Eucalyptus Planting in 'Social Forestry' in India: Boon or Curse?

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Contents

Introduction

Over the last twenty years, large-scale planting of *Eucalyptus*, as a fast growing exotic, has occurred in India, as part of a drive to reforest the subcontinent, and create an adequate supply of fuel and timber for rural communities under the augur of 'social forestry'. Initially in response to the international community's consternation regarding deforestation, social forestry was, in its early days, largely a product of development aid (Sargent, 1998). The ambitious scheme intensified, particularly in the 1980's when plantations were established at a rate of 1.4 million hectares (Mha) a year (Hall and Ravindranath, 1994) to existing plantations of about 1.5 million hectares (Prabhakar, 1998). Estimates of total land area currently under plantations exceed 17 Mha. Over $400 million has been invested (Poffenberger, 1990, cited in Morrison and Bass, 1998) from the Indian government, and with assistance from international financial institutions such as the World Bank.

The preference for *Eucalyptus* given rise to a highly polemical debate, particularly between environmentalists and foresters / policy makers. Foresters maintain that *Eucalyptus* can help meet increasing wood demands from dwindling natural forests, supplying local communities and industry alike (Shyam Sunder and Parameswarappa, 1989). Environmentalists, however, are opposed to *Eucalyptus* due to perceived ecological hazards and the charge that the choice of species is fundamentally flawed; that *Eucalyptus* is ill equipped to serve the variety of diverse end uses demanded of tree species in India for community use.

This review will examine available literature to assess the validity of claims from both sides. Initially, a brief overview of social forestry will be followed by claims of the ecological hazards of *Eucalyptus*, and a discussion assessing specific claims. Next, an examination of the establishment of *Eucalyptus* plantations will be considered, with particular reference to choices made from the ‘bottom up’. Case studies from different parts of India will be used to illustrate the argument, and give breadth and insight as to how this exotic has been received by different communities, differentiated by socio-economic factors, and geographical features, such as climate. Lastly, a broader discussion, encompassing the political economy of *Eucalyptus* and its context as part of a particular development trajectory will be considered, and wider criticisms will be revisited.

The spread of *Eucalyptus*

Despite a drive for modernisation and industrialisation, and growing urbanisation, India maintains a largely biomass-dependent rural sector. Out of the 1991 population census, where the population was found to be about 850 million, over 600 million live in rural areas, and are dependent on forest resources to varying degrees. With little to suggest that this scenario will change in the near future, and a growing population, it is imperative that local biomass needs are met. Forest area per capita is extremely low, at 0.075ha, and is likely to reduce further, on account of a growing population, and increased degradation of natural forests from industrial, developmental and subsistence demands.

Changes in forest cover have been extrapolated by different workers, and wide discrepancies are evident. FAO, (1993) estimated deforestation rate of 339,000 ha $year^{-1}$, between 1981-1990, while Hall and Ravindranath (1994), observing changes in forest cover from satellite images in the same period, note an annual decline in forest cover of 23 750 ha (0.04%). However, Hall and Ravindranath also extrapolate from satellite data in the same period, a year on year increase in dense tree cover of 302,000 ha (0.8%), considered as areas of forest with tree-crown cover greater than 40%. During the 1980’s, India’s forest area stabilised around 64 Mha (19.5 of the total geographic area). According to FAO, however, land under forest in India is estimated at a greater 70.6

Mha, of which 18.9 Mha is estimated to be under plantations. Hall and Ravindranath do not give estimates for plantations, though assuming similar proportions, plantations occur over 17 Mha, with 14.4 Mha being established between 1981 and 1990 (Hall and Ravindranath, 1994).

Large-scale afforestation during the 1980's reflects radical policy and management changes. Recently, the government has formally recognised the legitimacy of local communities' claims to forest resources, and in a turn-about of forest policy, is now encouraging rural participation in the management of natural resources. Social forestry represents one strategy to involve community participation, as part of a drive towards afforestation, and provides for the rehabilitation of degraded forest and common lands, with the planting of species such as *Eucalyptus spp.*, and *Acacia spp*. Farm forestry, encouraging trees to be grown on private land, and extension forestry, increasing areas under trees, are also provided for, and laid down in the National Commission on Agriculture. Box 1, below, lists the scope of social forestry, with the potential areas that could be brought into the scheme.

Box 1: The scope of social forestry (after Prabhakar, 1998)

1. Creation of woodlots in the village commonlands, government wastelands and panchayat lands. (Estimated at least 12mha).
2. Planting of trees on the sides of roads, canals and railways. This, along with planting on wastelands is known as 'extension' forestry, increasing the boundaries of forests. (Estimated at nearly 1 million ha).
3. Afforestation of degraded government forests in close proximity to villages, which have experienced the unauthorised harvesting of biomass. (Estimated at over 10mha).
4. Planting of trees on and around agricultural boundaries, and on marginal, private lands, constituting farm forestry, or agro-forestry, in combination with agricultural crops. (Agricultural land covers about 143mha)

Social forestry, then, has shown enormous potential to kick-start a mass afforestation programme on the subcontinent, and indeed, as noted earlier, already appears to be making a considerable difference in overall forest cover in a short time, most probably due to the vigour and productivity of the exotics employed. The principal species used in afforestation is a eucalyptus hybrid, *Eucalyptus tereticornis*, though *E.globulus* has also been employed.

Eucalyptus globulus was first introduced to India in 1843 in the Nilgiri Hills, as an experiment to find high yielding species for fuel and timber (Penfold and Willis, 1961), and it soon became a favoured species of the colonial rulers. However, after trials on the Mysore Plateau, *E. tereticornis* was found to be more productive, and the hybrid became the most popular choice for afforestation.

Criticisms of *Eucalyptus*

Despite the enthusiasm with which eucalyptus has been received and promoted by policy makers and forest department officials alike, its large-scale establishment in India since the early 1980's has invoked passioned criticism from environmentalists, social activists and some NGO's. Perhaps most vocal in the condemnation of eucalyptus is the environmentalist and writer, Vandana Shiva. In a series of articles in the mid 1980's featured in publications such as *Ecologist*, *Ambio*, and followed with an 'ecological audit' of the species, Shiva charges eucalyptus with nothing less than ecological fascism. Although also criticised on political and socio-economic grounds, Shiva roundly destroys the case for *Eucalyptus* in India on scientific and ecological grounds. Charges laid against *E. tereticornis* particularly, are as follows:

1. *Eucalyptus* is water intensive, and reduces water available for other species, effectively out-competing them. Shiva follows that in arid areas, the consequent suppression of other plant life, coupled with a high water demand, reduces soil moisture, preventing the recharge of groundwater, and can reduce local water tables. This is exacerbated by a high transpiration rate indicative of the inefficient use of water. Shiva maintains that in 'vulnerable ecozones', such as the Deccan Plateau, which is in the rain shadow of the Western Ghats, the introduction of species with high water demand will 'destroy the hydrological balance' of such areas, and contribute to increasing aridity, soil erosion (Shiva, 1983) and eventual desertification (Shiva and Bandyopadhyay, 1985). Particularly vulnerable are arid areas with annual rates of precipitation that correspond to the lower range of *Eucalyptus* demand, about 700mm.
2. *Eucalyptus* is nutrient intensive, which creates deficits for other plant life, a process that is exacerbated by its low returns in leaf litter to the soil. Thus it does not promote the building of humus, and by implication, does not contribute to the long-term fertility of the soil, as other species might (Shiva and Bandyopadhyay, 1983) resulting in an over all nutrient impoverishment of the soil (Shiva and Bandyopadhyay, 1985).
3. *Eucalyptus* is toxic, due to allelopathic properties, which serve to reduce not only other plant life, including crops, by restricting germination of other species, but is also detrimental to soil micro and macrofauna. (Shiva and Bandyopadhyay, 1985).

Eucalyptus and hydrology

Regarding the claims concerning *Eucalyptus* and water, as listed in 1, it might be instructive to compare water use by *Eucalyptus*, with native Indian tree species, to see if it has a higher demand per unit of biomass fixed. According to experiments undertaken at the Forest Research Laboratory, Kanpur, *Eucalyptus* actually appears to be more efficient in water use than other 'useful' native trees. The study showed that *Eucalyptus* consumed 0.48 litres of water to produce a gram of wood, compared to 0.55, 0.77, 0.50 and 0.88 litre per gram for siris, shisham, jamun and kanji respectively (Prabhakar, 1998). However, that said, the reason why *Eucalyptus* was introduced as an exotic to the subcontinent, is because of its rapid growth and productivity. In one year, total biomass produced is greater than many of the slower growing native species. Prabhakar (1998), claims that on eight year rotation, the mean annual growth of *Eucalyptus* per hectare, is about 8 cubic metres (cu.m.), though has been known to reach as much as 40 cu.m, while for indigenous trees, the average is 0.50 cu.m. An overall high productivity therefore necessitates a greater overall water demand. Another study, cited in Saxena (1994), supports this supposition. Chaturvedi, Sharma and Shrivastava (1988) report that of ten species tested for water consumption (it is not known whether the others were native or exotic), *E. tereticornis* was found to be the most efficient in biomass production per litre of water consumed, but also found to consume most water overall, given its high productivity. Under the regime within which *Eucalyptus* is cultivated; en masse, as a short rotation crop, though sometimes as coppice with standards (Sagreiya, 1967), parallels may be drawn with any other intensively produced crop, such as a modern high-yielding variety.

Eucalyptus, then, has been shown to be efficient in its water use. However, this genus has also been criticised by Shiva for a high rate of transpiration, and possible contribution to water shortages in arid areas. Prabhakar (1998), notes that transpiration of *Eucalyptus* is high under conditions of high soil moisture, termed 'luxury consumption', and under conditions of water stress, stomatal closure occurs, which restricts water loss from the plant. Yet, there does appear to be an extreme threshold before the onset of stomatal closure. Pryor (1976) states that severe permanent wilting will trigger stomatal closure, as part of a strategy to endure a critical water balance, which can last for some time. This strategy is possible due to the development of hard tissue, called the sclerenchyma, and plants that adopt such a strategy are known as sclerophytes. Pryor notes that *Eucalyptus* has 'an ability to extract water from the soil even though soil moisture tension is higher than that at which more mesophytic plants can extract water. Transpiration rates remain high even though water supply from the soil is dwindling'. How this may affect soil conditions in a large area planted under *Eucalyptus* over time is not certain, and no literature could be found on this point. Though Edgar (1984), in a book about *Eucalyptus* for wood production, describes an increase in water yields after clearcutting an area of *Eucalyptus* plantation, attributable to reduced transpiration losses. Greenwood, Klein and Beresford (1985), cited in Sargent (1998), measured and compared transpiration from two species of *Eucalyptus*, and grassland, and annual average transpiration rates were found to be 2700 mm and 390 mm respectively. However, another study in Kanowski and Saville (1990), indicate that plantations of *E. tereticornis* and *E. camaldulensis* use no greater quantity of water than degraded indigenous forest on adjacent sites.

Locally, perhaps plantations are able to modify the hydrological budget, though whether this could significantly reduce the water table, seems a shaky proposition. Sargent (1998) concedes there is a likelihood of drought potential from fast growing plantations of *Eucalyptus*, notably *E. camaldulensis* in areas where plantations ameliorate peak flows, and where there are down-stream water shortages. Shiva is certainly articulating fears and concerns at grassroots with this specific charge. In some communities, the establishment of *Eucalyptus* plantations has coincided with a drop in the water table. In August 1983, farmers from two villages in the Tumkar district of Karnataka, south India, led a symbolic protest to a nursery, where *Eucalyptus* seedlings were uprooted and replaced with indigenous species, such as tamarind (Tamarindus indica) and mango, (Mangifera indica). According to the villagers, the local plantation was sited in the catchment area of the streams feeding their agricultural land, which had recently dried up (Shiva and Bandyopadhyay, 1985). Others have made the pertinent point that the water table has reduced in many regions of India in recent years, both in areas with and without plantations, which may be due to over extraction of ground water, and aggravated by factors such as deforestation (Karanth, 1983).

Shiva hypothesised that the knock-on effects of this mechanism (in arid areas) would serve to increase aridity, increase the hedgemony of *Eucalyptus* in an area, as a superior competitor for scarce water, at the expense of other species, which could ultimately result in desertification. In some instances, which will be discussed later, *Eucalyptus* may impact detrimentally on surrounding vegetation, but this is more a function of qualities other than water use. That *Eucalyptus* is a xerophyte, which renders the genus resilience to withstand drought stress, indicates an ingenious and specialist strategy, in a harsh and sparsely vegetated environment rather than a fascist design to suppress other species. Indeed, in Portugal, E. tereticornis is the species of choice in arid and semi-arid areas, where precipitation is about 400-500 mm per year, due to its drought tolerance over other species, including other *Eucalyptus* species. Fifteen years on, there seems to be no evidence of large-scale erosion and desertification due to *Eucalyptus* plantations (erosion will be specifically addressed later). However, what must also be remembered is that ultimately, any manipulated system will only be as viable and sustainable as the management regime (including intensity) supporting it. This perhaps is given more resonance in areas of climatic instability, specifically regarding cultivation. In arid areas where large-scale and intensive agriculture has been attempted, significant degradation has been known to have occurred, ‘the dustbowl’, in the U.S. during the 1930’s, is a case in point.

To briefly summarise the discussion regarding *Eucalyptus* and water. Contrary to Shiva’s charges, *Eucalyptus* is efficient in its water use, though transpiration rates are high, which may modify local-level hydrology. The claim that plantations may lead to desertification is not substantiated, though ultimately such a process is more concerned with human agency, rather than an intrinsic feature of the genus.

Eucalyptus and nutrient budgets

Shiva claims *Eucalyptus* can undermine the biological productivity of arid regions, by its excessive nutrient demand, which creates deficits for other plant life. A small return of litter to the forest floor and poor humus building consequently reduces fertility, which results in the overall impoverishment of the soil. Shiva cites a study of Singh, (1984), where the nutrient demand by *E. tereticornis* was found to be 217 kg of nitrogen, 100 kg of phosphorous, and 1594 kg of calcium per hectare per year. The nutrient demand by *Eucalyptus* seems well established in literature. Even in the nutrient poor soils of Australia, Attiwell (1972), followed the distribution and movement of nutrients within a forest of *E. obliqua*, and found demand for phosphorous, calcium and potassium per hectare, per year, to be 36 kg, 400 kg, and 272 kg respectively.

Although Eucalyptus can complete their life cycle on sites of very low nutrient status, Pryor (1976) notes the genus retains the ability to respond favourably to improved nutritional status, and when introduced to an environment with higher nutrient levels, particularly nitrogen and phosphorous, there is a marked response of increased vigour, and productivity. Therefore, as with any cultivated crop, productivity is largely dependent on its access to nutrients.

That is not to say that as a genus, *Eucalyptus* is intensive in its nutrient demand. Hillis and Brown (1984), comment that compared to most other genera in Australia grown on short rotation, demand for nutrients by *Eucalyptus* is less than others, principally because heart-wood begins to form at approximately five years. After this point, a significant proportion of nutrients in wood is recycled to other parts of the tree or soil, and the quantities that are immobilised are kept to a minimum. Therefore, similar to its water uptake, *Eucalyptus* is efficient in its nutrient use. However, its notable productivity, but more notably, the management regime in which it is cultivated, grown en masse, in short rotations of between six to eight years, may render a nutrient deficit in areas that are not conducive to intensive cultivation, such as arid and semi-arid regions. Returning to Attiwell's (1972) study, it was shown that under regimes of intensive wood production, a high proportion of the phosphorous in the biomass of *E. obliqua,* 60% is likely to be transported off-site, as it is found in the harvested stem wood and bark.

The findings of an FAO bulletin (1988) mentioned by Saxena, (1994) concludes the following: 'the rapid depletion of the reserve of nutrients in the soil due to cropping of *Eucalyptus* on short rotation is a direct consequence of their rapid growth'. The clear implication in the preceding quote singularly lays the blame for nutrient depletion in the productivity of *Eucalyptus*, and not in the management regime. In other words, if the exotics were not as productive, they would not be harvested in short rotation. Yet it is a surreal notion to 'blame' the crop, and not the regime in which it is being cultivated; Shiva also appears to mis-direct criticisms to perceived attributes of the genus as a whole, rather than examine the role of human agency.

Regarding the implications for soil fertility, Shiva explains that nutrient deficits are due to its productivity in Indian soils: 'In its native habitat in Australia, *Eucalyptus* manages to sustain itself because it is not fast growing in its sites of natural occurrence'. Shiva maintains a decline in soil fertility is exacerbated by low returns in leaf litter. *E tereticornis* is noted for having a small crown, and so Shiva equates a smaller return of leaflitter (compared to indigenous trees) with a decline in soil fertility over time, as a consequence of poor humus building. Drawing on Singh's (1984) study, mentioned earlier, it was found that annual returns in leaf litter were 35 kg for nitrogen, 14 kg for phosphorous, and 335 kg calcium, per hectare per year. Shiva details the severe depletion of nutrients predicted after 20 years and two rotations, which are listed as 3640 Kg for N, 1720 kg for P and 25,200 kg for Ca. Shiva states: 'this nutrient deficit is the reason for the "second rotation decline" in Eucalyptus plantations', rather than considering the flipside, that the nutrient deficit has come about as a consequence of two harvests. It is doubtful whether any cultivator would consider harvesting two crops without any attempt at maintaining fertility, either through natural or artificial means, as declining soil fertility and yields are an inevitable consequence. Indeed, some workers have warned that the intensive regime of very short rotation cycles in monoculture plantations may cause a loss of nutrients, and recommend that farmers increase the length of rotations, as well as supplementing site fertility (Campbell and Smith, 1987).

Shiva does not appear to consider plantations as artificial, cultivated systems that require nutrient management. Moreover, Shiva goes on to compare plantations with natural forests: ‘while most trees indigenous to a habitat form a self-sustaining system of living resources, *Eucalyptus* plantations harvested at short rotations are non-sustainable’, without regard for the circumstances and purpose of management. Mixed, indigenous forests are not intentionally managed with such an intensive regime (though, admittedly, they sometimes are).

The creation of humus, however, may be hindered by small returns of leaflitter to the soil, as already discussed. What little litter is returned to the soil may be slow to decompose. As *Eucalyptus* is an exotic, there may well be a paucity of associated soil micro and macro organisms that perform ecological functions such as decomposition. Where *Eucalyptus* is planted in arid areas, there may also be a less abundant detritivore component, more as a function of climate. Decomposition in such areas may be hindered by other factors also, e.g., lack of humidity (Nagy and Macauley, 1982), or because of the structural uniformity of the environment (Sargent, 1998). Low returns to the soil may also be a consequence of biotic disturbance. In some areas where natural forests are scarce, and *Eucalyptus* has been planted as a remedial measure to provide biomass, leaves are collected daily for fuel needs, and therefore do not remain on the plantation floor (Karanth, 1983).

It seems unlikely that Eucalyptus is nutrient demanding to the exclusion of other plant life. In many areas where Eucalyptus plantations are established, they are done so precisely because the genus may grow where other useful plants may not, such as in areas of scarce water and poor nutrient status. Where a paucity of ground cover has been observed under *Eucalyptus,* various explanations have been offered, such as biotic disturbance (Karanth, 1983), dense planting of trees under short rotation, (Prabhakar, 1998), and allelopathic properties of *Eucalyptus,* which will be considered next. However, it should also be noted here that according to Attiwell, (1975), soils in undisturbed *Eucalyptus* forests, (in Australia), are sometimes too nutrient poor to adequately supply seedlings. In a productive *E. obliqua* forest, Attiwell found so much of the phosphorous was taken up and cycled within the stand of vegetation, there was insufficient in the soil to promote a vigorous growth amongst the seedlings. Nevertheless, *Eucalyptus* is the most popular choice to be planted along the edges, or bunds, of agricultural fields, and appears to be well incorporated and accepted in agro-forestry in India (Tejwani, 1994).

Shiva also charges *Eucalyptus* with the ability to augment erosion. As Sargent, (1998) comments, the presence of an understorey and ground cover are critical determinants in protecting the soil from erosion, particularly on slopes. However, as already discussed, the absence of humus or detritus from the plantation floor may be attributed to human agency, such as management, e.g., dense planting, or the harvesting of leaves from the floor. As *Eucalyptus* plantations are commonly established in areas of degraded forest, as a matter of policy, it is unlikely the taller architecture of the vegetation will confer a vulnerability to erosion. More likely is that the establishment of taller vegetation will provide additional protective cover against wind and rain.

To sum up, *Eucalyptus*, like any other cultivated crop, requires nutrients to maintain yield productivity, and soil fertility. That *Eucalyptus* is inefficient in its nutrient use and as a genus has qualities which serve to reduce soil fertility, undermining the biological productivity of arid regions, are not supported. Decomposition may be affected by *Eucalyptus*, given its exotic status, and perhaps, climatic factors. Any reduction in fertility in areas of Eucalyptus plantations, is a consequence of the management regime, similar to any other cultivated system, as is incidence of erosion.

Toxic *Eucalyptus*?

Shiva and Bandyopadhyay, (1985) maintain that *Eucalyptus* can jeopardise the biological productivity, principally of arid regions due to allelopathic properties. In this way, the genus has a deleterious effect not only other plant life, including crops, by restricting germination of other species, but is also detrimental to soil micro and macrofauna and.

Literature is generally supporting of the allelopathic properties of Eucalyptus. However, whether allelopathy is found in all species of the genus is not certain. Hillis and Brown (1984) state ‘there is …evidence that some eucalypts are allelopathic’, citing a study of Ashton (1936), on *E. regnans.*

Species that are allelopathic suppress their own progeny, and by extension, other plant life, by the leaching of chemical inhibitors from the trees’ litter or roots. Several studies describe the adverse effects of *Eucalyptus* on crops in India. Basu et al, 1987, Narwal, 1990, and Suresh and Vinai Rai, 1987 (in Saxena, 1994) all found *E. tereticornis* to reduce the yield of rabi, when planted between fields. *E. tereticornis* was found to have the highest allelopathic affect.

However, allelopathy might be more marked in arid areas. Shiva cites a study of Rao and Reddy (1984), where it was found that allelopathic products in leaflitter remain for a long time in regions of low rainfall. However, after rain, toxins were found to be rapidly leached away. In other areas, such as the Doon valley, where much forestry research is conducted, abundant vegetation under *Eucalyptus* is commonly noted, in a region of plentiful rain. Similarly, workers have noted regenerating Atlantic forest, in the understorey of an *E. grandis* plantation in Brazil, *E. grandis* therefore showing no allelopathic effects on the re-colonising understorey (Claudio et al, 1995).

Literature could not be found regarding deleterious effects on soil fauna, though interestingly, in its native habitat, allelopathy of Eucalyptus is sometimes increased by the development of antagonistic soil microbes (Florence and Crocker, 1972, in Hillis and Brown, 1984).

Overall, some of Shiva's criticisms are supported, but many are not. Shiva appears to bestow sinister qualities on the genus, without giving proper consideration of the role of human agency. Any ecologically deleterious effects that may occur as a consequence of large-scale *Eucalyptus* plantations, are not the result of *Eucalyptus* design and physiology, rather it is a problem that is human-induced, and is a matter of management. The debate around Eucalyptus plantations, therefore, is more political, than ecological, or scientific.

Has Social Forestry Fulfilled its Aims?

According to the FAO, recent estimate of land under forest in India is thought to be 51.7 Mha and 18.9 Mha for natural forest and plantations respectively. Plantations therefore account for over 25% of the total forested area, of which *Eucalyptus* is the most popular choice, though some other species are also used, such as *Cassia spp*. and *Acacia spp*. 18.9 Mha represents a considerable achievement in afforestation, which reflects the Indian government's intent to provide forest cover. Such a large afforestation must also be indicative of its popularity amongst communities in the subcontinent. However, to understand exactly how social forestry has been received, and how effective *Eucalyptus* is at providing fuel and timber for rural communities, its original remit, it would be worth drawing on some studies from around the subcontinent.

Several studies have been conducted in the late 1980's and 1990's in different parts of India. Here, four studies will be considered, from Uttar Pradesh (U.P), in the north, West Bengal and Orissa in the east and Karnataka in the south. Two studies will be examined in some detail, (U.P and West Bengal); the others will be used to highlight prominent features of social forestry.

In the commercialised and agriculturally prosperous region of the northwest, known as the 'green revolution belt' of India, Saxena (1992) surveyed four villages in 1989-90, regarding uptake of social forestry. Traditionally in the fertile alluvial plains of the northwest, trees were not an important component in farming systems, unlike other parts of India, where they are used to provide fuel, fodder and maintain fertility of the soil. In the northwest, the high fertility of the land led to the maximisation of area under crops. Fuel was traditionally supplied from dung and agricultural residues rather than wood. When the afforestation scheme was launched in the late 1970's and early 1980's, it was expected that interest from private farmers would be minimal, and therefore the focus in this area was on the reforestation of common land, rather than farm forestry. The state government had set an initial target for the distribution of eight million seedlings to farmers in U.P, between 1979-1984. However, 350 million seedlings were distributed, due to an unexpected demand from farmers. It was anticipated that 88% of the output from farm forestry would consist of fuelwood, leaf and grass fodder to meet subsistence demands of the rural community. The dominant choice of species, though, was *E. tereticornis*, which accounted for 94% of all the seedlings, distributed and was planted not just on marginal land, and between fields, but also on fertile and irrigated agricultural land, which replaced annual crops. According to Saxena, *E. tereticornis* was favoured over other species offered under the farm forestry scheme, as it was perceived to be a highly marketable tree; it is quick growing, taking only six years to mature, and grows straight, making it an ideal choice for poles, but also for pulpwood. The small crown of *E. tereticornis* also encouraged farmers to plant them between fields, with little worry of shading crops in adjacent areas.

Table 1, below, shows land ownership and trees planted by different households. Out of the 1024 households considered in this study, 394 were ‘planters’. From the table it can be seen that 80% of the big farmers (>2.5 ha), 41% of the small farmers (0.5-2.5 ha), and 24% of the tiny farmers (<0.5 ha), planted trees. However, the intensity of planting was similar for the small and large farmers, reflecting a similar willingness to uptake new techniques, in this region that is known for its ‘agrarian dynamism’. Interestingly, Saxena found that among the small and large farmers, more trees were planted by upper caste households. Low caste households were found not to plant proportionately to their land. It is likely that the higher caste farmers are better educated, with closer contacts to bureaucracy, better access to seedlings and extension, and more likely to be in control of village institutions, which can channel resources for their own benefit. The growing of *Eucalyptus* was especially convenient to large absentee landowners, as there was no danger of losing the crop from grazing, and seedlings were easy to keep track of. However, small marginal farmers also found it worthwhile to divert land for crops, which were known to fail every two or three years, over to *Eucalyptus*. In this way, poor farmers had an opportunity to generate an additional income through wage labour. Instead of subsistence needs, then, the agriculturally prosperous northwest of India, in keeping with the commercial bias of region, used farm forestry for agrarian capitalism.

	Total	*Large Farmers*	*Small Farmers*	*Tiny Farmers*	*Landless*
No. of households	1024	226	349	126	323
— Planters	394	181	162	30	21
— Non-Planters	630	45	187	96	302
Total land owned (ha)	1716	1195	477	44	nil
— Planters	1250	998	242	11	nil
— Non-Planters	466	197	236	33	nil
Average land owned (ha)	1.7	5.3	1.4	0.3	nil
— Planters	3.2	5.5	1.5	0.4	nil
— Non-Planters	0.7	4.4	1.3	0.3	nil
Trees planted	136533	106417	26342	2579	1195
Trees per household	133	471	75	20	4
Trees/ha of land owned by planters	109	107	109	234	

Source: Village Census

Table 1: Tree Planting and Land Ownership of Resident Households (Saxena, 1992).

In the eastern states of India, a different picture emerges. The more humid and populous states of West Bengal and Orissa are more subsistence than market oriented. An economist, Bardhan, (1982) states: ‘Output-raising investments in agriculture are carried out less often in eastern than in north-western India… The ecology of densely populated monsoon paddy agriculture, accompanied by agricultural involution, dwarf holdings and petty landlordism (nurtured for long by the particular land tenure under the colonial administration in this region) leaves the generation of investible surplus per farm rather low.’

In West Bengal, where the average size of landholdings is less than 2.5 acres, Nesmith (1991) investigated the impact of social forestry. In a study conducted in Midnapore, SE West Bengal, it was found that participation in social forestry and its associated benefits are mediated by class and gender. The West Bengal Social Forestry Project (WBSFP) was initiated in 1981 with financial assistance from the World Bank for 69% of the project cost, or $29 million. According to the World Bank, the main objectives of the project were to increase availability of fuelwood to rural areas, along with the provision of non-timber forest produce (NTFP’s), such as fruit, fodder, etc… the main beneficiaries of which were termed the rural poor.

Nesmith studied 197 households in three villages, Bokulgram, Rangpur, and Chandrapalli, which were composed of mixed castes and tribes. Socio-economic status was calculated according to landholdings, crop yields livestock ownership and income, and was then allocated into one of four groups. The larger landholders belonged to the upper castes of Kayastha and Sadgop, and were also the top income groups, while the more numerous and lower caste Lodha and Maji along with other tribal groups were smallholders, or landless, were generally found in the bottom two income groups, which were below the poverty threshold, except in Chandrapalli, where all households were Lodha. The percentage of households in the top two income groups in Bokulgram, Chandrapalli and Rangpur are 37%, 29% and 58% respectively, while the percentage of households in groups 3 and 4 were 63%, 71% and 42%. Therefore, poverty in Chandrapalli is particularly prominent, while Rangpur has the largest proportion of top income groups.

Table 2 shows the number of households in each village, and the participation rates in WBSFP. It can be seen that Bokulgram demonstrated the highest participation rate with 70%, while Rangpur was a lower 49%, but the lowest was Chandrapalli, with only 29% participation. Table 3 shows the number of total households and participant households in each income group. In Bokulgram, participation is fairly evenly distributed across income groups, in Rangpur, it is found concentrated in the top two groups, and declines along income groups, while the reverse can be seen in Chandrapalli, with most participation amongst the bottom two groups.

Village	No. of households	No. of participant households	Participant households as % of total
Bokulgram	83	58	70
Rangpur	59	29	49
Chandrapalli	55	13	24
Total	197	100	51

Table 2: Number of Households in Each Village and Participation Rates in the Social Forestry Scheme (Nesmith, 1991)

Nesmith explains that several factors affect participation rates. In Bokulgram, good access to land, and effective extension from forest officers and locals is thought to contribute to similar participation rates across income groups. In Rangpur, however, social marginalisation manifests itself in a physical separation of low caste households on the periphery of the village, which has affected potential opportunities to participate. The local motivator who was responsible for extension (the local teacher) did not visit the low caste block, and by the time these villagers heard about the scheme, the seedling quota was exhausted. This also reflects the policy of the forest department where an influential villager, usually affluent, is the first contact with the village. Other factors were lack of suitable dahi land; lateritic soil that is less suitable for rice cultivation, which was the most significant reason non-participants gave for not planting trees, and which is generally indicative, as Nesmith comments, of the project's bias against the poor and landless.

Village/ income group	No. of households	% of total households	No. of participant households	% of income group
Bokulgram				
1	10	12	7	70
2	21	25	17	81
		(37)		
3	27	33	18	67
4	25	30	16	64
		(63)		
Total	83	100	58	70
Rangpur				
1	10	17	8	80
2	24	41	16	67
		(58)		
3	11	19	4	36
4	14	24	1	7
		(43)		
Total	59	101	29	49
Chandrapalli				
1	1	2	0	0
2	15	27	1	7
		(29)		
3	19	35	7	37
4	20	36	5	25
		(71)		
Total	55	100	13	24

Table 3: Number of Total Households and Participant Households in Each Income Group (Nesmith, 1991)

Gender bias is also evident, in that there is a male hedgemony of power within the village structure, reflecting the norm in institutions generally. Therefore invariably extension workers are male villagers, as are forest officers. Benefits from social forestry then, are unlikely to be shared equitably amongst the villagers, when access to resources are determined by ownership and social relations, which are mediated by class and gender.

However, the establishment of *Eucalyptus* groves was estimated to have reduced the collection of fuel from six to eight hours, down to two. This gave women, the major fuel collectors, the opportunity to undertake paid employment. Nevertheless, again, there was differential access to groves across villages. Bokulgram operated an equitable grove, where women who had planted trees, and those that had not, were allowed to access. Rangpur, meanwhile, where social stratification is marked, planting of *Eucalyptus* had been undertaken by the higher caste families, (discussed earlier), who placed exclusions on access regarding the low caste families on the periphery of the village. In this way, women excluded from the *Eucalyptus* groves tend to be the poorest, most marginal, and most in need of the resources available through social forestry. Indeed these are also the very groups that the World Bank was attempting to target. Nesmith successfully shows how economic inequalities are reinforced and accentuated in the implementation of social forestry.

The cases, although not extensive, do nonetheless highlight important features of social forestry; and also the difficulties involved in implementing such a scheme on the ground, particularly given marked social stratification. Both the cases discussed clearly show that the primary beneficiaries of social forestry are those groups of influence within their own communities, which is as much down to the short comings of the project design, (Nesmith, 1991), as it is to the general problems around social and economic marginalisation. The beneficiaries may not necessarily be in need of assistance to access biomass resources for subsistence. Indeed, there appears to be a clear indication that, as a matter of policy, the incorporation of 'farm forestry' under the remit of social forestry gives clear provision for producing *Eucalyptus* for the market.

Of course, there is nothing intrinsically illegitimate in producing *Eucalyptus* for the market; an additional cash crop produced on agricultural land, with government subsidies, is a creative solution to timber shortages in the market, but has led to much criticism from environmentalists and NGO's, that the real beneficiaries of 'social forestry' have been wealthy farmers, (CSE, 1985) and industry (Alvares, 1983), while genuine subsistence needs have been sidelined (Devi, 1983). The production of Eucalyptus on farm land is most usually to supply industries, particularly the burgeoning paper industry with pulp. Eucalyptus, as a quick growing soft wood is an ideal raw material to be used as pulp; particularly as the optimum age for prime pulping is about six to eight years. As *Eucalyptus* ages, it is generally used for poles. Therefore *Eucalyptus* is a lucrative cash crop for a commercial farmer, which can, in theory, maintain a high turnover.

In some parts of India, however, the large-scale planting of *Eucalyptus*, under the augur of social forestry has caused widespread resentment, amongst communities that perceive their needs are being subverted to those of industry. In Karnataka, the implementation of social forestry has involved the removal of mixed indigenous forest, with the replacement of *Eucalyptus* monoculture (Chandrashekhar et al, 1987). Since the early 1960's there has been an intensive demand on the forests of south India for timber and pulp, which led to the formation of the Karnataka Forest Plantations Corporation in 1972, to produce wood for industry. By 1986, *Eucalyptus* plantations over 112,748 acres had been established. However, under social forestry, another 370,330 acres, almost wholly *Eucalyptus* plantations were raised on government lands – forests, pasture land and open areas suitable for cultivation. Therefore, by the mid 1980's, *Eucalyptus* monoculture of nearly half a million hectares had been established. As Chandrashekhar notes, the agriculture commission did not envisage social forestry as a means to meet the large-scale wood demands of industry, nor was there an explicit mention of *Eucalyptus* as a species to be particularly encouraged in social forestry. Yet the end products of 'social forestry' are invariably sold to the paper, rayon and viscose factories. In Bangalore district, the entire production of Eucalyptus, while in Kolar district, 97% of the production was sold as raw materials to a factory, Harihar Polyfibres.

Local people have shown mounting concern over the diversion of good agricultural, food producing land, to *Eucalyptus* plantations and a concurrent decline of areas traditionally used for pasture, for the same. The area under the traditional staple, ragi, has declined significantly in Karnataka. In the Kolar district, mentioned earlier, between 1977 and 1981, ragi cultivation dropped from 142,000 ha, to 48,000 ha producing a marked reduction in yield from 175,000 tonnes to just 13,000 and increasing its price by 200% in the market (BES, 1984). Although a drought may also have been implicated, (Prabhakar, 1998), real fears over food security for local communities have been expressed, from grassroots and environmentalists alike. Moreover, under farm forestry, the Karnataka government planned to bring under plantation, for industry, 45,000 ha of so-called ‘C’ and ‘D’ classified land, considered as degraded forest, but also traditional grazing grounds. The ‘Wastelands Development Project’, was another scheme where 2.5 Mha were planned to be brought under *Eucalyptus*.

However, it was the attempted state appropriation of 75,000 acres of common, cultivated, and occupied land, designated as ‘C’ and ‘D’ for *Eucalyptus* to Karnataka Pulpwood Limited, a private and government initiative, that ignited widespread protest. In an irony of ‘peoples’ participation,’ ‘social forestry’ has been implemented with the coercion of the people by the police force, attempting to evict dwellings and claim cultivated land (Chandrashekhar et al, 1987). The social forestry situation in Karnataka has drawn criticism from indigenous and international organisations, for the narrow choice of species, to the overall lack of focus and direction to meet the forestry needs of the rural and semi-urban poor. There seems to be confusion over the remit of afforestation and social forestry here.

Social forestry, while inadvertently successful in meeting the needs of industry, appears to fall short of providing for subsistence needs, particularly regarding the marginal groups the scheme was supposed to target. The shortcomings can be attributed to the design of the scheme, and exacerbated by marked social stratification in the communities where social forestry has been attempted.

Is *Eucalyptus* a useful resource?

Setting aside some of the problems highlighted here, regarding the implementation of social forestry, can *Eucalyptus* fulfil biomass needs of the rural poor, given the diverse role of an indigenous, mixed forest in the rural economy? Many commentators have contributed to this particular debate, which has become rather polarised between an ‘environmental lobby’, such as Shiva, Centre for Science and Environment (CSE), and the writers and environmentalists, Gadgil and Guha, and a ‘plantation lobby’, comprising of foresters, policy makers, and industry.

Foresters have put forward the view that plantations in general reduce pressure on indigenous forests, and are critical in meeting increasing biomass needs. However, in practise, as discussed earlier here, ‘unproductive’ indigenous forests have been clearfelled, to make way for ‘productive’ monoculture plantations of exotics, usually *Eucalyptus,* rendering this supposition rather dubious. In the case of Karnataka, the large-scale appropriation by the state of common land, on which plantations of *Eucalyptus* were raised for industry would have had an adverse impact on local communities; the effect of shrinking commons would only serve to increase pressure on remaining lands. However, in Karnataka, there was a fundamental lack of consideration of rural communities.

The environmental lobby has highlighted the shortcomings of Eucalyptus as a useful contribution to the rural economy. Regarding the potential of the species, Shiva et al (1982), points out that many indigenous trees, and particularly those cultivated around the homestead, and protected on the village lots are multi-purpose trees. Neem (*Melia azadirachta*) for instance, is used as medicine, and for oil, pesticide, food, and firewood. Similarly, in south India, honge (*Pongamiya glabra*) is useful for oil, firewood, and is a popular source of fodder for cattle. *Eucalyptus* is limited in its scope as a resource; its allelopathic properties deter browsers, indeed, it is promoted as a species that can withstand planting in areas of high cattle densities, precisely because it is unpalatable. *Eucalyptus* cannot be used as a medicine, and it does not bear edible fruit. The only potential minor produce from this exotic species, would be its oil, yet as Prabhakar (1998) points out, the leaves of *E. tereticornis* does not bear cineole in sufficient quantity for commercial production.

The only relevant use for *Eucalyptus* in a rural subsistence economy, consistent with the original aims of social forestry, is for the provision of fuelwood and timber. Yet when the broader economics of *Eucalyptus* is considered, its use as a fuel may not be viable. Shiva et al (1982), make the pertinent point that *Eucalyptus* fetches too high a price on the market, reflecting its worth to industry, for it to be economic as subsistence firewood and therefore alternatives are always sought. Nevertheless, in some instances, the collective management and sale of *Eucalyptus* by rural communities, as an income generating venture may be possible. When this candidate was recently in India, researching joint forest management, I encountered villages managing small woodlots of *Eucalyptus* and *Acacia*. One particular community, Chaatipur, in the Ranpur district of Orissa, was by all accounts very satisfied with their 7 ha plantation. (See the back page for a photograph). Although established by the forest department on part of their village commons, it was effectively given over to the village when the trees were about six years old. The plantation provides surplus fuelwood for the village needs. Management involves thinning every year, and the harvesting of coupes every few years, of which the proceeds from the sale are shared amongst the villagers, and into the village council purse. Chaatipur is a small and fairly homogenous village, with a history of collective management, and as such, a village plantation seems to work. As discussed earlier, in other villages, where social stratification is marked, there will in all likelihood, be an inequitable arrangement.

The large-scale establishment of *Eucalyptus* can impact the rural economy in a multitude of ways, not always apparent at the outset. A reduction of fodder provision may occur (Shah and Weir, 1987), which can result in a potential loss of fertility for agriculture, and a potential loss of material for biogas systems. If established on good agricultural land, local food security may be compromised, which may result in a double loss to the rural poor; not only is local production reduced, but prices increase, and employment opportunities may be curtailed. A fundamental question also arises, in that areas under *Eucalyptus* might better serve rural communities' needs if under mixed species, rather than monoculture. Prabhakar (1998) advises that 'pure plantations on a large-scale must be avoided' and recommends inter-planting with fruit and fodder trees, effectively 'hedgebetting.'

The usefulness of *Eucalyptus*, then, is questionable, given its limited scope in a rural economy, and once the wider implications of its impact are considered. However, in some circumstances, small village managed plantations of exotics, may prove a viable income generating opportunity. The large-scale implementation of *Eucalyptus*, though is ultimately linked to a certain development trajectory, and as such represents a particular way of thinking which will be briefly discussed.

The philosophy of *Eucalyptus*

Despite some dubious scientific claims about *Eucalyptus*, Shiva and Bandyopadhyay (1985) nonetheless make some interesting points about the politics of exotics in general and *Eucalyptus* in particular. Shiva comments quite rightly: 'the tree species which get planted and the land on which it is planted determine to a large extent which groups accrue the benefits.'

The overwhelming drive for *Eucalyptus*, at the encouragement of the forest department, and sometimes as the only species on offer, has been interpreted in different ways. Shiva and Bandyopadhyay (1985), comment that the social forestry programmes which emphasise the use of *Eucalyptus* 'implicitly accept the impossibility of community participation'. *Eucalyptus*, therefore, is a tree which polices itself from the incapacity of communities to manage their own resources; non-browsable, resilient, an allelopathic alien, self-dependent. The favoured choice amongst large landholders, particularly absentee landholders, where individuals, and not communities are responsible for plantations. A safe choice to leave unattended.

Eucalyptus, promoted by the forest department, is the species the policy makers think rural communities need, for the common good. Representative of the 'I manage, you participate' brand of rural development (Chambers et al, 1989). For usufruct. For economic upliftment.

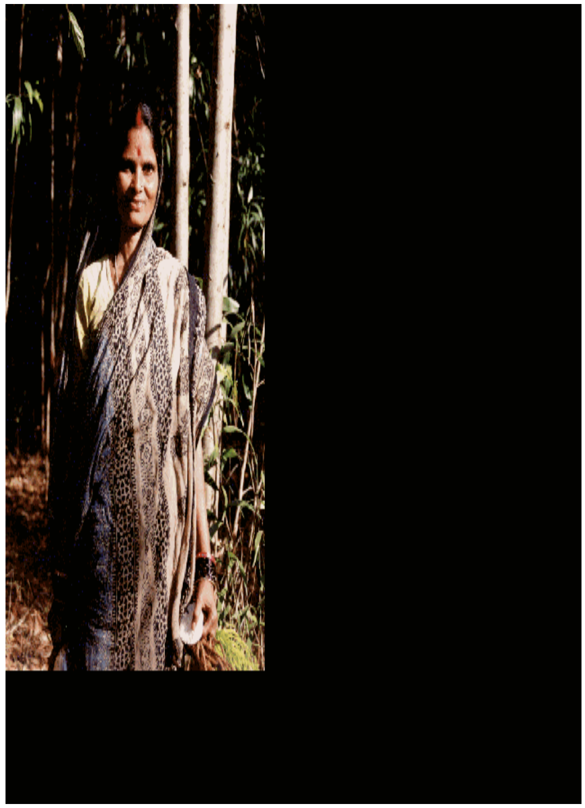
Eucalyptus, the principal colonial tree (Sargent, 1998), is now the favoured choice of international financial institutions, such as the World Bank, and donor organisations. A quick fix solution. A symbol of development and a symbol of aid. Of trickle down and top-down, a neo-colonial vision.

Conclusion

Social forestry has largely not fulfilled its remit. The narrow provision of species, illustrated by the overwhelming drive for *Eucalyptus*, has overlooked economic, social and ecological factors. *Eucalyptus,* as an exotic, is intrinsically unable to provide for the diverse range of goods and services a mixed, indigenous forest can ordinarily provide. As such, it cannot fulfil subsistence demands, but some communities may have income generating opportunities from plantations. More usually though, social and economic inequalities may result in the distribution of any benefits from *Eucalyptus* inequitably, and exacerbating processes of marginalisation amongst more vulnerable groups (those the scheme were supposed to target). Social forestry has achieved enormous success at supplying industry with raw materials.

Almost twenty years on from the large-scale afforestation drive, and social forestry does not seem to be sustaining interest in the local communities it was designed to serve. In Orissa, following a yield study in 1993 of mainly *Eucalyptus* plantations over 40,000 ha established between 1984-88, it was found that an average of 40% of the plantation areas sampled were ‘non-productive’, and had to be reclassified (ISO/Swedforest, 1993). In the neighbouring state of Bihar, meanwhile, tribal communities, the most marginalised of groups, and arguably the most dependent on forests, have protested at the large-scale establishment of *Eucalyptus,* initiated, after all, for ‘social’ benefit (Sargent, 1998). Even in the prosperous green revolution belt of the northwest, the unprecedented uptake of *Eucalyptus* amongst farmers led to a flood of poles and pulp material on the market, and a price crash occurred. Farmers had also anticipated greater gains, and smaller costs, from cultivating this exotic, while the trees were not always good quality, and did not grow into perfectly straight boles, which commanded higher prices. For these reasons, the commercial interest in *Eucalyptus* plummeted, and according to Saxena (1994), no farmers in Uttar Pradesh undertook replacement planting on their land but many removed the coppiced roots and resumed the cultivation of annual crops.

Many of the scientific claims made by Shiva et al against the exotic do not stand. As discussed here, the perceived environmental impacts of *Eucalyptus* owe more to the role of human agency, than any intrinsic property of the genus. However, *Eucalyptus* appears to be a wholly unsuitable species for large-scale planting under the remit of social forestry, on social and political grounds.



Manju Lata Rout, a manager of *Eucalyptus*

and *Acacia* plantation, Chaatipur, Ranpur, Orissa

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