Theme Paper for National Biodiversity Strategy and Action Plan

Tree Plantations and Biodiversity in the Indian Context

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Tree or forestry plantations have been eulogized by corporate and industrial stakeholders for being predictable, reliable, malleable and flexible (Anon., 1998). These virtues speak very little when it comes to their role in biodiversity conservation. Plantations have impacted on biodiversity in complex ways. While, in some cases, plantations have undermined biodiversity wealth, in certain cases, they have facilitated conservation of biodiversity. While the need for conserving biodiversity in India is central, a national programme for development of natural resources is necessary for its success. Accordingly Chapter 11 of the Agenda 21, calls for national forestry action programmes, that promote, amongst other activities, revegetation of degraded areas. Tree plantations, particularly those that are multi-specific in nature could minimize pressures on the India's biodiversity wealth if well designed, structured and managed.

The pattern of relationships between plantations and biodiversity conservation would depend upon the ownership structure of plantations and the target groups to which they cater in terms of their end-products. The view that man-made plantations with their monoculture bias and orientation towards production of industrial raw material orientation constitute a direct threat to biodiversity has been well harped upon particularly in the context of the *Eucalyptus* debate in India during the 1980s and 1990s. On the other hand the role of man made plantations

in improving the biomass base of rural economies and in reducing biotic pressures on protected areas and reserved natural forests has been highlighted by the forest establishment (Lal, 1989).

The impact of farm forests and other public owned forest plantations on agro-biodiversity including livestock and agrogenetic resources has been a much debated issue. The positive impact of multi specific tree-plantations and polyculture agro-forestry systems in increasing the diversity of consumptive and non-consumptive biomass relevant to local communities is a point that is accepted by different interest groups.

The paper has been structured against the backdrop of these issues. This paper examines the typology, evolution and rationale for tree/forest plantations in India from a historical perspective. After taking note of the fact that plantations evolved on account of the limits reached with regard to exploitation of natural forests for supply of industrial raw materials, the paper proceeds to critically survey the principal sustainability issues concerning tree plantations in India.

The paper attributes the failure of forest plantations in India to their harmful ecological and social effects. This in turn can be attributed to many reasons including inappropriate and improper choice of plantations sites. The paper argues that apart from being ecologically unsustainable in a large number of cases, plantations have not been successful even in the narrow economic sense. In other words tree plantations in India have, notwithstanding a few exceptions, been neither conducive to biodiversity conservation nor to economic success. However these facts do not take away the intrinsic strength of plantations as a reliever of biotic pressures on natural forests and agroecosystems.

The paper argues that plantations have to be multi - specific if they are to properly serve their mission of saving the biodiversity of natural forests. Therefore the solution to the present problems associated with India's tree/forestry plantations lies in adoption of a slew of measures to improve their sustainability. The paper suggests a matrix of sustainable plantation activities for biodiversity conservation in India.

Typology and Evolution of Tree Plantations in India

In terms of their ownership control, management structures and fundamental goals, tree plantations in India can be categorized into the following:

- Public forest plantations of the State Forest Department which have been raised on forest lands (both degraded and graded) for the purpose of supplying industrial raw materials.
- Social forestry plantations of the State Forest Department which are designed to satisfy biomass needs for rural communities.
- Farm forest plantations raised on private property resources in different parts of India, and whose products also meet the raw material requirements of industries.
- Plantations that have been raised (or regenerated) and managed through Joint Forest Management Programmes.

India sustains a diverse range of vegetation and fauna both in forest and non-forest lands. Of special concern has been the protection of natural vegetation in forest lands in India. Forests of India can be categorized into 16 major groups covering 221 types of forests. A forest type is a unit of vegetation, distinct in physiognomy and structure and which gets distinguished from others on the same count. As per the 1993 assessment of the Forest Survey of India, the forest cover in India extended over 640107 sq. km. This covers dense forests with crown density above 40%, open forests with crown density from 10 to 40% and mangroves. Dense forests accounted for 385008 sq. km in 1991 while open forests accounted for 249930 sq. km. in that year, while temperate vegetation characterizes the Lower Himalayan Region. The situation of change in forest cover in India, during 1991-93 to 1993-95 is

brought out in **Table 1**. A clear picture of decline in forest cover emerges from **Table 1**. On first sight the decline may not be perceptible as it comes to only 0.85% during the period under reference. But if one excepts the fact that the rate of growth and stocking of forest resources is a slow process, the severity of losing nearly 1% of the resource in a span of 2 years becomes apparent. India's goal of attaining a forest cover equivalent to 1/3rd of the country's geographical area makes it absolutely important to reverse even a small decline in forest resources. It has also been our endevour to increase the stocking levels of forests with low crown density. Plantations are considered to be one of the favoured solutions for achieving areal increase in forest cover. The scope for increasing stocking levels of our country's of India's commitment to biodiversity conservation, the 'biodiversity' impacts of tree plantations need to be carefully evaluated.

Table 1

Comparative Account of Forest Cover of States / Union Territories in 1991-93 and 1993-95

State / Union Territory	Forest area (million hectare) based on satellite imagery		
	1995 assessment (period 1991-93)	1997 assessment (period 1993-95)	Change
Andhra Pradesh	47.112	43.290	- 3.822
Arunachal Pradesh	68.621	68.602	- 0.019
Assam	24.016	23.824	- 0.237
Bihar	26.561	26.52	- 0.037
Delhi	0.026	0.026	Nil
Goa	1.247	1.252	+ 0.005
Gujarat	12.320	12.578	+ 0.258
Haryana	0.603	0.604	+ 0.001
Himachal Pradesh	12.501	12.521	+ 0.020
Jammu and Kashmir	20.433	20.440	+ 0.007
Karnataka	32.382	32.403	+ 0.021
Kerala	10.336	10.334	- 0.002
Madhya Pradesh	135.164	131.195	- 3.969
Maharashtra	43.843	46.143	+ 2.300
Manipur	17.556	17.418	- 0.140
Meghalaya	15.714	15.657	- 0.057
Mizoram	18.576	18.775	+ 0.199
Nagaland	14.291	14.221	- 0.070
Orissa	47.107	46.941	- 0.166
Punjab	1.342	1.387	+ 0.045
Rajasthan	13.280	13.353	+ 0.073
Sikkum	3.127	3.129	+ 0.002
Tamil Nadu	17.045*	17.064	+ 0.019
Tripura	5.538	5.546	+ 0.008
Uttar Pradesh	33.086	33.994	+ 0.008
West Bengal	8.276	8.349	+ 0.073
Andaman & Nicobar Islands	7.615	7.613	- 0.002
Chandigarh	0.007	0.007	Nil
Dadra & Nagar Haveli	0.204	0.204	Nil
Daman & Diu	0.003	0.003	Nil
Lakshadweep**			
Pondicherry**			
Total	**638.879***	**633.397**	**5.482**

Note: *An area of 72,100 hectares of tea gardens, earlier shown as forest cover, has been excluded from the forest cover; ** No discernible forest cover

Source: Anon 1997, The State of Forest Report 1997, Forest Survey of India, Dehradun

The origins of forest (tree) plantations in India can be traced to the pre-independence period. Nilambur in Kerala is often recorded as the site of the first teak plantations in India. Between 1841 and 1855, 1500 acres of *Tectona grandis* (Teak) plantations were raised in Nilambur under the supervision of the District Collector of Malabar by name Connolly. (Rao, 1971). In North West Bengal teak was raised in 1868 in Bamanpokhri, while *Eucalyptus globulus* plantations made their entry into Ootacamund in 1843 followed by exotic *Acacias.* In the Western Himalayas planting of *conifers* was taken up a little later in 19th century and *Cedrus deodara* (Deodar) was the principal species in Eastern Himalayas. *Cryptomeria japonica* had also made its advent as plantation species in the Himalayas in 1868 mixed with indigenous *oaks*, *maples*, *laurels* and *magnolias.* Plantations of Dalbergia *sissoo* were raised in the dry Punjab plains in the 19th century. Between 1866 and 1960 nearly 3800 hectares of this tree got planted in Punjab. (Ghosh, 1977). Notwithstanding, the success of these plantations, industrial raw materials needs in pre-independence India were met through systematic exploitation of India's natural forests. Clearfelling, selective felling, shelter wood systems, natural and artificial regeneration, formed the major silvicultural systems applied to Indian forests for extraction of their timber wealth (Anon, 1989). Teak plantation areas in Kerala, Karnataka, Tamil Nadu, Madhya Pradesh, Maharashtra and Andhra Pradesh came under clearfelled areas (ibid). The silviculture technique of 'selective felling', whereby mixed forests were worked upon by the Forest Departments, was based on felling of selected species, which met the needs of urban and industrial users. A wide range of evergreen forests were subjected to selective felling in Kerala, Karnataka and Tamil Nadu while moist deciduous forests in Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, Andhra Pradesh and Assam were placed under selective felling regimes. The dry deciduous

forests subjected to selective felling included tracts in Tamil Nadu, Karnataka, Bihar, Uttar Pradesh and Madhya Pradesh (ibid). Management of the Upper Assam evergreen forests was primarily dictated by the growing demand for raw materials by the plywood industry. The parameters of rotation, regeneration period and exploitable girth were revised periodically to enhance immediate wood supply. But implementation of regeneration prescriptions was far from satisfactory. Further, the 'selective felling' with its species-oriented approach neglected the complexity of the ecological status of forests, contributing thus to unsatisfactory results on the regeneration front (Anon., 1989). Consequently, most of the forests in Upper Assam became depleted. The plywood industry had to rely upon resources available from States / Union Territories like Arunachal Pradesh and Nagaland to fill gaps in demand. Natural forests in these regions also soon fell into a state of degradation (Anon., 1989). Compared to these systems of exploitation of forest, regeneration through 'coppice' and 'artificial regeneration' were great improvements. While natural regeneration through coppice had worked well with *Shorea robusta* (Sal), artificial regeneration was resorted to in areas where natural regeneration was not possible.

The paper and pulp industry of India also underwent changes. In the earlier stages in post-independence India, the paper industry of the country relied on sabai grass (*Eulaliopsis binata*) for more than 50 % of the raw material requirements (due to its special fibre characteristics and durability and strength of this species). By mid 1960s the bamboo replaced the sabai grass. However, with the depletion of these raw materials, from the natural forests, new raw materials had to be sourced. This had to be achieved without destruction of natural forests.

The stage was therefore set for initiation of large programmes of planting trees on both degraded and non-degraded forestlands of India. While natural forests and non-degraded forestlands were both transformed in order to raise high productivity forest plantations. Forestry plantations in degraded areas came up without the destructive practice of 'clear felling'. The Planning Commission of India in the mid sixties recommended raising of forest 'plantations' to prevent user industries from falling into a raw material resource crunch situation. While noting the increased dependence of India's paper and pulp industry on bamboo (*Dendrocalamus strictus* and *Bambusa arundinacea*), the Commission advocated plantation programmes centering on 'bamboo' to compensate for the depleting stocks in North, South and Eastern India. The trend towards adoption of plantation programmes was further accelerated in the seventies on account of the recommendations of the National Commission on Agriculture (NCA) (1973). The NCA, while projecting negative wood and timber balance for India in the closing decades of the 20th century, advanced the concept of 'production forestry', based on establishment of 'high productivity' man-made plantations. A string of Forest Development Corporations (FDCs) was accordingly set up in the 1970s to corporatize the process of production forestry in India. It was envisased that by transforming departmental programmes of afforestation into corporatized plantation programmes, institutional finance for forest plantations could be leveraged for the sector on a larger scale than before. It is noteworthy that the FDCs were envisaged to take up man-made forestry programmes after clearfelling natural forests (Anon., 1989).

Also recommended by the NCA was a scheme of social forestry on forestry lands. This recommendation was impelled by the realization of

the enormity of the growing deficit in wood and biomass balance in the rural and peri-urban areas. The social forestry programme included the activities of reforestration of degraded forests, farm forestry, extension forestry and recreation forestry (Kapoor., 1994). The scope of the social forestry programme involved utilizing, village waste lands and surrounding degraded forest lands for raising tree plantations. Firewood and small timber were considered to be the primary products of social forestry programmes. It was also the aim of the social forestry programmes to arrest the trend towards degradation of natural resources and ensure optimum utilization of land, water, livestock and human resources. However, the species choice in social forestry schemes were biased towards *Eucalyptus* and *Acacias* (Ravindranath et al., 2000). This point substantiates the point made by ecologists about the fragmentation effect of *Eucalyptus* and related monocultures on natural diverse ecosystems of India (Gadgil et al., 1990). This situation was logical given the trends towards single specie plantations noticed in India in the post NCA and social forestry phases. In the late 1970s and early 1980s, the popularity of fast growing tree species (notably *Eucalyptus* spp.), induced large scale practice of 'farm forestry' in the drier areas in North, Central and South India. Whereas previously only the village wastelands and common property resources were taken up for cultivation of these species, farm forestry caused the spread of these tree species to traditional cereal cultivated lands as well. Farm forestry mushroomed in the States of Punjab, Haryana, Gujarat, Karnataka and Tamil Nadu.

On 5th January 1985, with the establishment of the National Wastelands Development Board, a target of bringing 5 million hectares of wastelands under fuelwood and fodder plantation was initiated in the Seventh Five Year Plan through a peoples movement. The National

Forest Policy of 1988 was subsequently introduced with greater focus on conservation and peoples' participation. In many ways this policy overcame the bias of the National Forest Policy of 1952 against local needs and conservation interests (Nadkarni., 1996). The stage was thus set for the JFM process.

In June 1990, the Government of India came out with its circular for involving local communities and non-governmental organizations in the development of forests. The 'Joint Forest Management' (JFM) process thus commenced in the country. The JFM process involved setting up of forest protection committees for the management of degraded forest lands. These committees comprised of representatives of local communities and local forest officials. The committees had to protect the forests and also impose fines and other regulatory practices necessary for such protection. The benefits of protection were to be transferred to communities concerned. Where the 'produce' was sold, a share of the sale proceeds was deposited as village development funds for uplift of the village forests. In States such as Karnataka, 25 % of the sale value on timber is also distributed to the protecting communities. The JFM model has been considerably influenced by the success of the Forest Department of West Bengal, in mobilizing village communities for revival of 1272 hectares of degraded sal forests in 11 revenue villages of Araberi in Midnapur District.

Apart from the Araberi experience, the JFM process has also been successful in certain pockets in the States of West Bengal, Bihar, Orissa, Karnataka and Haryana, where self initiated community forest management systems have been in vogue (Ravindranath et al., 2000). According to the authors JFM accounted for nearly 39.22 % of the open forest area in the country. JFM has also been practiced in revenue

wastelands, roadsides, canal sides and tank-shores. The authors further note that JFM plantations have not always been based on mixed species and have also not adopted a rational approach in tribal dominated areas. The authors also observe that JFM has been budget-intensive. JFM is also considered to have ensured gender participation. In states such as Gujarat, Jammu and Kashmir, Karnataka and Madhya Pradesh, women representation in executive committees of JFM bodies is specially provided for and well enforced. The significance of managing NTFP plantations with active participation of women is noteworthy since they account for a high proportion of NTFP collection (Ravindranath, et al., 2000).

Despite its limitations the JFM had by 1st January 2000 covered 10.24 million hectares of forestlands through 36075 committees in 22 States of India.

Today India has the world's largest area under forest plantations as per FAO's Forest Resources Assessment of 1990. As per this report, of the 30.66 million hectares of forest plantations reported by 90 countries of the tropical zone, India accounted for 13.23 million hectares of the tropical world total plantations. The National Wasteland Development Board, reported planting of 18,000 million trees in the country between 1980 and 1988, of which 10,000 million trees (equivalent to an area of 5 million hectares) was planted on farm lands covering an area of 5 million hectares. Between 1990-91 to 1995-96, 5.571 million hectares of public lands were afforested by the Government of India and the States, while 6.9649 billion seedlings were distributed for planting on private lands (Agarwal et al 1999).

Table 2 sums up the details.

Table 2
Government Afforestation Effort during the 1980s

Year	`Area of public lands covered, including forest lands (million hectare)		Seedlings distributed for planting on private lands (billion)	
	Target	Achievement	Target	Achievement
1990-91	0.550	0.744	2.5000	1.2588
1991-92	1.050	1.016	1.5000	1.4194
1992-93	0.064	1.062	1.4500	1.2450
1993-94	1.165	0.963	1.3509	1.1097
1994-95	1.031	0.984	1.2085	1.0810
1995-96	1.123	0.802	1.1354	0.8509
Total		**5.571**		**6.9649**

Source: Various Annual Reports of the Ministry of Environment and Forests, Government of India, New Delhi

Thus forest plantations in India evolved out of the necessity for supplying industrial raw materials. Plantations started coming up in the wake of the dwindling supply of forest based raw materials from natural forests. In the post independence period the production forestry slogan gave further push to the process of forest plantations. However the advent of social forestry schemes in India in the late 1970s was motivated by the need to provide for the biomass needs of rural and peri-urban population. It took nearly one and a half decades after the initiation of the social forestry programme for the Government of India to impart distributive justice to the local communities from this programme. The introduction of the Joint Forest Management Programme was the first step in this direction.

Sustainability Issues in Tree Plantations

Bass and Sargent (1992) conceive sustainable plantations as comprising of the following:

- Industrial plantations providing a proportion of the wood harvest to local people;
- Industrial plantations with multi-purpose trees as a component, and guaranteed public/community access;
- Small plantation blocks within a farm system, usually as outgrower plantations;
- Silvi-pastoral systems in which commercial wood production and local grazing are combined;
- Agroforestry systems in which wood production and agricultural crops are combined;
- Integral taungya systems, where a large forestry plantation resource is built up by phasing many small participatory forestry operations;
- Tree tenure forestry, where landless or poor farmers establish plantations on state land allocated to them specifically for tree growing;
- Forms of plantations that can accommodate recreation/amenity requirements.

The authors rightly note that plantations are inappropriate when established on land of higher value for other social, environmental and economic purposes. These include natural forests and agro ecosystems, which are rich in biodiversity. Plantations that come up in degraded sites can relieve biotic pressures from natural forests, provided that they themselves display multi specie characteristics.

Moore et al., (1999) consider ‘stability’, ‘structure’ and ‘productivity’ to be the critical factors that render biodiversity important for forests managed supply of industrial raw materials. Ecosystem stability tends to be intrinsically lower for single specie crops as they are more vulnerable to pests and diseases on account of low genetic and structural diversity. Likewise single specie plantations by eliminating natural associates deny possibilities of multi-layer canopy, forest floor variation and diversity of biotic community. This in turn could affect the very sustainability of such plantations. Even viewed from the ‘productivity’ angle, higher plant diversity produces sustainable positive effects on yield levels of the preferred species. (Damodaran 1992). Indicators of a sustainable forestry plantation include floral variety, avifaunal and herpetofaunal variety, presence of forest mammals and invertebrates, amongst others.

In short the sustainability issues concerning tree plantations can be extremely difficult to comprehend in terms of its systemic complexities. Narrow economic considerations which just focus on maximizing the output of a preferred species can be counter productive in the long run as they deny the principle of diversity resulting in gradual decline of the desired output.

Sustainability Issues Concerning Tree Plantations in India

The debates on tree plantations in India, have centered on three dimensions viz. the ecological sustainability, social equity and economic viability. Tree plantations have been criticized as being neither economically viable nor ecologically sustainable. The latter criticism led to the National Forest Policy, 1998, prohibiting clear felling of natural forests for raising fuelwood plantations with exotic species without scientific trials.

Ecological and Social Equity Concerns with Tree Plantations

The principal ecological concerns with tree plantations have been voiced in the context of experiences with monoculture plantations and more prominently in the context of the pines, poplars and *eucalyptus* plantations attempted in India in the past. These debates raised ecological and social issues of concern relating to these plantations.

The following events recount the context of the debates.

In the pre-independence period forest departments experienced setbacks in trying to grow certain local species as pure plantations. Thus *Gmelina arborea* failed as a pure plantation crop after it fell to infestation by *loranthus*. Similarly pure stands of *Cedrela toona* attempted in different parts of the country suffered from die-down. Pure plantations of *Michelia champaca*, a favoured species of Bengal suffered damages from the bug *Urostylis punctigera*, while plantations of *Simul* attempted in different parts of India fell prey to attacks by a shoot-borer by name *Tonica niviferana*.(Rao., 1971).

The advent of Chir Pine *(Pinus rexburghi)* in the Uttar Pradesh and Himachal Pradesh hills invited the allegation of promotion of monoculture in the Himalayan region. The rationale for popularising Chir Pine plantations was its rich resin base. The ecological effects of Chir pine plantations (which had by 1980 covered an area of 20,000 hectares in the Himalayas) have been highlighted in terms of depletion of soils and streams, suppression of undergrowth and more significantly in terms of its destructive effects on the oak ecosystems, natural to both Western and Eastern Himalayas (Sinha., 2002). The negative effects of pine needle decomposition on under growth and reestablishment of Oak was another point of criticism levelled against the species. Some of

these criticisms have been countered. (Singh., 1993). However, even its ardent defenders concede that Chir pine, with its invasive characteristic is a ruderal-cum–stress tolerant species (an early successional species, having ability to colonize disturbed sites which complements its ability to withstand exterme environmental stress). The Chipko movement of Garhwal Himalayas had successfully raised the voice of local communities against pine plantations, on the ground that they have displaced local diversity on which people's livelihoods were dependent besides inhibiting local communities from access to pasturelands or degraded forests. The movement against new pine plantations in Bastar District by the affected Adivasis is another clear hint of the growing movement against monoculture plantations, that have the effect of adversely affecting the cultural and biodiversity wealth of local communities.

The Southern States of Karnataka, Tamil Nadu and Kerala formed the battleground of the *Eucalyptus* debate in its initial stages. This was natural, given the tradition the three states enjoyed in patronizing this genus. Tipu Sultan, Captain Cotton and the Kanan Devan Produce Co., were the respective patrons of *Eucalyptus* in the states.

The initial rumblings started over *Eucalyptus* plantations raised over 30,000 ha in the Malnad region of Karnataka (particularly the districts of Shimoga, North Kanara and Chikmagalur) for catering to the Harihar Polyfibres. The resentment was mainly on account of the clearance of natural forest areas in this region for raising *Eucalyptus* plantations under the fast growing species project launched by the state government in the First and Second Five Year Plans. In the Nilgiris (Tamil Nadu), the Central Soil and Water Conservation Research and Training Centre recorded complaints about *Eucalyptus* depleting ground

water in large quantities. Interestingly Nilgiris was the pioneer Districts as far as *Eucalyptus globulus* (Blue Gum) plantations. The first *Eucalyptus globulus* plantation was established by Captain Cotton in 1856. The ostensible strategy behind this plantation activity was to solve the firewood shortage problem in Nilgiris. While these plantations could achieve these objectives, this entailed destruction of Sholas.

The Kerala Forest Department, which took up a chequered programme of afforestation in the high range grasslands of Peeremeedu, Pamba and Devicolam in the 1950s. The Kannan Devan Produce Company introduced *Eucalyptus g*randis as fuel species in 1955. In the following year the Kerala Forest Department made an experimental plantation of 2 acres in a grassy area near Peermade. Subsequently moist deciduous, semi-evergreen and evergreen forests over 6,000 ha were cleared for planting *Eucalyptus* g*randis* and the controversial *Eucalyptus tereticornis* (Mysore Gum) species in Perumuzhy, Vazhachal, Kalady and Perumbavoor. This experiment invited the disaster of pink-disease fungus ridden trees and criticism from environmentalists (Nair., 1984). Among the more than 600 species of *Eucalyptus*, *Eucalyptus* tereticornis (popularly known as Mysore Gum) was the most prominent object of controversy as this species was over-enthusiastically tried out almost everywhere from Kanyakumari to the Himalayas – in sandy and clayey soils and under rainfall conditions ranging from 500 mm to over 1000 mm per annum.

These plantings, which often ended in failure, were carried out at the cost of the natural vegetation. Indeed, the Central Forestry Commission in 1982 (still wedded to the National Commission of Agriculture philosophy of production forestry) had to admit that the newly planted *Eucalyptus* grown in clayey Babul *(Acacia nilotica)* – occupied tracts of

Andhra Pradesh had to suffer destruction by the Babul Stem and Root Borer. On realizing the mistake of the dangerous *Eucalyptus* course in high rainfall areas, the Karnataka forest department banned planting of *Eucalyptus* in clear-felled forest areas in high rainfall zones. The other two states likewise adopted a cautious policy. It was also accepted that the policy of planting Mysore Gum in all agro-edaphic zones was not desirable.

Hydrological apprehensions also assumed major proportions as the focus of the debate shifted to the dry land areas. This was spurred by secondary information on the role of *Eucalyptus* as a remover of water-logging and a depressor of ground-water levels in countries like Australia and South Africa. Kapoor reports how experiments conducted by the Uttar Pradesh Forest Departments had proved that the uptake of water by *Eucalyptus* hybrid was minimum (as compared to *Albizzia lebbeck*, *Acacia auriculaeformis* etc.) reckoned in terms of water consumed per gram of biomass produced (Kapoor., 1994). However this did not allay apprehensions of local communities in water short areas. In Rajasthan a movement started in a village named Samredkalan Khurd in the year 1994, whereby residents of the village alongwith Sarpanches from nearby villages protested by chopping of old *Eucalyptus* trees on the ground that it caused depletion of ground water. However no primary proof existed regarding the hydrological effects of *Eucalyptus* in dry areas in general and in the specific context of India.

Meanwhile, the context of the debate was rapidly shifting to *Eucalyptus* plantations in the semi-arid and dry agriculture areas. Karnataka was again the major theatre of debate at this stage as the state had a substantial chunk of non-arable lands (referred to as C & D lands) in the districts of Bangalore, Tumkur, Kolar, Chitradurga and Dharwar under

Eucalyptus. Equal was the concern about the dramatic spread of Mysore Gum in agricultural lands replacing the traditional cereal of Finger Millet (ragi) in these dry areas. There were deeper apprehensions about the adverse effect of the *Eucalyptus* trees on the yields of agricultural crops planted and cultivated nearby, due to the hydrological concerns described earlier.

The debate at this stage also assumed interesting social dimensions. It has been increasingly known that rich farmers and absentee landlords are prime beneficiaries of the *eucalyptus* based farm-forestry trend in the districts. A study of a drought-hit village in the nearby taluk of Hoskote by this author noted the area impact of *Eucalyptus* plantation, on the village livestock, thereby triggering an acute fodder crisis (Damodaran 1987). Though the Forest Department was blamed for popularizing a 'pernicious' tree as a farm forestry / agro-forestry crop through liberal supply of seedlings, the popularity of the tree was not entirely attributable to the liberal promotion of the tree forest departments. On the other hand, the popularity of *Eucalyptus* had much to do with the unequal land distribution and the widespread prevalence of absentee landordism in large areas of rural India.

In some ways, inadequacies of *Eucalyptus* plantation pointed to the need to undertake both ecological and economic audits of *Eucalyptus* species. Environmentalists spearheading the anti-eucalyptus debate were baffled by the support the tree received from farmers in Punjab, Haryana and Gujarat who experienced phenomenal commercial success with *Eucalyptus* as a farm / agro-forestry crop.

Nevertheless, debates on the ecological plane had one important effect. It raised the awareness of policy makers and local communities

about the possible negative effects of monocultures. On the other hand the social equity issues raised by these debates provided the basis for the Joint Forest Management (JFM) movement in India in the 1990s.

Economic Concerns with Tree Plantations

Tree plantations programmes in India have also been criticized for their 'economic inefficiency'. As early as 1980s, criticisms had mounted against the Forest Department policies of subsidized supplies of pulpwood to paper and rayon industries. Originally plantations of *Eucalyptus* were established by the forest departments of Karnataka, Kerala, West Bengal, Tamil Nadu, Haryana and Madhya Pradesh ensuring pulpwood supplies.

In Kerala, according to a study of the Kerala Forest Research Institute (KFRI), the gap between the mean annual revenue and expenditure on *Eucalyptus* plantations raised by the forest department was as high as Rs. 23 lakhs at 1970-71 prices. (Krishnankutty et al., 1986) The loss was attributed to subsidized supply of *Eucalyptus* to the pulpwood industry. In UP, the U. P. State Forest Corporation sold *Eucalyptus* to paper mills at Sahranpur at less than one-third of market price during 1983-84. In Haryana, pulpwood prices at Rs. 200 per cubic meter during 1984-85 were far below the price of Rs. 500 per cubic meter at which *Eucalyptus* wood was sold as poles.

In Karnataka, according to an estimate made by Dilip Kumar, the cost of production of *Eucalyptus* raised by the Karnataka Forest Development Corporation was Rs. 1,066 a tonne, which compared unfavourably with the market price of Rs. 600 a tonne (Dilip Kumar, 1992). Losses incurred by the forest department plantations were attributed to other reasons as well. The main one was the low productivity of *Eucalyptus*

plantations raised by the forest departments. The KFRI study referred to above, mentioned how the mean annual increment of *Eucalyptus* obtained after a rotation of 9 to 12 years ranged as low as 3.3 cum to 6.3 cum per hectare as compared to the normatively prescribed level of 10 cum per hectare for fast growing species in general.

A similar situation obtained in Karnataka where Narendra Prasad estimated an average yield of 1.68 tonne per hectare per year for plantations raised in Bangalore District by the Forest Department. This was much below the yield of 20 tonnes per hectare that was projected for the dry-zone plantations of *Eucalyptus* in the state (Prasad, 1986). By contrast, the productivity of the Private Farm Forest *Eucalyptus* were estimated to be 7.19 tonnes per hectare per year in Kolar and Bangalore districts. Indeed various assessments about the performance of farm forests in the states of Uttar Pradesh and West Bengal conducted by the Government of India, indicate comparable performance by farm forests

All these findings did not for a long time deter the efforts of State Forest Department at raising *Eucalyptus* plantations. Certain developments on the price-front in the post-1987 period, however produced re-thinking on this score. The boom in *Eucalyptus* prices in the early 1980s, which had stimulated large areas of farm plantations *Eucalyptus*, gave way to a price crash from 1987 onwards. Saxena , from an elaborate survey of the wood markets in UP, Haryana and Punjab, brings to light the sharp decline in prices of *Eucalyptus* trees from Rs. 100 in 1985 to Rs. 49 in 1989 (Saxena.,1995).

At a macro or general level, the cause for the price crash was the excessive supply of *Eucalyptus* wood in the mid-1980s. The drought of

1987 exacerbated the problem by causing distress sales of wood products by farmers in drought hit regions of the country. At a dis-aggregated level one can, however, see market imbalances as having contributed to the problem. The disappearance of bamboo as feedstock for paper mills and the subsequent advancement of hardwood pulping techniques, opened a large market for *Eucalyptus* in the 1970s. However, the policy of subsidized pulpwood supply by forest department plantations had forced some of the wood farmers to direct their supplies to its other market segment, viz., the pole market.

As Saxena *op.cit* brings out, the subsequent glut in the pole market, further forced the 'wood' farmers to turn to the last and 'unremunerative' segment namely the fuelwood market where prices realized were far below expectations due to 'visible' competition from the forest department depots and 'invisible' supplies by countless head-load carriers. Prices crashed as a result of over-supply in the fuelwood segment of the *Eucalyptus* market, particularly in North West India. In an environment of falling prices it was natural that the ire of the farmers turn towards the marginal or low productivity units, viz the forest department plantations, since it was pervasively felt that had the Forest Department not been raising *Eucalyptus* plantations the glut conditions would not have occurred.

It was logical that the low yielding Forest Department *Eucalyptus* plantations were chosen for criticisms. Many farm forest owners and protagonists, who until the mid-1980s were firm allies of the forest departments in the *Eucalyptus* battle, turned rivals of the latter demanding that forest departments abandon raising *Eucalyptus* plantations and stop subsidizing pulpwood supplies to pulp and paper industries. These demands were paradoxically similar to that of the

environmentalists who had crusaded against the forest departments about the tree in the initial stages of the debate, though the motives differed. While the farm forest protagonists desired state withdrawal from the *Eucalyptus* scene for improving the viability of farm-raised trees, the environmentalists were crusading for eliminating the tree both from forests and farms.

In the meantime the Karnataka Forest Department drastically reduced planting of *Eucalyptus* from 1992-93. Even, if for a moment, one assumes that *Eucalyptus* is not a undesirable proposition, one cannot but touch upon a few imponderables arising from the State withdrawing from the *Eucalyptus* sector. These arise from the peculiar segmentation of the *Eucalyptus* wood market into the pulpwood, pole and fuelwood compartments. Since these different markets compartments require wood of differing dimensions and quality, they call for different growing periods or, in forestry parlance, differing ‘rotations’. Since, in general, it takes lesser time (three to six years depending upon site conditions) to raise *Eucalyptus* for fuelwood purposes, a rise in fuelwood prices was bound to increase the temptation to harvest the trees within a shorter period. This in turn was bound to constrict pulpwood or pole supplies in the long run. Farmers who had to wait for 10-15 years for supplying pulp/pole grade material preferred to shorten their rotation to 5 to 6 years and dispose the produce to the fuelwood markets.

Resolving the Issues

The Government of India has already responded to the ecological sustainability issues involving tree plantations by banning clear felling of natural forest for raising fuelwood plantations with exotic species. Indeed the National Forest Policy 1988 lays down clear guidelines for sustainable raw materials supplies to forest based industries. Para 4.9 of the policy lays down that there shall be careful regulation on establishment of forest based industries in India particularly from the point of view of raw material supplies and that the fuel, fodder and timber requirements of local populations shall not be sacrificed for establishing plantations designed to turn out industrial raw materials. The policy also clearly stipulates that natural forests, which help to serve the purpose of ecological balance, shall not be made available to industries for plantation activities. Further the policy also clearly states that the practice of supplying forest produce at concessional prices should cease. The accent of the policy is on encouraging plantations for industrial raw materials in marginal and degraded lands.

State Governments have since the advent of the policy gone slow on their forest plantation schemes involving controversial crops such as *Eucalyptus* spp. However, there are areas where tree plantations are continually being taken up for meeting social objectives. Tree plantations undertaken under social forestry and rural development programmes form outstanding examples of efforts undertaken to provide life support biomas for rural poor. However the industrial users of forestry products have been dissatisfied with these efforts. Concerned at the growing constriction of pulpwood supplies in the light of the developments described earlier the pulp industry of India initiated a major effort, in the 1990s, to secure allotment of forest lands for

pulpwood plantations. They pressurized Government for allotment of forest land for pulpwood raising. But such a step can go against the very principles of sustainable development and conservation to which India stands committed under the National Forest Policy 1988. Indeed as Dietrich Brandis the first Inspector General of Forests of India reports, even the British Colonial Government had, way back in 1862, strongly disapproved and prohibited efforts to throw open India's forest to private enterprise (Brandis.,1994) On the other hand, continuous involvement of the forest departments in the matter of fuelwood supplies (through other varieties such a *Prosopis juliflora*) can be a good measure as it will encourage reasonable fuelwood prices for the common man while encouraging agro/farm forestry section to concentrate their supplies to the pulpwood sector. This would not only lead to reasonable fuelwood prices but also to better pulpwood prices in the market. It would also lead to lessened calls on the part of pulpwood industries for captive pulpwood plantations.

The other area where the tree plantations continue to have significance is under the programme of compensatory afforestation. The scheme of compensatory afforestation is undertaken to compensate loss of forestlands diverted for non-forestry use, under Section 2 of the Forest (Conservation) Act, 1980. However, the compensatory afforestation scheme in India has tended to produced certain distortions, especially in biodiversity rich States such as Kerala. Indeed, the example of the State of Kerala, affords fundamental lessons for policy makers concerned with the effects of tree plantations on biodiversity in general and biodiversity conservation programme in particular. The compensatory afforestation programmes in States like kerala have not paid adequate attention to species diversity and the natural vegetation of the area. The accent has seen on proper "Stocking" of lands taken up for compensatory

afforestation than on natural or artificial regeneration of species endemic to the area.

Recommendations

Adoption of the goal of Multi-specific Plantations by the NBSAP

A biodiversity approach to tree plantations in India would emphasize on the significance of multi-specific plantations which besides conserving biodiversity of natural forests and agroecosystems would also be helpful in meeting the sustainable livelihood requirements of rural and urban poor including life-support biomass and NTFPs. This is also in spirit with the latest circular (21st February 2000) of the Government of India on Joint Forest Management. This then could be the approach of the National Biodiversity Strategy and Action Plan to tree plantations

New Approach to Compensatory Afforestation and Plantation Activities in Wildlife Sensitive Areas

Non-forest, community wastelands and other common lands are short of availability in the North-eastern States and certain States such as Kerala. This has hampered the scope of tree plantation activities in non-forest lands under compensatory afforestation programmes in these States. The latter activities have therefore tended to focus on degraded forest areas in these States. Degraded forests in Kerala, those with crown density of less than 0.4, are distributed in evergreen, semi-evergreen and moist deciduous forests.

Compensatory afforestation in the present form, should not be taken up in these patches of forests, particularly if the scope for natural or artificial regeneration exists in such patches. A case in point is planting of *Acacia auriculiformis* plantations by the Kerala State Forest Department in forest and non-forest environments. These plantations have not only proved to be sub-optimal in terms of their economic

performance (Jayaram and Rajan., 1991), but also inimical to biodiversity conservation in the State. As Nair reports, it is important from the biodiversity conservation point of view to demarcate areas for long-term conservation from rest of the forest areas, so that all efforts are made to restore 'corridors for floral and faunal exchange', without the interference 'tree plantations' (Nair.,1991). Given the fact that in India, identification and management of corridors is considered essential for conservation of the Asian Elephant, the Tiger and the Indian giant squirrel, it is essential to ensure that land management of corridors is sustainable and the impacts of plantations in these corridors is carefully evaluated. Forest areas which are minimally fragmented, should be restored through natural regeneration than through plantations based on non-natural or endemic species. Suitable guidelines need to be issued to incorporate these concerns.

Environment Impact Assessment (EIA) of Forest Plantations Raised by Forest Development Corporations

The other priority is to prevent tree plantation activities being carried out by fund starved forest development corporations in degraded forest areas with regeneration possibilities. Since bank finances for afforestation activities are not available at moderate rates of interest, these corporations tend to plan their tree plantation activities in such a manner that gives priority to timely payments of loans and interests. The objective of biodiversity conservation assumes secondary importance under the circumstances. The plantations established by these Corporations consequently tend to favour a mix of fast growing and endemic species, with greater emphasis on the former. Tree plantations may be welcome in non-forest lands in rural areas. But it may entail social and ecological problems by way of removal of grazing rights for village livestock. This could, in turn lead to unsustainable man-livestock

relationships involving pastoral communities in Himachal Pradesh (Saberwal., 1999) besides causing deterioration of biodiversity of agro-ecosystems as instances from the semi-arid tracts of Karnataka denote (Damodaran, 1987 and 2001). Given these facts, an Environment Impact Assessment is a pre-requisite for afforestation and tree plantation projects undertaken in common grazing lands.

EIA of Contract Farm Forestry Projects

While farm forests in general are taken up on private lands by farmers on their own volition, there are many instances where farm forestry gets 'structured' by industries, through 'contract farming practices'. For instance, the scheme of free distribution of seedlings of casuarina and subabul by Andhra Pradesh Paper Mills Ltd. in East Godavari, West Godavari and Krishna Districts of Andhra Pradesh State, initiated in the year 1994-95, while designed to source raw materials for the paper mills was inappropriate for the ecologically rich non-degraded farm lands in the coastal areas of the State. In other words, contract farming systems for tree plantations need to be subjected to Environment Impact Assessment particularly from the angle of their biodiversity impacts.

Compatibility with Tribal Life Styles and Gender Balance

There are certain other undesirable tendencies with respect to tree plantations. The practice of encouraging tribals inhabiting forest areas to grow cashew and rubber plantations through plantation subsidies needs to be stopped in the larger interest of biodiversity conservation. Similarly, in the integrated afforestation and wasteland development programmes carried out by the Government of India in different States, large scale planting of fast growing tree species needs to be carefully reviewed. Such species may be tried out only as belt plantations. Planting of exotic species in degraded forest areas under these

programmes should be discouraged. Similarly, care has to be taken to ensure that publicly funded plantation programmes meet with the specific requirements of tribal communities. For instance bamboo plantations undertaken in degraded tribal inhabited forest areas in States of Madhya Pradesh and Chattisgarh accord primacy to *Bambusa vulgaris*, the species used for nistar by the tribals than to commercial and industrial bamboo. Similarly while planning afforestration programmes, priority should be accorded for projects in Districts which have high tribal density per square kilometer of forest cover. For instance in Madhya Pradesh, it is seen that Districts with high density of tribal population such as Jhabua, Ratlam and Dhar have the lowest ratio of forest cover to geographical area of the District (Kushwah et al., 2001). It is these Districts that deserve attention.

There should be a proactive system of assessing tree plantations from the viewpoint of gender balance. This could be done on terms of assessing the role of gender in the design, development, growth, protection and benefit sharing in plantations. Similarly the success or failure of tree plantations has to be judged not only in terms of their productivity or ecological benefits but also in terms of their role in promoting empowerment of women through their involvement in management, harvesting and distribution of forest produce. The significance of developing and securitising markets in NTFPs also deserves to be actively considered as part of JFM programmes. The success story of the JFM scheme needs to be collated and disseminated to project authorities, analysts and critics.

In the context of eco-development models in protected areas (PAs), there are efforts to alter the traditional agricultural land use systems of local communities by inducing these communities to go in for

horticulture tree crops. This is ostensibly to encourage alternative income sources for these communities and wean them away from PAs, for biomass needs. (Paradeshi, 1996). Such shifts need to be avoided particularly in zones where agro-biodiversity of traditional cultivation systems are high and the alternative plantation crops have the adverse effect of displacing these systems.

Indeed as Kothari (1996) notes the conversion of pastures to other uses in protected areas coupled with other changes in land-use patterns can have severe adverse impacts on the natural habitats of these areas.

Subsidies for Regeneration and Sustainable Plantation Activities in Marginal Lands

Planting of non-timber forest produce in degraded forest lands with low rootstock may be desirable provided they are sustainable in ex situ conditions and if there are adequate facilities for upstream processing activities within the local area itself. However, cultivation of non-timber forest produce in such degraded lands is very often hampered by low availability of funds and the higher cost of planting items such as medicinal plants and other utility plants. The situation can be obviated by enhanced provision of subsidies for cultivation of medicinal plants degraded forest areas. Similarly, subsidies should also be enhanced for setting up upstream processing facilities for non-timber forest produce in the plantation area itself. This is also in keeping with the spirit of revised JFM guidelines issued by the Government of India on 21st February 2000 whereby local communities are sought to be involved in microplan preparation, with active focus on marketing linkages for NTFPs that are harvested by the local communities.

The larger utility of such plantations is that they prevent the resources occurring in natural forest areas from getting depleted. A case in point from a non-JFM context is that of the tree species "*Litsea polyantha*" which is endemic to the Simplipal National Park in Orissa. Reckless felling of this tree in the National Park for selling of bark has been for long, one of the greatest threats to the ecological wealth of the park. Similarly, the unsustainable exploitation of Agarwood (*Aquilararia malacensis*) from Assam forests for exports has been a matter of great concern from the point of view of conservation of these forests. In case such rare species can be successfully and sustainably regenerated or planted ex situ, the pressures on their natural habitats would have been considerably lower. Indeed Pal et al., (undated) report about over-exploitation of medicinal herbs even in JFM areas with no attention whatsoever on regeneration and propagation (Saigal et al., 1996). Nevertheless it is noteworthy that the revised JFM guidelines issued by the Government of India on 21st February 2000 has placed special emphasis on extension of JFM in good forest area with focus on NTFP management. This is a welcome step given the fact that NTFP extractors who take to sustainable harvest practices, alter populations of only a small number of plants and animal species and at best harvest plantations at rates comparable to natural tree fall gap formation. (Nepstad., 1992). Situations such as those described for Simlipal and Assam forest areas could be avoided by extension of the JFM scheme to dense forest areas. Stress on NTFPs and endemic species would neccesiate greater priority to natural regeneration methods of plantations raising in degraded areas. In critical ecosystems where natural regeneration is not possible due to advanced stage of degradation, artificial regeneration methods may have to be thought of, prior to a decision for clearfelling of endemics and their replacement with exotics. There are many success stories from India in this regard.

For example mangrove scrubs in West Bengal have been successfully subjected to enrichment plantations involving endemic mangrove species such as *Cenops decandra*, *Excoecaria agallocha* and *Bruguiera gumnorrhiza*. Such techniques of plantations promote muti-specificity, encourage NTFP approach to plantations, besides helping to conserve biodiversity in critical ecosystems which have deteriorated on account of different factors.

Sustainable Imports of Forestry Products

The policy of subsidized pricing of forestry raw material needs to be reconsidered, given the fact that this has led to large scale decadence of natural biodiversity in India, by encouraging unsustainable tree plantations in natural forest areas, as has already been discussed. However it is equally important to ensure that the demand supply gaps with regard to forestry products is redressed. It is estimated by Sharma and Kumar that the unmet demand for sawnwood, industrial roundwood, particle board and woodpulp will increase considerably during the period from 2000 to 2010 (Sharma and Kumar.,1999). It is clear that the unmet demand for these products can only be met through imports. The authors estimate that total imports of forest products have grown by 7.87% during 1970 – 1994. However there could be complexities on the import front as well. The import dependent paper and pulp sector in India got into a jam in 1994-95, when international prices of wood pulp shot up to $ 1,000 a tonne from normal price levels of $ 400. Likewise, during the same period, waste paper prices underwent a sharp increase to $ 350 from a normal level of $ 100 a tonne. The long-term solution clearly lies in substitution of wood and forestry products by the user industries concerned. However in the short run, a liberalized import scenario could still help. In the wake of the WTO agreements, imports of timber and forestry products require to be liberalized through removal of quantitative restrictions and low import

duties. Thus it would not only be possible for Indian industries to source their raw materials at cheaper prices, but also prevent them from developing dubious and ill-conceived schemes of 'contract forest farming', within the country. However, in consonance with India's commitment to the Convention on Biological Diversity, it will be important to ensure that our requirements are sourced only from sustainably managed man-made plantations in importing countries.

Socio Economic Equity as Criteria for Evaluating Tree Plantations

Finally, Sarin (1996), notes in the context of the joint forest management in India, the focus of tree plantations should change from silvicultural orientation to that of empowerment of the poorer sections of the community and conservation of natural diversity. Apart from efforts to provide JFM groups with legal identity and providing for 50% membership for women under the revised JFM guidelines, there is a need to assess the success of plantations raised or protected under the scheme through an objective criteria. This could include a detailed assessment of the distributive impacts of plantations on different catagories of stakeholders has been attempted in the context of JFM plantations (Hill and Shields., 1998). To this extent, the role of economic analysis in the assessment of tree plantations has to be redefined. Indeed, in the context of the forthcoming National Biodiversity Action Plan such redefinitions should be treated as over-riding priorities. A similar dispensation should extend to forest plantations raised in non JFM areas.

Table – 3 provides a synoptic view of the spirit and content of the recommendations made. The table also indicates the agents/stakeholders who can act on the different recommendations.

Table – 3

Matrix of Sustainable Plantation Activities for Biodiversity Conservation in India

Recommended Initiatives	Action Points	Implementing Agency/Authority
Adoption of the goal of Multi specific Plantations under NBSAP	Incorporation in NBSAP document and ensuring implementation through audits	All stakeholders connected with NBSAP process
New approach to Compensatory Afforestation and towards Plantation Activities in Degraded Forests forming potential Wildlife Corridors	Issue of guidelines for restricting plantation activities in areas where natural/artificial regeneration possibilities exists under Forest (Conservation) Act and under wildlife management plans.	Ministry of Environment and Forests, and State Forest Departments including Wildlife Divisions.
EIA of Plantations raised by Forest Development Corporations in degraded common lands and forest areas	Ex ante Environment Impact Assessment of Plantation Activities undertaken by Corporations to assess social and ecological costs.	Ministry of Environment and Forests for issue of guidelines and financial institutions and State Governments for implementation of guidelines.
EIA of Contract Farm Forestry Projects initiated by Forest based Industries	EIA of the Biodiversity impacts of long term contract farm forestry systems with special reference to agro biodiversity	State Governments for issue of guidelines and for follow up, since agriculture lands fall within the domain of States.

(contd….)

Compatibility with Tribal Lifestyles and Gender Balance	Ensuring that Plantation Activities optimize production/generation of biomass resources utilized by Tribal Communities and Women's Groups	Government of India for incorporation of these principles in JFM guidelines. State Governments and particularly State Forest Departments, Tribal Welfare Departments for non JFM areas.
Subsidies for regeneration based plantation activities in low root stock areas	Regeneration of rare and high value NTFPs through low cost funds and improved assistance for common upstream processing facilities	Ministry of Finance and the Ministry of Environment and Forest Government of India, State Governments, NABARD and Co-operative Banks
Sustainable Imports of Forestry Products	Reduction of Import duties on Forestry Products for use by Indian Industries. Sourcing import from sustainable plantations	Ministry of Finance and Commerce and Industry, Government of India and the Ministry of Environment and Forests in collaboration with Industrial Associations and Accredited NGOs for identification of sources.
Socio- Economic Equity Parameters for Assessment of Tree Plantation Activities	Developing Criteria to Assess Impacts of Tree Plantations on Women welfare and Poverty Alleviation.	Guidelines for project evaluation to be Developed by Government of India and State Governments in consultation with NGOs

Conclusion

The paper aims to provide a critical survey of evolution and growth of tree plantations in India and the principal sustainability issues connected with their functioning, particularly from the angle of biodiversity conservation in the country. After taking note of the fact that tree plantations in India have experienced limitations and failures, the paper proceeds to outline a series of recommendations for turning tree plantation activities into biodiversity conservation opportunities. The recommendations made in this paper partake of policy and programme initiatives at the national and sub-national levels. It is expected that these recommendations would form the initial steps to render tree plantation activities compatible with national biodiversity conservation strategies and action plans.

(The author thankfully acknowledges the comments and inputs received from Ashish Kothari and M.V.M. Waqar on an earlier draft)

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