Role of Plantations in Providing Goods and Services

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Introduction

Plantation activities in India were started long back in 1840 when the first plantation was raised in Nilambur and Malabar in Kerala. Since then country has developed plantations of both exotic and indigenous species to provide goods and services in a short period of time. Presently, plantations are raised over 1 million ha/annum in the country (Anon, 1995). India's achievements in raising forest plantations, in term of area, have been impressive. It is estimated that up to 1997-98, the total area of tree plantation, under different schemes, was 23.38 million ha. of this, some 3.54 million ha. were raised before 1980, 13.51 million ha. during 1980s, and the rest during the 1990s. There is a contention that forest plantations can, to some extent, compensate for the deforestation and forest degradation. These plantations has been raised to supplement natural regeneration, to restock forest freshly clear felled or destroyed by fire and other factors, to replace miscellaneous slow growing indigenous species with fast growing economically important exotics. Tree farming with various indigenous and exotics species like *neem, poplars, eucalyptus, casuarinas, acacias* etc have been adopted in the farmer's fields to meet basic requirements of farmers like wood, fuel, fodder, fruits, gums, charcoal etc. Chandra (2001) has estimated that 60,000 ha. area in plains of UP, Punjab, Haryana and Uttarakhand was planted with *Populus deltoides.* This species is planted at a rotation of 6-7 years. The Silvicultural working in such cases is more artificial and more demanding technically and professionally (Ranney, *et al.*, 1997)

Moreover, the performance of forest plantations in India, in term of survival, growth and ideal, has been poor. Based on the survival rate and stock density, the affective area of forest plantation has been estimated to be about 11.0 million ha. about 40 to 50 per cent of the reported / recorded total. The MAI of forest plantation in India varies from about 2 cu.m/ yr for valuable timber species to about 5 to 8 cu.m/ yr for *Eucalyptus* and other fast growing species. This may be compared to an MAI of over 10 cu.m/ha/yr generally and about 50 cu.m/ha/yr for good quality industrial plantations in different countries, over 70 cu.m./ha/yr has been reported in certain cases. By any measure, the performance of forest plantations in India is far below the potential. Inadequacies in site selection and site-species matching, poor planting stock, lack of proper maintenance and protection (from fire, grazing, pests and diseases), lack of timely tending/thinning, delay in fund allocation, and lack of adequately trained staff are some of the causes of the situation. To meet the needs like timber, fuelwood, fodder of large section of the rural population, the state and central government in India have initiated large scale afforestation/reforestation projects with loan and aid from World Bank, DFID, EU, CIDA, JBIC etc.

Positive role of plantation

1. Productivity increment

There are few location- specific studies on the productivity of forest plantations (Ravindranath *et al.*, 1992; Bhat *et al.*, 1995). The national mean productivity is about 3.2 t (air-dry weight)/ha/yr. When the dominant plantation types are considered (*Eucalyptus, poplars, kadam* , *Casuarina, Acacia auriculiformis* etc.), Eucalyptus recorded the highest productivity of 6.6 t/ha/yr, which is double the national mean for all plantations. There are location-specific case studies, which show higher productivities in the range of 7.2 to 8.2 t/ha/yr in semi-arid Karnataka for *Eucalyptus* in farm forestry in croplands (about 70 mm of annual rainfall), 63.5, 25.0 and 11.90 t/ha from the 8 years old in case of *Eucalyptus globules, E. grandis* and *E. tereticornis* in Tamilnadu and 5.2 to 7.3 t/ha/yr for *Acacia auriculiformis*-dominated plantations on degraded forestlands in the heavy rainfall zone. It is evident that the productivity of tree plantations on village commons and degraded forestlands is low, particularly in semi-arid locations, and, as expected, the productivity levels are higher in the heavy rainfall zone. The productivity of mixed tree plantations under semi-arid and unfertilized but good soil conditions is about 6 t/ha/yr. A field trial in the same region showed that the annual productivity of mixed plantation is 5.8 t/ha/yr compared to 5.9 and 2.7 t/ha/yr for monoculture plantations of *Leucaena leucocephala* and *Eucalyptus*, respectively (Shailaja *et al.*, 1994). The performance of seven tree species planted under high density plantation on irrigated red sandy clay loam soils of Raichur, Karnataka revealed that at the end of fifth year *Eucalyptus* produced the highest wood yield (105t/ha.) as compared to the other species (Nadagouda et. al..1997). Yield estimation on poplars indicates a mean annual increment of 20-25 m3/ha in the field bund plantations. However, productivity in some cases has been found to be much more ranging from 25 to 28 m3/ha (ICFRE). The productivity of Poplar plantation in Punjab is as high as 46.92 m3/ha/yr from 8.75-year-old plantation at 3 m × 3 m of spacing. The *Bombax ceiba* plantation at 50 years rotation period in UP has shown 250 t/ha of productivity for matchwood yield. *Casuarina equisetifolia* is being utilized for fuel wood purposes. The wood production of *Casuarina* varies from 10 to 20 t/ha/year on 7-10 years rotation period. *Prosopis cineraria* has been planted in the tropical drier parts of India to provide fuel and fodder. The fuel wood yield of fifteen years old coppice shoots of *Prosopis* varies from 7-70 m3/ha. About 40-70 kg. of fuel wood can be obtained per tree from 20 to 30 years old plantation. Lopping may yield about 2-3 kg of firewood in the initial 8-10 years old plantation.

2. Microclimatic amelioration

Microclimatic amelioration results primarily from the plantations of trees for shade or as live supports, shelter belts. The following are the effect of microclimatic amelioration:

Reduction in temperature of air and soil : The shade of trees reduces the temperature of air and soil and reduces the trans-evaporation of shaded crop. In a study the production of Cocao has increased due to reduced radiation load under the shade of Coconut trees in India (Nair and Balakrishnan 1977).

Suppression of weed growth : The shade of trees can reduce weeds especially light demanding ones. Shade of Bamboo, Teak, and Sal reduces *Lantana camara* and *Parthenium* weeds considerably.

Reduction in wind speed in the tree crop : Trees reduce the wind speed. It has been reported that trees grown on field bunds as wind break or shelterbelt primarily reduced the wind velocity and changes micro climate which increases the growth of agricultural crops and ultimately in crop yield (Jansen, 1954, Carborn, 1957, Marshal, 1967). *Dalbergia sisoo* trees of 18 years old and 18 meter tall grown in field boundaries in the semi-arid areas of Haryana decrease the wind velocity by 15-45% in the leeward side. The growth and productivity of irrigated cotton increased upto distance of 4 times the tree height towards the leeward side. The yield of cotton increase by 4-1% (Puri *et al.*, 1992).

Conservation of moisture : The organic matter added by trees to the soil increases water holding capacity and the shade trees reduces the evaporation resulting in higher soil moisture near the trees. In an alley cropping study under semi arid condition of Zambia, the soil moisture content was higher under hedgerows of *Leucenea leucocephala* and *Flemingia macrophyla* then in maize rows during dry period (Chirwa *et al*., 1994)

Reduction in pollution : Urban settlements of India are facing several unforeseen situations in which environmental degradation perhaps stands out. Excessive population pressure associated with unplanned economic development and industrialization, and vehicular emissions are mainly responsible for the unwarranted urban pollution, which in many places has assumed serious dimension. Amongst various pollutions, air pollution has increased rapidly in many cities and metropolises, especially due to vehicular traffic and power plant emissions. The hazardous gaseous emissions adversely reflect the human health, vegetation and property. Plantations with pollution traps species in the form of green-belts is one of the potential alternatives to mitigate air pollution as plants produce oxygen, serve as a sink for pollutants, and also check flow of dust and fly-ash to the areas of human settlements and bring down noise pollution level (Rawat *et.al*., 1998). Plants are good indicators of air pollution, and some of them do well under certain pollution to some degree and still there are others known to fix air pollutants also, but practically all of them provide innumerable environmental benefits. Agarwal and Tiwari (1997) have studied the tolerance of species for the abatement of air pollution. The study found that *Albizzia lebbek*, *Ficus gibbosa* syn. *Ficus tinctoria*, *Terminalia arjuna*, *Madhuca latifolia* have found to be good for abatement of air pollution.

Roadside avenues planting in India was started in the forties of this century in Uttar Pradesh, it gradually spread to other states. The roadside and shelterbelt plantations also serve to camouflage moving army vehicle during war, and retard noise pollution during normal times. The present trends of silviculture is to reserve only the well shaped vigorously growing trees and to clear fell all dead, dying, damaged, uprooted, leaning or over mature trees.

Maintenance of improvement of soil productivity: The plantations contribute to soil organic matter through shedding their leaves and decay of roots. The organic matter improves soil structure water holding capacity, and aggregate soil stability. Aggarwal, 1980 has reported that *Prosopis cineraria* has improved soil condition. The soil has more organic matter, nitrogen, phosphorus, potassium and micronutrients. (Zn, Mn, Cu, Fe) and slightly lowers pH and electrical conductivity under field condition.

Mitigation in climate change : Climate is an important determinant of the geographical distribution, composition and produc-tivity of forests. Therefore, changes in climate could alter the configuration and productivity of forest ecosystems. These changes in turn, could have profound implications for traditional livelihood, industry, biodiversity, soil and water resources, and hence, agricultural productivity. Moreover, these climate change induced effects would aggravate the existing stresses due to non-climate factors, such as land use changes and the unsustainable exploitation of natural resources. Forest tree species are able to improve carbon sinks by absorbing CO_2 emissions and mitigate by drawing CO2 from air into biomass, being only practical way for mitigating the gas from the atmosphere. Currently, total above ground biomass in world's forests is 421×10^9 tonnes distributed over 3,869 million ha. Thus, forests stores 1,200 Gtc in vegetation and soil (Bhardwaj *et.al*., 2003). Forests sequester 1 to 3 Gtc annually through comined effect of reforestation, regeneration and enhance growth of existing forests. Every ha. of activity growing forest sequesters between 2 and 5 tonnes of carbon per year (Brown, 1996). If 10 million ha. of area is planted per year, 400 × 106 ha. of new forest will be by the year 2040. By the time, the new forest will mature (40-100 years after plantation) 25 to 50 Gtc of CO_2 has been sequestered from the atmosphere (Papadopol, 2000). If the trees will give 10 m^3 of increment per annum per ha. then 7,50,000 m^3 wood will be added annually. This will fix approximately 1.5 million tones of carbon and remove 2.5 million tones CO_2 from the atmosphere.

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