# Alternate Land Use Options for Industrial Biomass Production

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The population explosion has brought marginal rainfed lands in to cultivation, posing a serious threat to natural eco system resulting in low and un economical yields. Inappropriate arable cropping systems often lead to rapid degradation of arable land, besides holding little promise of coping with ever increasing needs of human and livestock population. At present nearly 70% of the area is affected by wind erosion. If destruction of natural vegetation and over use of marginal lands continues, up to 9% of the additional land may be affected by wind erosion by 2020. Rehabilitation of the degraded lands and enabling more food and biomass production from these lands is the priority in the immediate and medium term. Alternate land use systems with perennial tree/ bush/ grass systems are better alternatives for such regions. Development of perennial based systems for different agro ecological regions can meet the requirements of ever growing population of both human and livestock. With the development of Indian economy and growing per capita incomes, there is a growing requirement of products such as animal products, fruits, bio fuels, paper and environmental friendly packaging material, etc. besides fodder and fuel. These products can be obtained from perennial systems, which can be grown under rainfed conditions. Systems like agri horticulture, silvipasture, hortipasture, dye yielding, medicinal and aromatic plants not only meet diversified requirements of the economy but also enhances income to rainfed farmers. Further processing of these products could emerge as an important source of income and employment

**Fuelwood:** The rural population in India relies heavily on traditional biomass-based fuels (fuelwood, crop residues, and animal dung) for meeting its energy needs. Approximately 96% of rural households are estimated to be using these fuels. These fuels dominate the domestic sector and are primarily used for cooking. Fuelwood is the primary energy source for cooking used by rural households (78%). Use of wood for industrial purpose also has gone up remarkably in recent years. In the state of Andhra Pradesh alone, 67 biomass based power projects of 404 MW capacity are in operation and one of the problem faced by these plants is availability and procurement of biomass raw materials. Development of biomass based projects with co firing in existing coal fired power plants are increasing due to the emphasis on reducing $CO_2$ emissions from the power plants and also the emerging opportunities under Clean Development Mechanism (CDM) of Kyoto protocol. During 2000 the gap between the sustainably produced fuelwood and the consumption was about 200 m cum. The gap between consumption and recorded production of fuelwood has, however, been increasing, indicating the seriousness of the fuelwood problem in India. This gap is widely believed to be met from illicit and unsustainable exploitation of biomass resources.

**Pulpwood:** In India, the rapid increase in the population lead to a rapid increase in paper consumption (news print, printing paper, packaging material as a substitute for polythene, value added paper etc.). The rate of annual production is about 4.1% where as the growth in the consumption was at an average rate of 5.1% a year. The consumption has far exceeded the production every year and the gap has widened over time. In India, the annual per capita consumption of paper and paperboard was only 4.5 kg, compared to 42 kg in China and 55 kg worldwide. It is estimated that India's annual per capita consumption of paper and paper board will rise to 8 kg by 2010. Due to the inability of forests to meet the raw material requirements, industry to a great extent depends on the imported pulp. The imports were to the tune of 768 thousand tons costing about US $ 435m.

during the 2002-04. It is estimated that the consumption is expected to double by the year 2010-11 and likely to increase substantially by the year 2015-16.

**Average annual production, consumption and imports of paper and paperboard, 2002-04.**

| Category | Production (Thousand tones) | Consumption (Thousand tones) | Imports (Thousand tones) |
|---|---|---|---|
| News print | 700 | 1249 | 555 |
| Printing & writing | 1530 | 1539 | 106 |
| Household & sanitary | 40 | 43 | 3 |
| Other paper & paper board | 1861 | 1920 | 104 |
| Total paper & paper board | 4131 | 4751 | 768 (US $ 436m) |

(Source: FAOSTAT 2006)

**Timber:** Rapid urbanization and intensive construction activity in the country lead to large gap between domestic demand and supply. The wood demand has increased by over 60% in the last decades, where as the output from the forests has halved in the same period. Our forests are at the optimum level of conservation and further improvement in productivity may not be possible. It is obvious that government owned forests cannot meet the requirement of the country, let alone the future. The overall annual imports are to the tune of 2 million $m^3$ a year valuing about US$550 million a year. It is estimated that the requirements of various categories of wood will increase by 40% by 2013-2013. Now more than 50% of industrial timber is being contributed by agroforestry in private sector. With forests under increasing pressure, agroforestry is the only segment that can record growth in production in timber, fuelwood, industrial wood, fodder and grass and medicinal plants and farmers in rainfed regions should seize this opportunity in the years to come in a big way.

**Demand and supply of wood (in million cu.m)**

| Particulars | 1985 | 1996 | 2001 | 2006 |
|---|---|---|---|---|
| Wood demand for domestic furniture, agriculture, industries | 50 | 64 | 73 | 82 |
| Output from forests | 24 | 12 | 12 | 12 |
| Output from plantations, production from social and farm forestry | - | 41 | 47 | 53 |
| Deficit | 26 | 11 | 14 | 17 |

(Source: Report of National Forestry Commission 2006, MOEF)

**Agroforestry Systems for wood production:**

In India many fast growing plants were screened for their suitability for pulp and paper making. This includes a large number of annuals and perennials. Some of them are Populus, Bamboo, *Casuarina equisetifolia, Eucalyptus globulas, Eucalyptus grandis, Sesbania aculeata, Moringa oleifera, Prosopis juliflora, Leucaena leucocephala, Grevillea robusta, Pinus taeda, Sesbanea aegyptica, Acacia auriculiformis, Gmelina arborea, Pinus radiata,* and *Hibiscus sabdariffa*. Due to their adaptability to climate, soil and environmental conditions, rapid biomass accumulation, high quality of pulp, ready market and multiple uses such as poles, wood etc. The following tree species are grown widely by farmers in one or other parts of the country and the tree species are well integrated in to the existing land use systems.

**Poplar** (*Populus deltoids*)**:** Poplar is the most widely grown tree cash crop in north and north western parts of India. Poplars due to their fast growth, ease in vegetative propagation and multiple uses such as plywood, match splints, pulp, veneer, fibre board, fuel, fodder etc. resulted in wide acceptance with the farming community for the last so many years. With the systematic shrinkage of forest land in India and expanding human population, poplars have gained tremendous importance in meeting the demand of wood products so much so that 80% of plywood production in north India depends on poplar wood.

By and large poplar is grown above $28^0$ N latitude in the country. With the introduction of new clones and release of new clones through breeding among well adapted land races, it has been possible to grow them successfully well before this latitude in Maharashtra, Madhya Pradesh, Eastern UP, Bihar etc. it is estimated that around one million hectares of agricultural land is under poplar cultivation in one or other form of agroforestry. The total area planted annually works out to be about 23,000 ha (Rawat, 2001).

Due to the importance and utility attached to poplars, a large number of exotic poplars were introduced in India. The most widely planted species among them is *Populus deltoides*. It is grown on a large scale in Tarai regains of UP, plains of Punjab, Haryana, U.P., Himachal Pradesh and Arunachal Pradesh. Some of the new clones, introduced recently, which have shown promise in agroforestry systems, are S7C4, S7C8, S7C15, S7C20 etc. WIMCO seedling ltd. Rudrapur has also developed some clones such as Udai, Kranti and Bahar, which are being planted by farmers. Some of these poplars produce a mean annual increment of up to 50 $m^3$/ha/year, the overage is being 20$m^3$/ha/year against a maximum of 4.5$m^3$/ha/year available from forest plantations. The growth habit of poplar tree with straight and cylindrical bole, moderate conical crown, mostly deciduous during winter months helps to keep the tree-crop competition to a minimum.

Poplar is generally planted either at 3 to 4m spacing in linear rows on one or more bunds of agricultural fields or at 5x4m spacing throughout the agricultural field. Poplar has been successfully integrated with agricultural crops and several agroforestry models, which are ecologically and economically viable, are available. Field crops such as wheat, sugarcane, sunflower, mustard, oat, maize and pulses are grown extensively with poplar either in irrigated or rainfed conditions (Sharma & Dadhwal 1996). However when grown under marginal lands without irrigation the growth rates and biomass accumulation is quite low. A variety of inter crops were tested with poplars for their suitability and performance. Some of them are lettuce, beet root, pineapple, yams, including essential oil yielding annuals viz. tagetes, etc. Among them pineapple and yams have shown promise of cultivation as an inter crop with poplars. Lettuce, beet root perform well with poplar and registered yields as high as 275q/ha and 150 q/ha, respectively. Among the essential oil yielding crops picholi and tagetes hold promise (Chandra 2001).

**Eucalyptus** sps*.:* - Extensive plantations of eucalyptus is being taken up by government and non government agencies in the recent past because of the economic gains associated with shorter rotation cycle of Eucalyptus. In Punjab & Haryana during 80's farmers adopted wide scale plantation of eucalyptus at a closer spacing keeping in view the demand for local pulp mills. However the development of high yielding and disease resistant clones has revolutionized eucalyptus cultivation in many parts of India. The productivity of these clones under rainfed conditions ranges between 12-44 $m^3$/ha/yr. In certain trials the productivity of best clones has been more than 10 times the productivity of seedlings control treatment or the worst performing clone (Piare Lal, 2001). The plantation of

eucalyptus in India has increased tremendously during the last decade through various forestry and agroforestry programs. Over 0.62 m. ha of land is covered by this genus (Singh and Kohli, 1992). Due to short rotation cycle i.e. 4-5 years and high returns associated with clonal plantations, they became popular among the farming community. An average yield of 40-50 ton/ha/3yrs. is not uncommon in deep soils. Besides that the coppicing ability of eucalyptus makes it suitable to take up 3-4 harvests continuously without any additional expenditure. Supply of improved plant material at subsidized rates, continuous advisory services and guaranteed minimum support price offered by the state government are some of the other contributory factors encouraging the cultivation of eucalyptus in large areas in the vicinity of paper industries. Due to the non availability and high cost associated with labour and risky nature of the commercial crops such as chillies, tobacco and cotton and guaranteed returns associated with eucalyptus, large number of farmers are growing eucalyptus in their agricultural lands.

Unlike poplar much of the eucalyptus cultivation is confined to rainfed areas. Areas receiving high rainfall are particularly suitable for eucalyptus cultivation. Better yields of eucalyptus can be obtained in sandy loam soils with good drainage. The best time of planting eucalyptus is the break of monsoon in June-July when the seedlings become 1m long and fit for planting in pits of size 45x45x45 cm. It is planted it a spacing of 3x2m. It has been grown not only as monoculture plantation but also as field bund plantation in agricultural fields. A large number of crops such as chickpea, lentil, wheat, mustard, berseem, blackgram and greengram are commonly grown with eucalyptus.

**Leucaena leucocephala**: *Leucaena leucocephala,* a leguminious multipurpose tree thrives well in neutral to alkaline soils where the annual rainfall ranges from 600-1700mm. It is an excellent source of fuelwood with high calorific value and produces large quantities of forage. The forage is highly palatable, digestive and nutritious. Foliage is very rich in nitrogen and can used as green manure. Besides above, leucaena is having good copping ability and ability to fix atmospheric nitrogen and can be successfully grown in marginal and sub marginal lands with less difficulty.

Several *Leucaena leucocephala* cultivars and *Leucaena diversifolia* were tested in India, Indonesia and other SE Asian countries as a raw material for pulp and paper. It was clearly established that they have the potential to produce high biomass and the cellulose content of the pulp was high indicating their suitability for pulp production. Pulp contains high amounts of alpha-cellulose (92-94%) with low ash content (0.05-0.06%). Experiments conducted in India revealed that plant growth and yield parameters were found to be minimum in the closest spacing i.e. 100x100 cm and maximum with wide spacing i.e. 200x200 cm. However, maximum dry matter production was obtained in the closest spacing i.e. 160 t/ha by the $5^{th}$ year and minimum biomass yield was obtained in the widest spacing i.e. 45 t/ha by $5^{th}$ year. With the increase in population the biomass yield per unit area was also increased (Saikia & Sharma 1994). The plant height, diameter and yield of biomass increased with the increase in nitrogen application and the trend was found to be linear (Saikia and Sharma 1994). Manivachakam et al. (1998) reported that the above ground biomass production of *L. leucocephala* at the age of 5 years amounted to 128.4t/ha in a sandy loam soil where as it is 49.8 t/ha in clay soil of Coimbatore. Farmers in the districts of Nagpur and Wardha of Maharashtra went for massive plantations of leucaeua during 1980's. Large area in the districts of Prakasam, Guntur, Krishna of AP is under Leucaena cultivation. Farmers generally adopt high density plantations. The spacing ranges from 1x1m to 3x0.6m. These plantations are distributed in areas receiving an annual rainfall of 500-900mm. Leucaena is generally harvested in 3.5 years and allowed to re sprout. 3-4 rotations can be taken up successfully. Agricultural crops such as cowpea, blackgram, green gram

and cotton are grown during the first year of each rotation. There is tremendous scope to increase its cultivation in sloppy areas of watersheds and it is particularly suitable for class III & IV lands of watersheds which are characterized by undulating topography, high intensity run off, shallow and light soils and whose ideal land use is to bring such lands under perennial vegetation.

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