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Village Voices, Forest Choices

Joint Forest Management in India

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Chapter 10

Ecological Stabilization and Community Needs: Managing India's Forest by Objective

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This chapter examines patterns of forest degradation prevalent in India. It also explores the potential to restore forest ecosystems if disturbances can be reduced or stopped, and ways in which natural forests might be manipulated to provide a sustainable and increased flow of products to communities. The first step to sustainable forest management will involve halting the degradation process. Once access controls imposed by communities are established, in many areas rapid regeneration will be initiated as a second step to ecological recovery. The third step in the process will require human ingenuity to develop site-specific methods to manipulate natural ecosystems to ensure a sustainable supply of important forest products while enhancing biodiversity, water, and soil conservation. This will often require a reversal of past and current forest management systems.

India's forests have historically been endowed with vast and varied flora and fauna. India is comprised of ten broad biogeographic zones, possessing approximately 15,000 flowering plants, and nearly 1200 species of birds and 341 of mammals.[1] The rapid expansion of human and livestock populations over the past four to five decades has placed extraordinary pressures on forest resources, undermining the nation's rich biodiversity. By the early 1990s, an estimated 27 per cent of all plant species and 65 per cent of bird species were classified as endangered.[2] In addition to the degradation of public forests, other common property resources (CPR), which were providing an important supply and range of biomass products to local communities, have dwindled. A study conducted in eighty-two villages in six Indian states, found that

CPR forest and pasture area had declined between 31 and 55 per cent since the early 1950s. Further, common lands have also lost species diversity and vegetation density.[3]

While the growth of human and livestock populations has long been identified as a major factor driving deforestation, as Westoby notes, 'It is an over-simplification to regard deforestation as the consequence of population growth. It is nearer the truth . . . to regard deforestation and population growth as joint manifestations of exploitative social relations.'[4] From the colonial to the post-Independence era, government policies that encouraged state control and commercial exploitation of forests and common lands have contributed substantially to deforestation and ecological deterioration, through both direct felling and the destabilization of indigenous management systems.[5]

With the destruction of the larger biological systems upon which India's agrarian economy ultimately depends, the smaller economic subsystems of both commerce and rural subsistence collapse correspondingly. While the government of India has invested billions of dollars in reforesting degraded lands with fast-growing, exotic tree species, complementary strategies, which can help stabilize and restore disturbed natural forests, must also be developed. Natural forest regeneration offers encouraging signs that a range of low-cost, replicable options can help to biologically restore India's degraded lands. To further explore the response and power of nature in resuscitating badly disturbed environments, and to objectively assess natural regeneration as a viable resource management option, a more comprehensive ecological understanding of both degeneration and natural regeneration processes is needed.

This chapter analyses the definition, extent, and condition of India's degraded lands. It reviews factors contributing to degradation and their ecological impact, and compares social forestry schemes with natural regeneration options for degraded lands, analysing their potential and merits. The chapter concludes with strategies to encourage natural regeneration management initiatives.

Defining Forest Degradation

According to Blaikie and Brookfield, 'Land degradation should by definition be a social problem. Purely environmental processes such as leaching and erosion occur with or without human interference, but for these processes to be described as "degradation" implies social criteria which relate land to its actual or possible uses.'[6] Consequently, land or forests are considered degraded when they suffer a loss of intrinsic qualities, which results in a decline in their capability to satisfy a particular use. Deforestation may not necessarily be considered degradation, even though changes in micro-climate, hydrology, and soil take place, since these lands may be brought under productive agriculture. It is only defined as such 'if the degradation process under one system of production has reduced the initial capability of the land in a successor system . . . In actual practice, this is often the case, since more serious degradation reduces capability for most, if not all, future possible land uses.'[7] Certainly, in India, where much of the remaining forest lands are located on soils with marginal fertility, incapable of supporting productive agriculture, deforestation often undermines the productivity of the original forest ecosystem, as well as the capability of the land to support alternative uses. The vast areas of the once dense, old-growth forests that now exist as unproductive, devegetated tracts devoid of topsoil, demonstrate this point. Since human activities and natural processes can both contribute to degradation and restoration, Blaikie and Brookfield suggest that the equation for net degradation reflects the outcome of natural degrading processes plus human interference minus natural reproduction and restorative management.[8]

A common method for assessing forest degradation is to compare the current state of a specific ecosystem with its former undisturbed condition. Even within a single forest ecosystem, species composition, structure, and density patterns will vary according to highly localized moisture levels, slope, aspect, and other variables. Consequently, the extent of degradation should be measured against the original state of the forest in specific contexts prior to the initiation of intensive disturbances by human and domesticated animals. This presents serious methodological problems for accurately assessing changes in forest ecology. While it is impossible to assess the precise patterns of ecological degeneration that has occurred in a given area, it is possible to observe the general patterns regarding biological changes that have and continue to take place.

In India, ecosystems experiencing moderate to serious disturbances are classified as wastelands. Degraded forests are typically defined by the government as land with less than 40 per cent crown cover. While providing a useful indicator of canopy closure, this definition of degradation does not reflect other changes that may occur underneath the crown, affecting soil fertility, moisture availability, species composition, and general biotic productivity. There is a need to develop more sensitive measurements of forest degradation to better monitor ecological change. Nonetheless, in forest areas with diminished tree canopy, a dominance of thorny, bushes or devegetated, rocky subsoil are commonly found.

Extent of Deforestation and Degraded Land

According to the National Remote Sensing Agency, the annual average deforestation rate in India between 1975 and 1982, was 1.3 million hectares, representing the degradation of 10.4 million hectares of closed forest.[9] Although the Ministry of Environment and Forests reports that Landsat data indicate an increase of 56,000 hectares of forest cover during 1989–91 it is likely that this is due to the massive plantation programmes. Many field observers, however, note that much of India's natural forests are continuing to degrade.[10] Although the decline in deforestation rates in India is a welcome and significant reversal, the distinction between deforestation and degradation is an important one. Satellite imagery often fails to pick up the more gradual processes of ecological decline. In fact, it is this successive deterioration of vegetative diversity, forest density, structure, and regeneration potential that poses the greatest threat to India's natural forests. Unless the process of degradation can be arrested and reversed before natural resilience is lost, opportunities to rehabilitate India's degraded forest lands will be seriously jeopardized.

The Society for the Promotion of Wastelands Development estimates that in 1984, 35.9 million hectares of forest land and 94 million hectares of non-forest area — both private and communal — were degraded.[11] This is equivalent to 40 per cent of the subcontinent's total land area of 328 million hectares. The process of devegetation associated with the creation of wastelands also leads to accelerated soil erosion, resulting in the loss of 6000 million tons of topsoil that is washed or blown away annually.[12]

Processes of Forest Degeneration

Forest degradation has numerous agents and causes, many of which reinforce the process. In India, human activities contributing to the degradation of natural forest vegetation, frequently involve five primary processes: (1) removal of woody species at rates exceeding their renewability, (2) excessive grazing by livestock of grass and other herbaceous matter, (3) increased incidence of fire, (4) topsoil loss and soil compaction, and (5) a decrease in water retention and recharge capacity. Degradation often occurs gradually as a succession of biotic disturbances slowly deplete vegetation, suppressing natural regeneration, and inducing sheet and gully erosion of topsoil. This type of degradation process may occur over several decades. Figure 10.1 depicts the more gradual process of vegetative changes common in many regions of India.

Degradation of forests often begins with the selective logging of larger trees, causing openings in the crown cover. Timber extraction results in damage to smaller trees, saplings, shrubs and herbs, as well as causing soil erosion and compaction. Roads cut into forests to facilitate logging open the once-isolated forests to other outside users. Further felling of trees can cause larger losses of crown cover, opening up more space for livestock grazing. In turn, grazing frequently causes further soil erosion and compaction, suppressing natural regeneration through loss of soil fertilizers and both seed and seedling destruction. Progressive losses of plant diversity and grass productivity are often coupled with the invasion of exotic, non-palatable weed species. Where fuelwood is scarce, local people may uproot stumps and roots, further disrupting soils and accelerating erosion. Ultimately, overexploitation through cutting and grazing may cause a near total loss of vegetative cover, topsoil, and soil nutrients. The ecological impacts of different anthropogenic interventions are summarized in Box 10.1. With each biotic interference, the critical impacts are relatively similar: loss of species diversity; disruption of nutrient cycling and loss of topsoil and its nutrients; progressive suppression of natural regeneration from both coppice and seed; and decline of biomass productivity and balanced ecological functioning.

In the end, the complex multi-tiered, multi-species forest structure is transformed to a depleted, highly vulnerable biological system, with little or no vegetative cover save for some scattered, thorny and non-palatable species. The soil structure is also altered — from deep topsoil, high in micro-organisms, humus, and clay or silt, to a pauperized condition with total loss of humus followed by topsoil erosion. Declining moisture-holding capacity of topsoil, accelerating surface water run-off, and minimal groundwater recharge capacity are associated with degradation.

Reversing Forest Degradation: Options and Strategies

The opening of the forest canopy also results in a reduction of critical fungi living on or in close association with the roots of many plants.[13] Mycorrhizae facilitate the absorption of nutrients and moisture for many plant species. Consequently, these microscopic, below-ground organisms play an important role in a large variety of plant communities, facilitating the process of forest succession in degraded ecosystems. Research indicates that the removal of canopy trees results in high substrate temperatures, which constrain the growth of mycorrhizal fungi, in turn reducing seed survival.[14] Deforestation also disrupts the food supply to many micro-organisms, causing their eventual death. 'When this happens, soils become virtually sterile and inhospitable to both higher and lower forms of organisms . . . The re-establishment of the mutualistic relationship of mycorrhizal fungi and host plants is the key to any restoration activity . . . particularly where trees are being re-introduced to degraded sites.'[15]

India's rich forests have gradually been reduced over the centuries. According to Norman Meyers, as much as 90 per cent of the subcontinent's forest cover has disappeared.[16] The total area under forest cover in relation to India's total land mass has declined from nearly 17 per cent in 1972, to 14 per cent in 1982, to approximately 11 per cent in 1992.[17] The shrinking forest cover stands in sharp contrast to an ideal forested area of 33 per cent.[18] As problems of forest degradation have escalated and become increasingly recognized over the past two decades, the government of India has initiated a number of programmes to rehabilitate disturbed ecosystems. These efforts have been carried out in conjunction with stricter controls on commercial timber harvesting, the extension of fuel-efficient stoves and biogas programmes, and attempts to substitute both non-forest raw material and finished products.

Plantations and Conventional Social Forestry Programmes

During the mid-1970s, concern over the rapid forest loss and the declining availability of wood products led government planners to introduce the concept of social forestry under its fifth Five-Year Plan (1976–81).[19] The original goals of the social forestry programme were to produce firewood, fodder, and small timber resources to meet the biomass needs of local communities, while helping relieve pressures on natural forests. The scheme aimed to reclaim wastelands through afforestation programmes that would generate employment opportunities in rural areas and restore the ecological balance. The social forestry programmes were infused with added attention and momentum through a large influx of funds from foreign governments and international agencies. Centrally sponsored social forestry projects in virtually all states were initiated during the early 1980s. Even commercial banks and industries developed programmes to provide assistance to farmers to establish tree plantations for specific purposes. The social forestry projects included community woodlots, strip plantations and farm forestry, and focused primarily on communal and private lands. The concept implicitly assumed that most natural forests would remain under strict forest department control to meet industrial and commercial needs, while common and private lands would be reforested through social forestry schemes to respond to the fuel and timber needs of rural communities.

Ecological Impact of Social Forestry Plantations

Between 1980 and 1990, social forestry activities expanded rapidly. The programmes achieved dramatic success particularly on private farmlands in the Punjab, Haryana, western Uttar Pradesh, and Gujarat — India's 'green revolution' belt.[20] However, rather than planting for subsistence fuelwood and timber requirements, farmers and communities began selecting fast-growing species, especially eucalyptus (hybrids of *E. tereticornis*), to respond to high market prices and labour shortages. In Uttar Pradesh, farmers exceeded the original target of 8 million seedlings, planting 350 million between 1979 and 1984.[21] In the Punjab, in only a decade, more than 3 per cent of the cultivated area had been planted under eucalyptus.[22] In Gujarat, from 1983 to 1984, farmers planted 195 million trees, quadrupling the 49 million mature trees previously targeted for the state.[23] Studies estimate survival rates for trees between four and eight years of age between 60 per cent[24] and 77 per cent.[25] While social forestry programmes have resulted in the establishment of billions of trees — mostly exotic, fast-growing species — most farmers and participating communities planted them with the expectation that they would be harvested in six to ten years and sold in commercial markets. The enthusiasm of rural people 'to plant eucalyptus declined after 1986, as the tree failed to generate the kind of returns that farmers were expecting from its sale. Some farmers removed the tree roots and went back to annual crops.'[26] Consequently, while social forestry–subsidized eucalyptus plantations have allowed India to reduce the annual rate of deforestation estimated at 1.3–1.5 million hectares per year between 1980 to 1985, to approximately 50,000 hectares per year, it is questionable whether these newly established woodlots will be sustained.[27] Since most social forestry projects are designed around short rotation felling, unless carefully controlled, this may reinitiate the degradation process. Many cut-over plantations may re-emerge as large areas without tree cover, which will be further subjected to degradation through a host of consecutive biotic disturbances.

The conventional plantation approach has led to serious losses of local tree diversity on common and private farmlands. Monoculture plantations with tightly spaced, high-density trees suppress natural regeneration and vegetative undergrowth due to shading and competition for soil nutrients and water. In contrast, the undergrowth and multiple-storey vegetation in mixed cultures and natural forests encourage a range of micro-habitats. In plantations, due to the loss of diverse, multi-tiered floral micro-niches, faunal diversity also declines. Loss of plant diversity additionally deprives local communities of a whole range and continuous flow of plant products such as food, fodder, oilseeds, leaf manure, and raw materials for artisans. Exotic, monoculture plantations have also proven substantially more vulnerable to pest attacks and disease. The lack of a multi-tiered structure in plantations also reduces ground cover and leaf litter, critical for reducing soil erosion and slowing water run-off. Raising short-rotation plantations of monoculture species like eucalyptus, which is repeatedly harvested, leads to depletion of soil nutrients. Subsequent harvest yields progressively decline. Important ecological implications of the conventional block plantation approach are illustrated in Box 10.2.

In short, while India's experiences with farm and community tree plantations have been relatively successful in responding to market demands for construction-poles, pulpwood, and timber, they should not be equated with the restoration of natural forests which serve very different economic and ecological functions. Ultimately, short-rotation plantations of monoculture species should be viewed more as a form of agriculture than as a management option for forest ecosystems. Although more than a billion dollars has been invested in social forestry plantation schemes in recent decades, they have failed to slow the process of natural forest degradation. Further, a huge area of wastelands needs restoration in India, encompassing up to one-half of the subcontinent's terrestrial landmass. Thus, it is not realistic to expect that enough human and financial resources will be available to restore this land. With plantation costs averaging Rs 10,000 per hectare, billions of dollars would be required to artificially replant a sizable proportion of India's degraded lands. Furthermore, the very low productivity of most forest plantations does not justify the current high costs incurred on restoring degraded natural forests, nor are markets available to absorb the produce. The biomass needs of village communities can be met better through the production of a large diversity of plant species, not by tree species alone. While plantation forestry will continue to be an important strategy to generate raw materials for plywood, pulp industries, packing cases, and to provide fuelwood and some construction timber, alternative management strategies need to be developed to restore India's degraded natural forests.

The strong emphasis of conventional social forestry afforestation programmes on degraded common and private lands has diverted attention and support away from the management problems of state forest lands. Further delays in reversing the process of forest degeneration will finally render the land ecologically unfit for rapid revegetation and rehabilitation. The operational problems faced by forest officers attempting to implement social forestry projects in the face of pervasive degradation over large territories are exemplified in Box 10.3.

There is an urgent need for a strategy that will permit rapid reclamation. The strategy must offer a diversity of forestry options that are compatible with physical factors such as soil and rainfall, as well as desired product outputs. Natural regeneration under community protection provides a low-cost alternative to plantation restoration.

Natural Regeneration Patterns

In recent decades, natural regeneration has received inadequate attention from foresters. The promotion of social forestry plantations has preoccupied forest managers, planners, and field workers, drawing attention away from the opportunities that natural regeneration presents. Natural regeneration provides an attractive and widely replicable alternative to reclaim degraded lands quickly to enhance their biological potential, while meeting the diverse biomass needs of local communities in a sustainable way.

Natural regeneration comprises processes of secondary forest succession. The level of plant biomass depends upon the availability of sunlight, water, and mineral nutrients, as well as the impact of factors such as floods, grazing, and other human interventions. The natural process of vegetative succession involves the gradual replacement of ecological phases — low biomass vegetation dominated by grasses and herbs, to shrubs and young, pioneering woody saplings, to a state of high biomass dominated by tree canopy. Rates and quality of regeneration are determined both by the natural characteristics of the local ecosystem (e.g. rainfall, altitude, slope and aspect, soil type) and its level of degradation.

If protected before sites become seriously disturbed, both natural forest regeneration and 'enhanced' or 'assisted' natural regeneration have proved to be effective methods to reverse the degradation affecting natural forests. In many cases, natural regeneration will occur rapidly if abused lands are provided simple protection from anthropogenic disturbance. Social fencing based on co-operative community agreements and actions are often effective in protection. Access controls are normally imposed by communities who establish patrols to stop grazing and cutting. Once regenerative processes are under way, community management groups may decide to allow some thinning or grazing. Initially, logging, fuelwood cutting, burning, and grazing must be stopped or lightly controlled. Even if it proves impossible to halt grazing, experience from the Western Ghats and West Bengal indicates that grazing must at least be prevented during the first two to three years of recovery. Some communities bring degraded forest land under protection gradually, facilitating the initiation of regeneration in certain areas first, while other areas remain open for grazing and collection. Once regeneration advances and tree saplings grow above grazing levels — averaging 1 metre to 1.5 metres — these lands can be reopened as regulated pasturage. Sequentially, over a period of two to four years, villages can bring increasing amounts of land suitable for natural regeneration under controlled access.

Forest Succession and Natural Regeneration

The process of natural regeneration also follows a succession pattern, characterized by a series of phases that vary in length and type depending on the environment and degree of disturbance experienced previously. Figure 10.2 depicts the process of natural regeneration under two different scenarios: a degraded forest environment with high coppicing potential, and a forest with few coppicing species, but good tree-seed supplies. In areas with high coppice potential, some silvicultural operations may be required to clean the rootstock. During the first rainy season, coppice shoots, grass, shrub, and herb vegetation will emerge. In the next few years, shrubs and saplings dominate, leading to the decline of the grass-herb layer. The coppice shoots continue to grow; thinning of coppice shoots will accelerate stem growth. In five to ten years, the coppice stems will develop an increasingly closed canopy, suppressing even the shrubs. The trees will reach a height of about 10 metres after fifteen years, and some species may be ready for harvest as construction poles. Others will start producing non-timber forest products (NTFPs), and in twenty years, tree growth rates may decline. After long periods of protection, climax species may appear and the tree growth rate would be nearly zero.

In many situations, such as in the Western Ghats or Haryana, coppice potential is low because of the composition of forest species. In areas with a low percentage of coppicing tree species, but an ample supply of mature, seed-dispersing trees, natural regeneration is likely to require a modified time frame and follow a different pattern than trees in a coppicing area. With protection, grass production will increase with herbs starting within the first year. By the second or third year, the soil moisture may improve and germination of tree seeds from natural seed dispersal mechanisms (wind, birds, bats) is likely to occur. By the fifth year, grass production may peak, and shrubs may start to grow; tree seedling growth will continue at a slower pace. The tree seedlings may reach a height of 5 metres by ten to fifteen years. By that time, the canopy would be closing, grass production would be marginal, and shrubs would also decline. By the twentieth year, long gestation trees will start yielding NTFPs (e.g., mango, *jamun*, and tamarind) and some species may start even earlier. Certain coppice species would be ready for harvest. Very long periods of protection may lead to changes in species composition from deciduous to evergreen as observed in the Western Ghats.

In extreme situations, where soil erosion has reached conditions characterized by gullies and ravines with little or no vegetation, natural regeneration alone may have little immediate impact in improving vegetative cover. In such cases, alternative, highly intensive forestry options are required. The following review highlights experiences with natural regeneration in the semi-arid Shiwalik hill tracts of Haryana, in the sal coppicing forests of south-west Bengal, and in the moist evergreen forests of the Western Ghats of Karnataka.

Experiences with Natural Regeneration: Case Studies

The following three case studies document changes in biodiversity and productivity after varying periods of community protection and management in three distinctly different ecological zones. Open access control plots receiving no form of management were selected to assess the impact of uncontrolled use on vegetation.

The parameters monitored include species richness, species distribution, tree density, size of trees, basal area, grass productivity, and extent of coppicing. Vegetation was monitored in sample quadrats and data were recorded for tree, shrub, herb, and grass layers.

In all study areas, promotion of natural regeneration was possible only through the participation of the local community; little or no capital or technological investments were made. In the Karnataka study-sites, protection and management was undertaken solely by the community; in the two other states, management was jointly implemented by the community and the forest department. Both institutional systems provided viable opportunities to regenerate degraded forest lands.

In all locations, prior to community protection, vegetation was very poor, with no trees and only remnant shrubs and stumps. The soils were eroded, and the community had free and unlimited access to harvest or graze. There was no management system in operation, which could control extraction of biomass, overgrazing, and progressive degradation.

The Evergreen Forests of the Western Ghats

Sagara block in Karnataka's Western Ghats was selected to represent natural regeneration under community protection for both deciduous and evergreen forest ecosystems. The area receives an annual rainfall of about 100 centimetres. In the study areas local initiative led to the promotion of forest protection activities to facilitate natural regeneration. Initially, grazing was banned for three years, but later free grazing was resumed. No harvest of green wood was permitted. Only fallen twigs could be harvested with the village committee's permission. Although there was no official guard, local access control was strictly enforced by the entire village. In Hunsur village, the forest was guarded by each household for one day on a rotational basis. Any harvest or removal not permitted by the village committee was punished by imposing fines. In extreme cases of forest abuse, a social boycott was imposed. The Karnataka Forest Department was not involved in this self-devised community management system.

In two villages, Padauagodu and Honkeri, the plots under protection have regenerated for ten years; and in Alahalli, plots have been under protection for fourteen years. Hunsur, a village with a long tradition of over 100 years of community management, was also selected. To ensure similar socio-ecological conditions, all four study villages were within a radius of 10 kilometres. In each study area an unprotected control plot adjacent to the village was chosen, allowing a comparison of natural regeneration in protected and unprotected patches.

The study indicates that the number of different tree species over 1.5 metres in height increased from zero in the unprotected control plots to twenty-six after fourteen years of protection in Alahalli. The species diversity rose to fifty-five in the 100-year-old protected forest of Hunsur. The number of trees larger than 10 centimetres in diameter at 5 feet above the ground (GBH) also increased from zero in the unprotected plot to 1477 after fourteen years of protection. The number of shrubs and herb species also increased up to fourteen years of protection; these numbers appeared to decline thereafter, possibly due to the growth of tree canopy and shading.

Basal area provides an important indicator of standing tree biomass or standing tree stock. In the control plots, there was no standing tree biomass. In contrast, in plots under protection, standing basal biomass per hectare increased from 4.1 square metres within ten years of protection to 9.7 square metres within fourteen years of protection and finally to 33 square metres in the century-old Hunsur site.

Succession from deciduous to evergreen species could also be distinguished when comparing the dominant species in the fourteen-year-old and 100-plus-year-old plots. The findings clearly show that natural regeneration under community management has led to significant increases in species diversity, tree density, and biomass. In Alahalli village, only 12 per cent of the tree regeneration was based on coppice growth, while in Honkeri village, more than 50 per cent of the trees originated from coppice rootstock. This indicates that given adequate seed sources, even in the absence of coppice rootstock, natural regeneration by seed can succeed.

The Sal Forest of East Midnapore

East Midnapore forest division of West Bengal was selected for monitoring vegetative changes. The area receives a mean annual rainfall of 120–150 centimetres. Sal dominates the vegetation on generally poor laterite soils. The promotion of natural regeneration was initiated by the forest department under a joint forest management system. The programme involved the formation of Forest Protection Committees (FPCs) in each village. FPCs entered into an agreement with the forest department to jointly protect and promote natural regeneration in a patch of degraded sal forest. Each participating community was assured 25 per cent of returns from sal tree harvests and was guaranteed full access to all NTFPs. FPCs generally did not permit grazing initially; however, some grazing was permitted as the forest recovered.

In the Moupal-Ranja beat of east Midnapore, three forest plots near a village were selected for study. The plots included one unprotected control plot of degraded forest, a sal patch protected for five years, and, in a neighbouring village, a sal patch protected for ten years. The number of trees above 10 centimetres in GBH increased from zero in the unprotected site, to 765 after five years and 961 after ten years. Correspondingly, the basal area increased from zero to 7.4 square metres per hectare after five years, and to 16.5 square metres per hectare after ten years, with an annual growth rate of 1.6 square metres per hectare. The number of shrubs, herbs, and climbers increased sharply whereas the lower-storey species declined somewhat as the canopy closed, presumably due to shading by the sal trees. The number of climbers, whose tubers are a crucial source of food for the locals, nearly doubled during the first five years of protection to 235 per hectare.

The Mixed Deciduous Forest of the Shiwalik Mountains in Haryana

The study locations were selected from the Morni and Pinjore forest ranges of Ambala division. The area is hilly with steep ravines and a mean annual rainfall of 100–120 centimetres. Natural regeneration was facilitated by protection provided by community-based Hill Resource Management Societies, which were formed to promote soil and water conservation, and manage the eroded Shiwalik watersheds. Later, a joint forest management system was introduced. Grazing was banned in the selected area and protection was done voluntarily.

In Haryana, researchers investigated the processes of natural regeneration and its effects on grass production under varying periods of protection. Sample plots were chosen to reflect three, six, and ten years of protection from grazing. A set of unprotected control plots subjected to free grazing was selected for comparison. The researchers found that the number of trees per hectare increased from 90 in the unprotected plots to nearly 500 after ten years of protection. The number of shrubs also increased during the first three years, and then declined slightly, possibly due to an increase in trees and shading. Grass productivity increased from less than 1 ton per hectare per year to nearly 3 tons during the initial three years of protection. However, per hectare grass yields, declined by nearly 50 per cent between three and six years of protection, falling somewhat further up to ten years of protection, probably due to the increasing number of trees and shrubs shading out lower-storey grasses. While natural regeneration has clearly led to increasing biomass and basal area in protected areas, tree and shrub vegetation in regenerating plots may need to be manipulated to ensure a steady supply of fibre and fodder grasses to communities.

The initial findings from three diverse ecological contexts in south-western, eastern, and northern India demonstrate that community protection has led to significant increases in plant diversity and biomass production. Yet, evidence supporting the efficacy of natural regeneration for restoring degraded forest lands is much stronger. In West Bengal, over the past decade, 350,000 hectares of degraded sal forests have been brought under the protection of 2350 community FPCs.[28] The impact of local management on forest regeneration is clearly visible by analysing a time-series of satellite images of the region, as well as from field-level observation. Thousands of village forest protection groups operating in neighbouring southern Bihar and Orissa have had similar success in regenerating degraded forests with little or no capital investments. In the Sarangi Range of Dhenkanal Division in Orissa for example, more than 100 FPCs protect several thousand hectares of once badly disturbed forests. In Rupabalia forest, the community noted that prior to protection the hillside forest above their village had been reduced to a stony wasteland with little grass. After fifteen years of protection the hill is covered by a dense, multi-storyed forest with high diversity of trees, shrubs, and herbs.

More studies are required to identify patterns of vegetative changes in other parts of the country under natural regeneration.

High Priority Areas for Natural Regeneration

In her pioneering study of degraded forests in India with high natural regeneration potential, Manjul Bajaj used information on species composition, soil type, rainfall, and climatic conditions, combined with land satellite imagery and ground surveys indicating degraded areas.[29] The research found that forests with species that are resilient coppicers (sal, *dalbergia*, *khair*, dhak, and *anogeissus*), fire resistant (sal, pine, *sisso*), grazing resistant (*Butea monosperma-dhak*, acacias, *Zizyphus*), and colonizers (*adina*, pine, *alnus*, and *dalbergia*) had high regenerative potential. Areas with rainfall above 100 centimetres per year and annual minimum temperatures greater than 10 degrees celsius, were also considered conducive environments for natural regeneration. Bajaj found that these conditions prevailed in about 63 per cent of India's forest lands, covering over 40 million hectares. Further, ground studies and remote sensing data indicated that of the 40 million hectares, 29.5 million hectares were degraded with less than 40 per cent canopy closure and in need of community protection if their high natural regenerative potential were to be unleashed.[30] Another recent report noted that degraded forests with less than 40 per cent crown density, occupy 32 million hectares, constituting nearly 46 per cent of the nation's forest area. Much of this area has good ecological resilience and could be targeted for diagnostic assessments and support programmes, especially where communities are already protecting or motivated to assume protection responsibilities. Much of the remaining forests with 40 per cent or greater crown density may have already suffered extensive disturbance and may be rapidly degrading. Consequently, these areas will also need better access controls and require community protection.

More precise field assessments would allow a finer definition of priority areas for natural regeneration. The sequential stages of degradation shown in Figure 10.1 need to be assessed in determining the viability and rapidity of natural regeneration in different forest environments. In stage 3, where logging has occurred but some remaining trees and good rootstock exist, natural regeneration potential is high. In stage 4, although no trees may be present but good coppicing stumps exist, natural regeneration also offers opportunities for rapid regrowth, especially if accelerated by modest soil and water conservation measures. By stage 5, coppicing tree stools may have been removed, topsoil losses are severe, and the hydrological balance is disrupted; weedy species dominate, undermining the establishment of more valuable local species. In stage 6, where most vegetation and topsoil are lost and hydrological conditions are poor, natural regeneration may be impossible, or at most a very slow process, requiring intensive capital investments in soil and water conservation, and plantation. There is an urgent need in India to begin field-level mapping of high potential areas, particularly those in stages 3 and 4, where communities are interested in managing forest resources. Finer spatial definition of high potential regions for accelerating joint forest management initiatives will help guide the forest department and foreign donor investments in this sector.

Approaches to Sustainable Forest Management

Although stopping degradation and initiating natural regeneration through community protection is the first step in restoring the productivity of forest ecosystems, natural systems can be manipulated positively to accelerate recovery and enhance the flow of desirable products. Human interventions, however, need to be directed by specific management objectives.

Soil and water conservation measures such as contour trenching, vegetative bunding, and small check-dams can enhance soil moisture and the accumulation of topsoil, accelerating rehabilitation of the micro-environment. Such conservation measures are helpful in improving germination and growth rates of seedlings. Enrichment planting of desirable local and exotic tree species in degraded forest gaps can generate additional forest products and improve forest density and composition. Cleaning degraded forest lands of dead brush, cleaning stumps, and cutting excessive coppice shoot growth can also facilitate regeneration and promote healthy growth. More extensive enrichment planting is suitable for locations with no coppice or low coppice potential and with moderate levels of soil degradation.

Natural forests can also be manipulated to generate different products, depending on the needs of communities. Artisan communities may place greater importance on specific raw materials needed for their cottage industries. Rope-makers require fibre grasses; potters need large quantities of fuelwood for their kilns; women involved in disposable plate making use sal and dhak leaves in large quantities. Forest resource requirements of different agricultural and pastoral systems also vary. Some farming systems, particularly in the Himalayas and the Western Ghats, depend on heavy nutrient transfers in the form of leaf mulch collected from forest lands. Pastoralists need large supplies of fodder like grass or leaves; forests may be used for open grazing or cut-and-carry systems, depending upon the size and composition of cattle. In other farming systems, the role of the forest may be most important in stabilizing micro-climatic conditions and hydrological functions, ensuring a steady supply of wood for farming tools, and maintaining a habitat for birds that control insect pests. Rural women often require the availability of a diverse range of forest products for food, medicines, tools, fuel, and fodder. One study indicates that certain multi-purpose trees, like *Zizyphus* and *Prosopis*, are particularly important to women. These species tend to be low, versatile coppicers with large crowns, which generate fruits, fodder, and twigs and leaves for fuel.[31]

If manipulated and managed carefully, natural forests can substantially improve the productivity of desired species, absorbing labour while generating greater income in cash and in kind according to seasonal demands. Unfortunately, only limited scientific research has been conducted to identify the most effective ways to manage natural forests intensively for both timber and non-timber products. While community-based, ethnobotanical knowledge is extensive for some ecosystems, it is often undocumented, and rarely used by outside planners. Further, communities have neither the tenurial security nor the right to manipulate forests for long-term productivity increases. In the future, if the natural forests of India are to be intensively managed to optimize yields of desirable products, a broad-based programme of systematic experimentation will need to be initiated jointly by communities and forest departments, in collaboration with universities and non-governmental organizations.

Strategies to Optimize Sustainable Productivity

Increasingly, foresters are beginning to think in terms of managing ecosystems rather than managing a few valuable timber species. Ecosystem management is more complex, because manipulations in one part of the system often affect other components. If forest management is to adapt itself to respond successfully to community objectives, new systems of production will need to be designed, tested, and monitored. The development of non-timber forest products must emerge as a major forest management strategy. NTFPs include fodder, fruits and other food, fibre, gums and resins, oils and aromatic extracts, tannins, medicinal plants, animals and insects, structural woody material, religious and ornamental articles. In other words, NTFPs exclude poles, logs, and pulpwood. From plants, NTFPs may be derived from the leaf, flower, fruit, seed, twig, pods, stem, roots, tubers, or bark. Unfortunately, not much is known about the practical ecological requirements of most NTFPs, including their management within a multiple-use forest, yield-data for different NTFPs, varietal and genetic improvements, and traditional patterns of manipulation and collection.

Reorienting management emphasis to multiple-use, non-timber forest production will help maximize both social and ecological benefits. Unlike timber-harvesting which typically causes major ecosystem disturbances, NTFP collection tends to be much less destructive. If product extraction rates do not exceed sustainable yields and technologies remain simple, the harvesting of timber and non-timber products that are annually renewable may be relatively benign and ecologically sustainable. Furthermore, having used NTFPs for centuries, tribal communities have significant knowledge about their uses, propagation, and ecological requirements.

NTFP-based systems have other advantages. Since they often involve optimization of a diversity of products, they contribute significantly to the conservation of biological diversity. Leafing, fruiting, and flowering patterns are typically seasonal, often becoming available during periods of food shortage or high unemployment, providing important labour opportunities and supplementary income and products during non-agricultural periods. NTFP collection activities tend to be labour intensive, small, and often household-based. Perhaps most significant, because their opportunity costs for collection are the lowest, NTFP systems are disproportionately accessible to the poorest, most forest-dependent minority groups, including tribals, landless families, and women. In fact, harvesting and management of NTFPs are most often practised by rural women; consequently, product benefits, whether they be cash or subsistence items, are likely to be more equitably distributed, both within communities and households. These characteristics combine to make NTFP systems highly strategic for the local economy and the local environment.

Management objectives must specify desired ecological and economic outcomes, reflecting the structure and composition of the forest, as well as indicating the level of product flows desired and the periods when they are most needed. In the forests of south-west Bengal, for decades the forest department has felled the sal trees every six to fifteen years to maximize revenues from the sale of construction poles. The primary goal of this management strategy was to maximize pole yields; however, under this short rotation the sal trees never mature to begin producing valuable oilseeds or reach a size where timber can be harvested. Further, by relying on optimizing sal pole production, markets have been flooded, depressing prices. Average prices received by the Arabari farmers in west Midnapore for 3-inch-diameter poles fell from Rs 14 in 1985 to Rs 5 in 1989.[32] Considering the oversupply of poles, more diverse product management systems need to be developed to maximize and stabilize income flows.

The clear-felling of the sal on a short rotation disrupts the forest ecology and many useful associated species. It also disturbs longer term succession patterns that renew soil fertility. A.N. Chaturvedi contends that rapid rotation fails to provide sufficient opportunities for humus accumulation, soil mycorrhiza development, and regeneration through seeding. He suggests that many sal coppice forests should be used primarily for NTFP collection and fuelwood thinning, allowing them to mature into primary forests over a period of eighty to hundred years.[33] When the forest is felled, villagers report that many important products disappear, while micro-climatic changes occur including the loss of localized humidity and the presence of stronger, hotter winds. To meet both the need for poles and to better maintain the natural ecosystem, the forest department and communities are discussing rotational harvesting of very small patches of forest, 1 hectare to 5 hectares, to protect the healthiest sal to mature into 'mother' trees. Alternatively, some communities may want to gradually thin out coppice growth to allow sal and other useful trees to mature, thereby facilitating the growth of valuable grasses, herbs, and shrubs.

Thinning, cleaning, soil and water conservation, enrichment planting, and timing harvests can all be used to facilitate growth of certain species, and increase and stagger productivity flows. Thinning and pruning allow more light to fall on desired species, accelerating their growth. Cleaning removes dead and decaying organic material, providing room for new shoots to emerge and stimulate healthy coppice stem development. Unfortunately, much of India's forests are not managed in this manner. Forest departments rarely have the budgetary or staff resources to carry out these tasks on more than a small fraction of their forest lands. Communities have no legal authority or usufruct security to manipulate forests. As a result, the productivity of most of India's natural forests is far below their potential.

For example, in south-eastern Gujarat, the state forest department planted thousands of bamboo culms over the past ten years.[34] The bamboo (*Dendrocalamus strictus*) was well-suited to the environment and quickly established itself in the degraded natural teak forests near Limbi village. Yet, the productivity and quality of the bamboo have been far below its potential due to the dense buildup of dead leaves and other organic material. The abundance of litter within the culm has suppressed the growth of new shoots and poses additional fire hazards during the dry season. If the stands were routinely cleaned and thinned, the danger of fires would be reduced, productivity would increase, and a regular flow of bamboo poles would be ensured. Since many *Bhanjara* basket makers live in the community, the demand for bamboo is high. Unfortunately, no mechanism exists to allow villagers to manage the bamboo culms, and the forest department cannot conduct cleaning operations without a budget to hire labourers. The management problem could be resolved by formulating an agreement to allow villagers to clean the bamboo routinely, giving them rights to the thinnings in lieu of pay. Villagers could even be encouraged to fertilize the culms to increase the bamboo's productivity and the community's profits.

Another example of new approaches to management is being developed by foresters and villagers in Harda Forest Division in Madhya Pradesh. In this 142,000-hectare forest tract, 155 village forest protection committees have been formed and now co-manage 70 per cent of the forest area.[35] Initial activities focused on grazing and fire control. Thousands of hectares of forests in Harda Division recently experienced profuse flowering of bamboos, an event that occurs every thirty-five to fifty years. Without protection from annual fires and heavy grazing pressures, bamboo regeneration after flowering is almost impossible. To allow the bamboo to become established, communities developed a system of rotational grazing, effectively keeping cattle out of flowering areas. Fire protection strategies have also been initiated by local forest protection committees, based on participatory rapid assessments where villagers analysed their own use patterns. Villager innovations include backfiring along all footpaths, since discarded bidis (Indian cheroots) at the edge of paths are a common cause of fires. People have also stopped lighting fires under mahua trees, a practice common in Central India to facilitate flower collection. As a result of people's involvement in protection, lush bamboo clumps are now becoming re-established in many protected forest patches.

Foresters and community groups in Harda are also beginning to develop more collaborative, improved management practices. Villagers have complained that multiple shoot-cutting to eliminate excessive coppice growth, was being done improperly and damaging the trees. They also noted that different tree species need to be pruned differently. More specialized techniques are now being developed, not only for teak but for other species including fruit trees. Local villagers with specialized knowledge are now familiarizing forest guards and other community members with these silvicultural techniques. The district forest officer has also noted that sharing agreements must be clarified prior to any operations and has given community members exclusive head-loading rights to all coppice shoot-cuttings.

Finally, in the Harda area many forest protection groups have complained that since the lucrative trade in tendu leaves was taken over by state-run co-operative societies, both yields and total income have fallen. Tendu (*Diospyros melanoxylon*) leaves are used to roll bidis, a low-cost cheroot widely smoked in India.

Tendu leaves are the most important NTFP in Madhya Pradesh and are a major source of employment in forest areas. Since the co-operative's budget for pruning labour is limited, most tendu plants are not pruned; consequently, the plants do not produce a healthy flush of young leaves, resulting in low productivity and a poor quality harvest. Further, because this task is often performed by outside labourers, tendu plants are often mishandled and damaged. The co-operative societies have also shortened the collection season, leaving many plants unharvested. The district forest officer has proposed that forest protection committees be given sole collection rights, and communities have responded very favourably. He has also recommended that they take responsibility for pruning and culturing the tendu plants in their areas. This allows the community to shift from being paid labourers to becoming share-holding managers, with the authority to develop their own culturing systems, including pruning and harvesting procedures.

Whether planning fire protection systems, sharing benefits from intermediate silvicultural operations, or controlling tendu leaf production and collection, the villagers of Harda are beginning to play an active role in forest management. They are moving from joint forest protection to actual joint forest management. Local foresters assist communities to clarify their objectives and discuss different silvicultural and management strategies by holding participatory planning exercises. If new options emerge for Indian forestry, they will be in villages like those of Harda, where the forest department and local communities are exploring new approaches to co-operative forest management.

In badly degraded natural forest environments, community members and foresters will need to plan for short- and long-term product flow requirements, considering ways to facilitate the recovery of lost soil fertility and enhanced micro-climatic and soil moisture conditions. Enrichment planting with nitrogen-fixing species and vegetative soil conservation measures may be initially advisable, followed by selective planting of more valuable trees and shrubs. These measures, however, are uneconomical, often costing Rs 8000 to 10,000 or more. India is rapidly gaining experience with much more cost-effective methods. In southern Rajasthan, foresters and villagers are experimenting with directly seeding local species, including acacia spp., dhak (*Butea monosperma*), *pongamea* (*Derris indica*), and mahua (*Maduca indica*), to complement the regeneration of native acacia, *Zizyphus*, *Lannia*, and *Boswellia*. Villagers collect the seeds in neighbouring forests and plant them in locations with better soils and moisture levels including along fence walls, in places where large stones were removed, in trenches and pits, within the vegetative (*tur*) fences, and behind small check-dams. Survival and growth rates have been good, often surpassing planted seedlings within one to two years. Further, costs range from Rs 300 to 600 per hectare.[36] Low-cost restoration strategies can liberate communities and foresters from depending on centralized bureaucracies and large projects, allowing them to initiate regeneration activities at any time.

Product flows change over time as certain species compete with others for light and nutrients. In Haryana, rope makers are concerned over declining fibre grass yields as *khair* (*Acacia nilotica*) tree canopies begin to close under community protection and grazing controls. Foresters and villagers need greater opportunities to experiment with enrichment grass planting and tree-thinning strategies to ensure that grass yields can be maintained, while allowing forest succession to continue. In the undulating Shivalik hills of northern Haryana, there is a diverse range of microclimatic niches determined by soil conditions, elevation, aspect, and topographic position, whether in a valley bottom, low, mid, or upper slope, or ridgetop. Each location has the capacity to optimally support a different mix of species. Some niches are better suited for grass growth, while others are better suited for acacias and hardy trees; some nutrient- and moisture-rich niches are capable of supporting a good growth of mangoes and other valuable fruit trees. To take full advantage of the capacities of each micro-environment, more detailed, site-specific management plans need to be formulated by local communities.

Optimal harvesting methods should take into consideration both the timing of product demands and sustainable extraction levels. Villagers may require products during periods of drought or unemployment during the agricultural off-season. Producers may also want to time the harvest to correspond to better market prices; yet, to ensure optimal productivity, harvesting may need to be timed to natural maturation cycles. Forest managers also need to assess how much of a given product can be taken without damaging the individual plant. For example, village makers of leaf *pongamea* (*Derris indica*), and mahua (*Maduca indica*), to complement the regeneration of native acacia, *Zizyphus*, *Lannia*, and *Boswellia*. Villagers collect the seeds in neighbouring forests and plant them in locations with better soils and moisture levels including along fence walls, in places where large stones were removed, in trenches and pits, within the vegetative (*tur*) fences, and behind small check-dams. Survival and growth rates have been good, often surpassing planted seedlings within one to two years. Further, costs range from Rs 300 to 600 per hectare.[36] Low-cost restoration strategies can liberate communities and foresters from depending on centralized bureaucracies and large projects, allowing them to initiate regeneration activities at any time.

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Fortunately, there is now increasing documentation from numerous Indian states of alternative, creative community management approaches that are already well-established and witnessing early successes. Through development of a co-operative partnership between forest departments and community user groups, joint forest management strategies can facilitate natural regeneration and improve management of natural forest lands. As biomass-dependent communities organize themselves around the protection and management of degraded forest lands, impressive gains in revegetation will be visible in many locations.

Notes

1. Ann Clark and Prabhir Guhatakurta, 'The World Bank in the Forestry Sector: Policies and Issues in India', *Wasteland News*, 9(1): 25, August–October 1993.
2. Ibid.
3. N.S. Jodha, 'Common Property Resources: A Missing Dimension of Development Strategies', World Bank Discussion Papers no. 169 (Washington, D.C.: The World Bank), pp. 22–4.
4. Jack Westoby, *Introduction to World Forestry* (Oxford: Basil Blackwell, 1989), p. 45.
5. Madhav Gadgil and Ramachandra Guha, *This Fissured Land: An Ecological History of India* (New Delhi: Oxford University Press, 1992), pp. 239–45.
6. Piers Blaikie and Harold Brookfield, *Land Degradation and Society* (London and New York: Methuen, 1987), p. 1.
7. Ibid., pp. 6–7.
8. Ibid., p. 7.
9. Walter Fernandes, Geeta Menon, and Philip Viegas, *Forests, Environment and Tribal Economy* (New Delhi: Indian Social Institute, 1988), pp. 2–3.
10. Noted in a presentation by the Inspector General of Forests, Mr. C.D. Pandeya, at the National Workshop on Joint Forest Management, Surajkund, August 1992.
11. Society for the Promotion of Wastelands Development (1984).

12. Madhav Gadgil, Nerendra Prasad, and K.M. Hegde, 'Whither Environmental Activism', *Deccan Herald* (Bangalore), 19 February 1984.
13. Michael R. Miller, 'Mycorrhizae and Succession,' in W Jordan, M. Gilpin, and J. Aber (eds), *Restoration Ecology: A Synthetic Approach to Ecological Research* (Cambridge: Cambridge University Press, 1987), p. 205.
14. Ibid., p. 209.
15. Nicholas Malajczuk, Norman Jones, and Constance Neely, *The Importance of Mycorrhiza to Forest Trees*, Land Resources Series no. 2 (Washington, D.C.: The World Bank, n.d.), pp. 2–5.
16. Norman Meyers, *Deforestation Rates in Tropical Forests and Their Climatic Implications* (London: Friends of the Earth, December 1989), p. 33.
17. World Bank, 'India's Environment: A Strategy for World Bank Assistance' (New Delhi: India Department, World Bank, March 1989), p. 4.
18. According to India's National Forestry Policy Act of 1952, one-third of the nation's land area was to be brought under forest cover.
19. D M. Chandrashekhar, B.V. Krishna Murti, and S.R. Ramaswamy, 'Social Forestry in Karnataka: An Impact Analysis', *Economic and Political Weekly*, 22(24): 935, 13 June 1987.
20. N.C. Saxena, 'Farm Forestry in Different Agro-Ecological Regions of India' (paper prepared for the International Workshop on India's Forest Management and Ecological Revival, New Delhi, 10–12 February 1994), p. 5.
21. World Bank, 'Uttar Pradesh Social Forestry Project' (Credit 925–IN), Project Completion Report, 22 May 1989.
22. See N.C. Saxena, 'Farm Forestry in Different Agro-Ecological Regions of India', p. 3.
23. Government of Gujarat, Lifting of Seedlings in Farm Forestry Programme', Gandhinagar, Forest Department, Government of Gujarat.
24. IIPO, 'A Report on the Survival Rates of Trees: 1983–84 to 1987–88' (New Delhi: Indian Institute of Public Opinions, 1991).
25. Mandred Seebauer (ed.), 'Study of Social Forestry Programmes in India: Draft Final Report' for the National Wastelands Development Board and the World Bank, p. 1.
26. See N.C. Saxena, 'Farm Forestry in Different Agro-Ecological Regions of India', p. 4.
27. Subhabrata Palit, 'The Future of Indian Forest Management: Into the Twenty-First Century,' Joint Forest Management Working Paper no. 15 (New Delhi: The Ford Foundation, December 1993), p. 3.
28. WWF and SPWD, 'Case Study on Participatory Forest Management in West Bengal' (New Delhi: World Wide Fund for Nature-India and the Society for the Promotion of Wastelands Development, 1994), pp. 17–18.
29. Manjul Bajaj, 'An Examination of the Potential for Investment in Natural Regeneration of Degraded Forests with Community Participation', *Wasteland News*, August–October 1990, pp. 7–22.
30. Ibid., p. 18.

31 N.C. Saxena, T. Shah, and R. Chambers, *To the Hands of the Poor* (New Delhi: Oxford University Press, 1989).

32. P. Guhatakurta, 'The World Bank in the Forestry Sector: Policies and Issues in India', *Wasteland News*, August–October 1993, p. 16.

33. A.N. Chaturvedi, 'Management of Secondary Forests', *Wasteland News*, August–October 1992, pp. 39–44.

34. M. Poffenberger, B. McGean, A. Khare, and J. Campbell, *Field Methods Manual: vol. 2, Community Forest Economy and PRA Methods in South Gujarat, India* (New Delhi: Joint Forest Management Support Programme, 1992), pp. 47–66.

35 V.K. Bahuguna, Vinay Luthra, and B.M.S. Rathor, 'Collective Forest Management in India', *Ambio*, 23(4–5): 269–73, July 1994.

36. Information from conversations with Deep Naryan Pandey, district forest officer, Udaipur South Division, Rajasthan, February 1994

37. Deb Debal, 'An Estimation of the Possible Effect of Community Leaf Harvesting on the Productivity of Sal' (Calcutta: IBRAD, 1990).

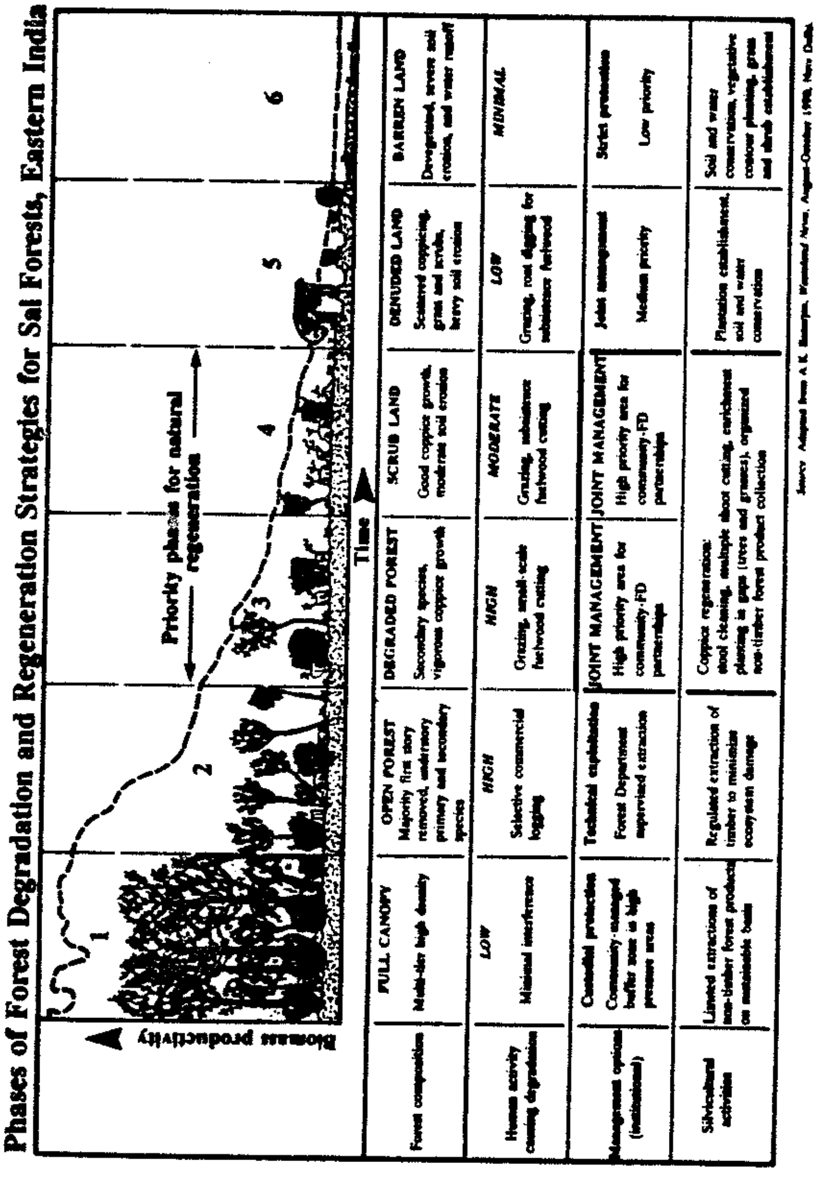

FIGURE 10.1 Common stages of forest degradation

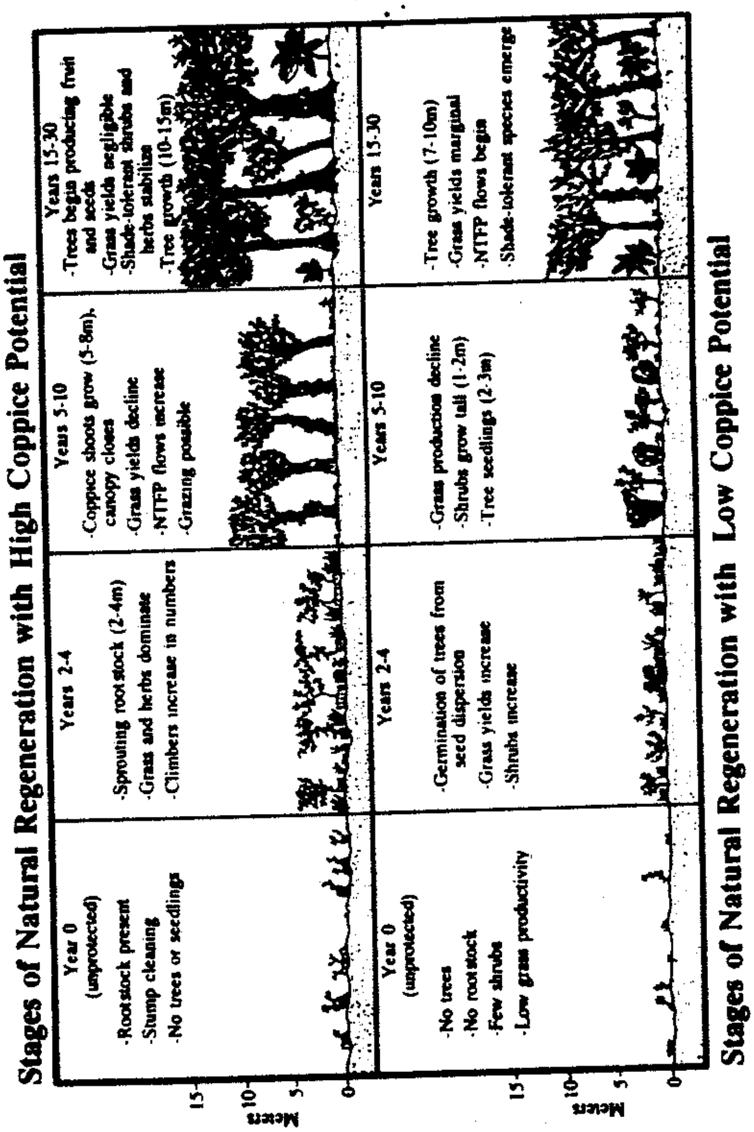

FIGURE 10.2 Typical stages of natural regeneration

Box 10.1: Forest disturbance activities and ecological impacts

Forest Disturbance	*Ecological Impacts*
Non-sustainable extraction of firewood	• increased soil erosion • higher water run-off, lower retention • loss of branches, leaf area index, photosynthetic parts • loss of tree and shrub diversity due to excessive removal • repeated harvest leads to mortality of tree/shrub • in severe cases even rootstock is dug up, preventing coppice regeneration
Excessive grazing	• loss of diversity and palatable species — emergence of non-palatable species • loss of protective vegetative cover to soil • suppression of natural regeneration: seedling and coppice • soil erosion • soil compaction — greater run-off and reduction of groundwater recharge
Excessive lopping of tree leaves for manure or plate making or for fodder	• canopy opening — invasion of non-native shrub and herb species • disturbance of nutrient cycling — loss of soil nutrients • reduction in tree growth

Non-sustainable legal and illegal timber felling	• loss of tree and tree species and companion species • canopy opening • more damage to plants due to felling, shaping, and transportation • increased soil erosion • increased water run-off, decreased waterholding capacity and slow discharge ability
Forest fire or grassland fire	• damage to natural regeneration • higher and more tender grass growth for next season • fire-resistant tree species survive and others induced to germinate • exposure of soil to high intensive premonsoon rains • increased soil erosion • increased nutrients temporarily • decrease in mycorrhiza due to high soil temperature and loss of food supply

Box 10.2: Ecological impacts of conventional block plantations

Parameters	*Ecological Impacts*
Tree species composition and loss of biodiversity	• loss of local tree diversity in forests, farms, commons • dominance of a few exotic tree species • vulnerability of monoculture to pests, disease, drought, etc. • loss of micro-habitats leading to decline in wildlife diversity • high density suppresses ground vegetation • loss of companion species for climbers, herbs • loss of multi-tier micro-habitats in degraded forests, farms, commons, for birds, insects, reptiles, micro-organisms, etc. • loss of diverse biomass and continuous product flow to humans: food, fodder, raw materials for artisans, manure, oilseeds, etc. • loss of soil quality (micro-organisms, nutrients, etc.)
Sustainability	• repeated short rotational harvests lead to reduction in soil fertility; monocultures are vulnerable to pests, disease attacks
Grass growth	• high density monocultures suppress grass growth

Productivity	• low productivity of plantations in the absence of appropriate soil and water conservation measures and high-quality seeds or coppice
Soil nutrient status	• reduction in soil nutrient status compared to mixed cultures; conservation or primary forests • soil erosion — loss of clay, silt, and humus in topsoil
Groundwater recharge and use	• generally known to be low in plantations compared to mixed cultures or natural forests • surface run-off high • exotic monocultures tend to be more water-demanding

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The DFO, with a small staff of range and beat officers, is unable to protect the vast forest area under his jurisdiction. Instead; much of his staff's time is devoted to planting a few thousand hectares of highly degraded land, while more than one-half of forest lands under his administration are rapidly degrading. Despite the innovative technical strategies being employed in the small project sites, requirements for budgeting, planning, nursery establishment, protection, and monitoring are staff intensive. As a result, donor support is drawing staff attention away from resolving the resource conflicts that are driving forest degradation on much of the forest lands. If such capital intensive, technically oriented social forestry strategies continue for another ten years in south Udaipur, while a few thousand hectares might be rehabilited, the vast majority of divisional forest lands could experience further degradation and lose much of their regenerative potential.

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1 J.P.L. Srivastava and R.N. Kaul, *Greening of the Common Lands in the Aravalis*, Government of Haryana Forest Department: Gurgaon. p. 5, 1994.

2. Ibid., citing Professor Dhabriya, *The Pioneer*, Press Trust of India, 16 December 1993.