (in this case deforestation) by number of researchers like Cropper and Griffiths[xxviii] (1994), Koop and Tole[xxix] (1999), Panayotou[xxx] (1995) and others. A simple model of EKH deforestation model is given below:

$$F_{a_{it}} - F_{a_{it-1}} = F(Y_i, \omega_{it}) \dots\dots\dots (3.23)$$

where, F_a is the area under forest, i the i-th country, Y_i is the per-capita income and ω_i represents a vector of other explanatory variables, example population density or growth and economic variables like per capita income and agriculture yields etc.

However, the EKH model does not show any unique relationship between the variables.

(ii) Competing Land Use model

Under this model the loss of forest cover has been considered as a result of competing land use between forest and agriculture (Barbier and Burgess[xxxi], 1997; Barbier[xxxii], 2001). The economic implication for the loss of forest cover is that the potential benefits derived from timber production and environment is irreversibly lost. This model therefore considers some measure of price or opportunity cost of land conversion and deforestation in terms of foregone benefits. The model is given as:

$$F_{a_{it}} - F_{a_{it-1}} = D^{a}(\rho_{it}, \omega_{it}) \dots\dots\dots (3.24)$$

$$\text{and,} \quad \frac{\partial D^{a}}{\partial \rho_{it}} < 0$$

where, ρ_{it} is the opportunity cost of forest land conversion, D^{a} is the demand for converting forest land for agriculture.

Using this model a cross-country analysis was done by Barbier and Burgess (1997) for tropical countries for the period 1980-1985. The study found that increase in population density has a direct bearing on the rate of deforestation, while rising per capita income and agriculture productivity checks then demand for expansion in agricultural land through conversion of forests. The implication of this findings is that introduction of new technology in agriculture shall help to reduce the pressure on forest lands. These results were seriously challenged because the data for variables like land values, timber rents etc. used as proxy for the variable ρ_{it} was inadequate in across countries.

(iii) *Forest Land Conversion model.*

The main focus of these models has been to find how agricultural household make decision to convert forest land for agriculture (Barbier and Burgess, 1997; López[xxxiii], 1997; Panayotou and Sungsuwan[xxxiv], 1994). The model considers that the demand for conversion is a derived demand and assumes that the household either use available labour to convert their own land or purchase it from market. In this model the aggregate equilibrium level of converted land is assumed to be a function of input and output prices, and is given as follows:

$$D_{it}^{a} = D^{a}\left(p_{it}, w_{l_{it}}, \mathbf{w}_{it}; \mathbf{x}_{it}, \mathbf{z}_{it}\right) \dots\dots\dots (3.25)$$

$$\text{and,} \quad \frac{\partial D^a}{\partial p_{it}} > 0, \frac{\partial D^a}{\partial w_{l_{it}}} < 0, \frac{\partial D^a}{\partial x_{it}} > 0$$

where p is the price, w_l is wage rate of agricultural labour, **w** is a vector of inputs and **x** is a vector determining accessibility to forest. The accessibility to forest generally depends on development of roads and infrastructure and also proximity to settlements.

(iv) Institutional models.

As the name suggests the model explore the impact of institutional factors like property rights, land tenure system, political stability etc. on deforestation. The model is given as:

$$F_i - F_{it-1} = F(\boldsymbol{q}_{it}, \boldsymbol{z}_{it}) \dots\dots\dots (3.26)$$

where $\boldsymbol{q}_{it}$ is a vector of institutional factors.

However, instead of the four way classification, a better alternative would be a cohesive model to explain land use change (Barbier, 2001). But any such land use modelling should assume with a caution that loss of forest is equivalent to expansion in agriculture land.

3.9 Land Use Change in India (1950-2001)

The Indian experience shows that factors other than conversion to agriculture are also important while explaining the loss of forest area. Firstly, the initial twenty years after independence, the country faced acute food shortage primarily due to increase in demand caused by rapid growth in population and inadequate supply of food-grains due to technological bottlenecks. In the absence of technological breakthrough the only hope to meet this increased demand for food, was by increasing the agricultural output through the expansion of net area under cultivation. As a result the government gave tacit encouragement for the expansion of area under agriculture, which increased from 118.75 million ha in 1950-51 to 140.00 million ha in 1970-71. Further, there was a massive conversion of land from forest to non-agriculture use during this period. The rate of forest loss was a matter of serious concern and to check further loss of forests the Forest Conservation Act (FCA) 1980 was passed. No further expansion in net sown area was also reported since the passing of the FCA 1980. Instead there was slight increase in forest cover since the1990s.

Table 3.1 Agriculture and Income Growth Trends during 1950-51 to 2000-01

Year	Population	Economic Trend		Agricultural Trend		
		Real GDP	GDP per	Net Area	Area	Yield

			caput	Sown	Irrigated	(Food Grain)
	Millions	%	%	Million ha.	%	Kg/Per ha.
1950-51	361			118.75	18.1	536
1960-61	439	3.7	1.5	133.20	19.1	710
1971-72	548			140.27	24.1	872
1981-82	683			140.00	29.7	1023
1990-91	843	5.9	3.8	143.00	35.1	1380
2000-01	1027	6.2	4.4	141.63	43.4	1626

Source: Ministry of Agriculture, Census 2001

Secondly, immediately after independence the Zamindari Abolition Act 1952 was passed and as a consequence of this, state ownership over forests belonging to princes and landlords was established. The area transferred was as large as 29 million ha that almost doubled the forest area under the State Forest Department from 25 million ha that it controlled before Independence. Though the process increased the area under state control, the cost entailed was high. The nationalisation of forest which was implemented in haste resulted in prolonged legal procedure that was slow and provided scope for unprecedented deforestation and forest degradation especially done at the behest of the intermediary tenures affected to make up for their losses.

Another problem associated with the abolition of the intermediary tenures was that the unsettled common lands were first passed on to the Revenue Department and then to the Forest Department. In most cases, such lands continued to remain as a notified forest under the State Forest Department and as well as a revenue land by the State Revenue Departments. When such lands were distributed to the landless, or transferred for non-forest use it creates ambiguous tenure in the field level.

The change in recorded forest area in India is given below:

Table 3.2 Recorded Forest Area between 1951 and 2001 (in million ha.)

Year	Recorded Forests (in million ha.)
1951	71.80
1961	68.96
1971	74.83
1981	75.00
1991	77.00
2001	76.84

Source: *State of Forest Report 2003*, Dehradun, FSI.

On the contrary, FAO[xxxv] (1990) reported that the natural forest area of the country declined from 75.8 million in 1950 to 57.3 million ha. in 1980. Important factors identified for the loss of the forests during the period were:

(i) Conversion to agriculture.

(ii) Deforestation for non-agriculture purposes like construction of roads, dams, industries etc., accounted for 4.3 million hectare (MoEF, 1984).

(iii) Shifting cultivation (actual plus rest period) especially in the North-East states account for a loss of 9.5 million ha. by FAO (1981) estimates.

Though the passage of FCA 1980 arrested conversion of forest lands but it was not considered to be sufficient to restore the health of forest alone. That the quality of forest cover was deteriorating over the years is shown in table 3.3 below.

Table 3.3 Changes in Dense Forest Cover in India during 1972 to 2003 (in million ha)

Year	Dense Forest Cover
1972-75	46.42
1980-82	36.14
1985-87	37.85
1987-89	38.50
1989-91	38.56
1991-93	38.58
1995-97	36.73
1997-99	36.72
2000-01	41.68
2001-03	39.05

Source: FSI – 2000 and SFR – 2001 and 2003.

To improve the quality of forest cover as well as to effectively protect the forest active participation of people in forest management was essential. Based on public private partnership model, participatory management system in the form of Joint Forest Management was prescribed for forests under the Forest Policy of 1988. Securing people's participation in forest management is easier said than done, especially when the state usurpation of forests CPRs has totally destroyed the traditional system of resource management (Agarwal and Narain, 1989). Reviving the old institution of CPR is also a difficult task since the village community for generations have lost the knowledge base required for an effective CPR system.

3.9.1 Forest Settlements in India: Decline in Community Access to Forest Resources

The encroachment on forest land has not always been due to agriculture only. Factors like pressure, opportunities, policies, vulnerability, and social organisation are considered to be important factors that determine land use change (Lambin[xxxvi], *et. al,* 2003; p. 226), where, Pressure $= f$ (number of resource users, labour supply, quantity of resources, and sensitivity of resources);

Opportunities $= f$ (market prices, production costs, transportation costs, and technology);

Policies $= f$ (subsidy, taxes, property rights, infrastructure, and governance);

Vulnerability $= f$ (exposure to external perturbations, sensitivity, and coping capacity); and

Social Organisation $= f$ (resource access, income distribution, household features, and rural-urban interaction).

To protect forests from all possible infringements it was essential that the rights were settled in the first place. The types of forest that came to be recognised under the Indian Forest Act 1878 were Reserve Forests (RF), Protection Forests (PF) and Village Forests (VF). As per the scheme of reservation of forests under the Act (chapters II and IV), the procedures of settlement under the RF are fairly elaborate and oriented towards higher levels of conservancy and government control. All activities (or rights) are prohibited and is an offence in RF unless specifically permitted, whereas nothing is an offence in PF unless it is specifically prohibited.

Under a State Forestry System, forest settlement was considered essential to fix and define the legal status of the proprietary rights of the State on such forest lands, as well as to enquire and record if such proprietary rights of the State are limited by lawfully existing rights of individual people or of a community. Such settlement does not in any way aim at prescribing the manner in which the forest administration and its management are to be conducted (Ribbentrop[xxxvii], 1900; pp. 123-24).

The 1878 Act prescribed for a forest settlement whenever a reserved forest was to be constituted (Guha[xxxviii], 1983; p.1941). The steps in forest settlement were:

(i) The State Forest Officer had to publish in native vernacular a declaration clearly demarcating the limits of the area to be reserved and asking people to place their claims of rights of use within the limit if any.

(ii) If any such claims are placed before the officer, an enquiry has to be made by the officer.

(iii) Upon enquiring, if the officer finds that the claims are valid then he may,

(a) admit them in whole or in part,

(b) extinguish the rights by paying compensation or by transferring the rights over any other area of the forest,

(c) once the private right is admitted, it is essential the nature of rights to be enjoyed must be specified.

(iv) Shifting cultivation was a privilege enjoyed as a favour from the settlement officer.

The settlement officer was given ample flexibility to deal with claims. The purpose for such flexibility was to secure the best deal for the State. However, there was a provision in the Forest Act of 1878, under which the government could extend or even create private rights on forests even when the final settlement had taken place. The flexibility given to the Settlement Officer in settlement of rights resulted in large inter-regional variations in resource use even when customary use of the forest between these regions did not differ significantly in the first place (*ibid*; p.1942).

The general principle followed during the British period was that those areas which are farther from the human habitat and over which the local population has least dependence were notified as RF, whereas neighbouring forest areas over which local people have high dependence for their livelihood were notified as PF. The Management Plans which flowed from this principle can be broadly classified as:

(i) Commercial management in RFs primarily for production of valuable timber, and

(ii) Subsistence management in PFs for production of poles, firewood, and other minor forest products especially for the local community.

The outcome of this difference was near exclusion of people from the RF areas and increased dependence on PFs for usufructs. As a consequence areas under PF rapid degradation of forest cover. Such broad outcome gave birth to the opinion that reservation of forests was essential as RFs was the key to improvement of forest health, and therefore, many State Forest Departments (SFDs) vigorously pursued re-reservation of PFs and unreserved forests (UFs) as RF under chapter II of the Indian Forest Act of 1927. According to Chapter2, Section 3 of IFA 1927, the provision to reserve a forest is stated as:

"*Power to reserve forest-State Government may constitute any forest-land or waste-land which is the property of the Government, or over which the Government has* *proprietory rights, or to the whole or any part of the forest-produce of which the Government is entitled, a reserved forest in the manner hereinafter provided...*"

The above view came to be widely accepted in the official circle is evident from the fact that more and more Forest Working Plans since early 1970s started replacing "Community Working Circle" with the phrase "Coppice Working Circle", even for Working Circles [WC] within village priphery. This change did not result in any change in the legal position of people's rights over the forest produce, but it brought about a significant change in the framework for soliciting participation of local people in forest works of the assigned areas.

The history of acquisition of tenure and property rights in forest lands, not only in India but throughout the world, has been the history of taking possession *(occupatio* in Roman law), followed by peaceable enjoyment (*usucapio*), and being perfected with the passage of time (Baden-Powell, 1898). A prolonged tenure gives a prescriptive right of ownership.

Limiting or curtailing such rights in forest use threatens livelihood security of the local community. However, this issue has not received sufficient attention for a considerable period of time even when about 100 million people in India derived livelihoods from forests (Saxena[xxxix], 2003). In the early period of the British regime, forests were considered as non-revenue generating resource. The official policy (Forest Policy Resolution 1894) was to encourage expansion of agriculture in forest areas. It considered that the "claims of agriculture are stronger than the claims of forest preservation, subject to certain conditions". The National Forest Policy (NFP) of 1952 made an attempt to reverse this and noted the indiscriminate extension of agriculture and consequent destruction of forests depriving the local population of fuel and timber, and also exposing lands to top soil erosion and frequent landslides in elevated terrains. It thus prescribed that one-third of the land must be under forest, but the proportion would not be the same everywhere. It would be 60 per cent in the hills and arid regions and 20 percent in the plains. The forest area requirement by function and for the country as a whole as per NFP 1952 recommendation is given below:

Table 3.4 Land use classification requirement as per NFP 1952 (in million ha.)

Land Classification	Geographic Area	Unproductive Land Area	Productive Land Area Allocation		
			Total	Forest	Non-forest
Hill and Mountain	100	30	70	42 (60%)	28 (40%)
Arid Region	35	20	15	9 (60%)	6 (40%)

Other Landscapes	193	15	178	35 (20%)	133 (80%)
Total	328	65	263	86 (33%)	167 (67%)

Therefore, unless we have information about the extent of forest and tree cover in India, we cannot say with certainty how much more area is required is to be brought under forest and tree cover to achieve the goal set by the National Forest policy. The policy prescribed that regions where there is deficiency in forest cover shall increase it through afforestation programme in marginal lands (like eroded river and village waste-lands).

As mentioned in the chapter on forest policy the NFP 1952 failed to arrest the loss of forests in India. The forestry in general and state forestry in particular was becoming unsustainable in India. In the early eighties, National Remote Sensing Agency (NRSA) took the initiative of assessing forest cover of the country using remote sensing technology. NRSA data revealed that the estimated forest cover of the country for the period 1972-75 and 1980-82 was 55.52 million ha and 46.35 million ha respectively. As per the assessment made by NRSA India's forest cover was 16.89% of geographic area in 1972-75 declining to 14.10% in 1980-82 (Gupta[xl], 2007). This assessment for the first time revealed that the forest cover in India was much below the desired level (FSI, 2003). Forest Survey of India (FSI) which was mandated to undertake forest survey of the country using conventional ground inventory, started to publish biannually forest cover assessment based on satellite data from 1987 onwards.

3.10 Shift in State Forestry: From Alienation to Participation

Forests are common pool resources since they share attributes of common goods:

(a) it is difficult to exclude individuals benefiting from a forests produce, and

(b) consumption by an individual subtracts from the common pool thereby reducing the amount available to others.

The forest is a resource system that produces a flow of "streams of benefit". Though forest is a renewable resource but the use of a unit of this resource subtract from the stock of forest which cannot be replenished immediately because trees cannot grow instantaneously. As a result forest may be degraded or even destroyed due to overharvesting of the resource. Restricting access to potential users of forest has often been prescribed to protect forests from being destroyed. Exclusion of potential users may not be feasible or may even be prohibitive due to high costs of monitoring and fencing forest (McKean, 2000). Devolution of forest management in the hands of local community was not considered as a viable alternative to other forest management practises. For many reasons, the effectiveness of decentralised system of forest management in the hands of local communities was seriously doubted.

However, isolated experiments since 1970s showed that co-management of natural resources had the potentiality to successfully regenerate and manage forests (Pretty, 2003). The concept of co-management in the form of JFM thus gained momentum since late 1980s in India. JFM was a radical shift from forestry practices based on detail survey, demarcation of forest land through settlements and guarding forests by policing. Instead JFM was based on sharing of products, responsibilities, control and decision-making authority over forest lands between the FD and local user communities under a formal agreement. JFM requires a shift in attitude of foresters from "protecting the forests from people" to "protecting with people" (Matta[xli], *et. al.*, 2005 *c.f.* Sood and Gupta[xlii], 2007). The main feature of JFM is the creation of grassroot level community institutions for managing forests on the basis of "care and share" principle (*ibid*, p. 293). The success of grass-root level institutions promoted under the JFM depended upon the collective action of the people. Collective interests do not automatically produce collective action (Heckathorn, 1996), and collective action does not always require an institution or any external facilitator (like FD). The JFM model however is not free from criticisms. It has been criticised for being elitist, thrusted upon local community by the FD. Under this scheme the basic forestry decisions like selection of species, the age of harvesting etc., still remains with the FD, while the local community is made a party only to monitor and help protect the trees. In the true sense thus, this has never been devolution of state control on forest rather JFM is a crisis driven response by the state.

On the other hand common property resource management system based on voluntary participation by the people is considered to be an institutional answer to forest management for reasons of efficiency, equity and welfare. The efficiency argument suggests that given a well defined set of rules and regulations for monitoring and enforcement of rights, CPRs are efficient because they allow for economies of scale and access unlike private property, and, ecologically more sensitive than state management (Wade, 1988). It has been suggested that 'it is in a situation where the market and the State both become inefficient that there is a case for strengthening community organisations by creating institutions that can manage "common property" or "common pool" resources' (Chopra *et al.*, 1990; p. 25). Many scholars who suggest that decentralised collective management of CPRs by their users can be an appropriate system for overcoming 'The Tragedy of the Commons' (Jodha 1986; Wade 1988; Ostrom 1990).

However, given that CPRs are usually established on the poorest land, the management system alone should not be held responsible for the degradation of resources (Bromley, 1989). The welfare and equity arguments suggest that access to public resources whether allowed by State or with open access or as common property, provides the subsistence basis of the rural economy and in particular, a safety net for the poorest of the rural poor.

Summarising, the transition of forest management practices since the first oil crisis in 1970s can be briefly traced as in table 3.5 below:

Table 3.5 Forest Management Practices since 1970s

Period	Event	Response
1970s	Oil crisis: This led to energy crisis and corresponding fuelwood crisis for the poor.	Afforestation to meet fuelwood needs of people.
1980s	Eco-disaster led to forestry renaissance	Social forestry and agro-forestry. The focus was on afforestation and rapid expansion in woodlots took place. Attention was given to fuelwood production and food security and income generation took a back seat.
Late 1980s	Change in development paradigm. Decentralised planning gained importance and centralised planning began to lose its significance.	Participatory management practices evolved for resource management. Importance of indigenous knowledge came to be recognised. NGOs role was widely accepted.
1990s onwards	New forest sector policies. Rio Declaration for sustainable development. Radical reform in State forestry.	Co-management or JFM. Forestry for multiple objectives, multiple stakeholders, multiple partnerships.

Source: Sood and Gupta[xliii], 2007.

Chapter Notes and References

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$$pv'(T) = r(pv(T) - c)\left[1 + \frac{1}{e^{rT} - 1}\right]$$

$$or, \frac{pv'(T)}{pv(T) - c} = r\left(1 + \frac{1}{e^{rT} - 1}\right)$$

$$or, \frac{pv'(T)}{pv(T) - c} = r\left(\frac{e^{rT} - 1 + 1}{e^{rT} - 1}\right)$$

$$or, \frac{pv'(T)}{pv(T) - c} = r\left(\frac{e^{rT}}{e^{rT} - 1}\right)$$

$$or, \frac{pv'(T)}{pv(T) - c} = r\left(\frac{1}{1 - e^{-rT}}\right)$$

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