

# Clonal plantations play a key role to increase agroforestry production enriching farm communities: Indian experiences

## Abstract

Because of poor results and ununiformity in seed route plantations, Clonal plantations have proven to be a best option to get desired yield in a stipulated time period. Various R&D supported programme by Research Organization, Institutes, Industries conducted to develop new clones of *Eucalyptus*, *Poplar*, *Shisham*, *Casuarina*, *Gmelina*, *Teak* and other woody species have now provided a good support to growers. Farmers of the country are using best management practises to obtain desired results in terms of better returns through high yield from their plantations. Various Institutes like Forest Research Institute, Dehradun, G.B. Pant nagar University, ICAR, IARI, State Forest Departments of U.P. Punjab, Haryana, Andhra Pradesh, Tamil Nadu and other states. Various Paper Industries like Century, Star, BILT, JK, ITC, WCPM, TNPL, SPB, Mysore etc. have played a vital role to promote agroforestry plantations among farmers so as to grow the raw material for their future use. Farmers adopted good practices of management to get the desired results from their plantation on their farm land through commercial plantations of above species. It is well known fact that the scarcity of labours and other constraints suffered the agriculture of marginal farmers. The introduction of clonal forestry and plantations in country have proven a boon for farm communities and also promoted the agroforestry. Now farmers are using their degraded land, unutilized land using various agroforestry models and taking the advantage of plantations and earning good returns from their lands.

**Keywords:** clonal plantations, paper industries, raw material, agroforestry models, degraded land

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## Introduction

Agroforestry is a land-use management system where trees or shrubs are grown around or among crops or in pasture lands. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land use systems. Agroforestry as a land use system is as old as agriculture. In a country like India with varied agro climatic zones, various combinations of trees with arable crops, fruits and animal husbandry exist.<sup>1</sup> Growing field crops like pearl millet, legumes and oil seeds in a field predominant by Khejri (*Prosopis cineraria*) and Bordi (*Zizyphus nummularia*) are examples of traditional agroforestry of Rajasthan, Punjab, Haryana and Gujarat States. Growing tree species, such as *Eucalyptus* spp, *Dalbergia sissoo*, *Azadirachta indica*, *Acacia nilotica*, *Grewia optiva*, *Morus alba* and *Ficus* spp., on the borders of fields to meet local demands for timber, fodder and fuel is a common practice throughout the country.<sup>2</sup>

## Agroforestry in India

Agroforestry research was initiated in India about two decades ago and considerable progress has been achieved since then. Agroforestry practices, i.e., growing trees with food crops and grasses, are believed to have been practiced during the Vedic era (1000 BC). Although practiced since then, it was only until the establishment of the International Council for Agroforestry (ICRAF) in 1977, which was renamed to the International Centre for Research in Agroforestry in 1991, that agroforestry as a science was introduced.<sup>3</sup> India has been at the forefront of agroforestry research ever since organized research in this area started worldwide about 25 years ago. Considering the country's unique land use, demographic, political and socio-cultural

characteristics as well as its strong contributions to agricultural and forestry research, India's experience in agroforestry research has proved important to agroforestry development especially in developing countries. It is crucial that progressive legal and institutional policies are created to eschew the historical dichotomy between agriculture and forestry and encourage integrated land-use systems. Government policies hold the key to agroforestry adoption.<sup>4</sup>

## Current status of agroforestry research in India

Agroforestry has significant potential to provide employment to rural and urban population through production, industrial application and value addition ventures. Agroforestry research is now conducted under the auspices of the All India Coordinated Agroforestry Research Project of the Indian Council of Agricultural Research at 31 centres distributed over India's tropical and temperate regions. It is also very important that Agroforestry is playing the greatest role in maintaining the resource base and increasing soil productivity. Agroforestry land use increases livelihood security, reduces vulnerability to climate and environmental changes, and it has an important role in increasing resilience of farming systems and buffering households against climate related risks. Therefore, agroforestry will be required to contribute substantially to meet the demands of rising population for food, fruits, fuel wood, timber, fodder, bio-fuel and bio energy as well as for its perceived ecological services.

## Role of national agroforestry policy-2014

Current estimate show that about 65% of the country's timber requirement is met from the tree on farms. Agroforestry also generates significant opportunities. Recent development of National

Agroforestry Policy-2014 is major breakthrough in this line. The National Agroforestry Policy is a path-breaker in making agroforestry an instrument for transforming lives of rural farming population, protecting ecosystem and ensuring food security through sustainable means. Among others, the policy will encourage farmers to practice agroforestry, enormously boost wood industry, and also help in biodiversity conservation (National Agroforestry Policy, 2014).

### Clonal plantations supported agroforestry extension

Technology based farm-forestry plantations with genetically improved, high yielding and fast growing clonal planting stock of species like Eucalypts have tremendous potential for diversification of agriculture and meeting growing shortages of industrial timber on sustainable basis. We cannot ignore the fact that *Eucalyptus* is one of the trees can be grown with crops. *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.<sup>5</sup> Silvicultural properties including straightness, narrow crown, self-pruning, high growth rates, adaptability to a wide range of soils and climates, coppicing ability, a tendency not to spread as a weed and wide utility of wood are some of the main features of *Eucalyptus* Clones making it popular among the farmers for raising as block plantations.<sup>5</sup>

Continuous decline of supply of industrial round wood from government owned forests, growing demand by wood based industries and commercial scale introduction of genetically improved, field tested and high yielding clones of Poplars and Eucalypts-supported with technical extension services, have accelerated the expansion of agroforestry plantations in many states of India. Scientifically managed agroforestry plantations, based on genetically improved clonal planting stock, have ensured unprecedented improvement of productivity of plantations and quality of timber ensuring far better net returns to farmers compared to returns from traditional crops. Average productivity of clonal *Eucalyptus* and Poplar Plantations ranges from 20-25m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup> at 5-6 years. However, many farmers have achieved 50m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup> from such clones confirming tremendous potential of agroforestry plantations to meet our national needs for timber and fuel wood.

Agroforestry systems for pulpwood production thus consist of growing of “commercial timber trees for wood industry in agriculture fields” with irrigation, fertilizers plant management technology, etc., in a harvest cycle of 4-7 years. Crops growing underneath from a small part of the gross income. Selective shade loving or shade-tolerant crops are grown to complement timber production and cash flow. The average annual yield from ordinary seed-raised agro forestry plantations is in the range of 5–6m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup> by the third year and 10–15 m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup> by the seventh yr of plant growth.<sup>6</sup> Whereas selected high-yielding clones can obtain mean annual productivity ranging between 16–20m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup> and 20–25m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup> by the third and seventh yr of plantation, respectively.<sup>7</sup> This highlights the need for vegetative propagation of such clones within a clonal forestry program, and the requirement to develop more efficient and reliable multiplication methods.

### Introduction of clonal plantation in India

The year 1984 heralded quite a few remarkable developments leading to development of commercial scale clonal plantations in India. These positive developments revolutionised productivity and profitability of plantations with major improvements in quality of timber based on large scale deployment of genetically improved,

uniform and true to type clonal planting stock. Clonal plantations exploit existing natural variation for fast and immediate genetic gains taking full advantage of superior genetic qualities of field tested clones. Vegetatively propagated clonal plants, developed from a single mother tree having most desirable genetic qualities, are uniform and true to type with all of the genetic qualities of the mother plant. There are many advantages of clonal forestry including better utilization of additive genetic variance because differences among tested clones include all the additive variance and complete capture of non additive genetic variance since deployed clones retain their entire genetic value. Another major advantage is possibility of exploiting genotype x environment interaction through deployment of most adapted site specific tested clones.<sup>8</sup>

### Initiatives of wood based industries for promotion of clonal plantations

#### Role of wimco seedlings

Wimco Limited started promoting Poplar plantations first time under agroforestry system on individual farmer's fields on a trial basis during the 1970s. Wimco Limited set up another company Wimco Seedlings Limited jointly with two Swedish companies in 1984 and set up a R&D centre at Rudrapur. Production of high quality planting stock of Poplars for farmers in Uttar Pradesh, Haryana and Punjab and long term R&D for development, testing and deployment of suitable clones of Poplars were the major responsibilities of Wimco Seedlings Limited. Wimco Limited also launched a major agroforestry project in association with the National Bank for Agriculture and Rural Development (NABARD) in 1984 for large scale growing of Poplars by private farmers. A separate Agroforestry Divisions was set up by Wimco Limited for implementing this project leading to a unique success story of commercial Poplar plantations under agroforestry system in India. This project covered three states of Uttar Pradesh, Haryana and Punjab. Wimco arranged following key inputs required by the farmers for ensuring commercial success of Poplar based agroforestry plantations:

- Supply of high quality planting stock of genetically superior field tested clones of poplars.
- Technical guidance and extension services to farmers for raising and maintenance of poplar plantations based on improved package of practices.
- Buy back guarantees to the farmers to purchase farm grown poplars on maturity with assured support price.
- Long term bank finance for poplar plantations through nationalized banks under this umbrella project with refinance assistance of NABARD.
- R&D support for this project including development, testing and deployment of new superior clones of poplars and suitable shade tolerant crops compatible with poplars.

State Governments of the aforesaid states were persuaded to exempt poplars grown by farmers from the cumbersome restrictive regime of getting felling and timber transit permits to facilitate harvesting and marketing of poplars. These positive steps combined with high yields and excellent net returns from plantations convinced many more new farmers to take up poplar plantations along with intercrops.

Planting of poplars under agroforestry system on suitable areas with assured irrigation facilities in these three states continuously went up. Likewise the demand for poplar logs by safety matches,

plywood, sports goods and pencil making industries kept increasing as more new units were set up. By the year 2000 nearly 15 million poplar plants covering roughly 30,000 ha area were being planted annually and similar area was being harvested maintaining a healthy balance between demand and supply of poplar logs.<sup>9</sup>

### Role of paper industries

More than 700 paper industries are active in the country and out of that around 26-28 companies are using wood as raw material for manufacturing of paper and paper products. It is widely known fact that Industries especially Paper industries always remained under big pressure to secure raw material as per their requirement. For that plantations programme were initiated by the industries and today also industries are playing a very important role to promote plantations.

Paper Industries always looked for waste /barren land available in their states and always requested to Central/State Government and Forest department to work under a joint venture to cover such lands under plantation so as to make surety raw material availability and to reduce the pressure on forest. Paper mills like Star Paper, Century Paper, BILT, JK Paper, Orient Paper, IP-APPM, ITC, WCPM, SPB, TNPL, Mysore Paper etc contributed towards promotion of Clonal Plantations either itself or through plantations on farmer's land.

The quality materials of high yield are being provided by the company to farmers on a subsidized rate to enhance the availability of raw material in the vicinity of mills. The above mills have set up state of art Hi-tech clonal nursery to produce lacs of clonal plants of *Eucalyptus* through vegetative propagation. In this Star Paper Mills is annually distributing 20-25 lacs plants of Clonal *Eucalyptus* among famers of Western UP, Uttarakhand and Haryana. Star Paper has developed a good rapport among farming communities through selling of their high yielding clones in Western U.P. to increase productivity of raw material since 2002. Star Paper Mills also promotes Poplar based agroforestry to farmers and distributed best clones of Poplar of high yield since 2006.<sup>10</sup> BILT through its concern BTTL launched farm forestry programme in various states like Chattisgarh, Orissa, Madhya Pradesh, Andhra Pradesh and distributing quality planting material to farmers. Orient Paper Mills has also set up its Hi-Tech Clonal Nursery and producing around 50-60 lacs of plants annually and distributing the plants in its catchment area. JK Paper also have set up State of Art Clonal Propagation system for *Eucalyptus*, Casuarina, Subabul and Acacia and producing around 1-1.5 millions of clonal plants and above species. Research is being conducted to develop new clones of high yield of *Eucalyptus* and Subabul. IP-APPM has also set up Clonal Production facility in its campus to produce around 1-2 millions of Clonal plants of Casuarina and *Eucalyptus*. Further Subabul is also included in production programme.

WCPM has also done a good job to promote clonal plantations on waste lands of farmers of Karnataka under its Captive Plantation Project through Contract for Farming. To date, company through its society SARA (Society for Afforestation, Research and Allied Works) has raised captive plantations on more than 50,000 acres of degraded land of farmers in different districts of Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu States through Contract for Farming (CFF) since 2006 under a simple agreement with farmers for a period of only five years. In support of agroforestry farm establishment, SARA provides fodder to the livestock such as *Stylosanthes scabra* and *S. hamata*. These are also integrated in the agroforestry farms. In some areas, the farmers are earning extra income by intercropping maize, cashew, peanut and ginger.<sup>11</sup>

The contribution of ITC paper towards development of Clonal *Eucalyptus* is well known and documented. More than 100 clones were developed and released by ITC for farmers under their R&D programme on Clonal Propagation of *Eucalyptus* after proper testing and field evaluations. Looking to the suitability of those clones, various other paper industries adopted those clones and introduced in their production system. Further few superior clones were adopted by other wood based industries also. Now industries are very conscious and focusing itself on plantations on commercial scales so as to secure the raw material in a very sustainable manner and they are doing plantations annually looking to their future requirement. The annual target of plantation of paper industries are shown in Table 1.

**Table 1** Annual Planting Target for Indian Paper Industries

S.No	Name of the industry	Annual target for plantation in Ha
1	Central Pulp	1325
2	J.K. Paper	5500
3	Bilt	5000
4	Sirpur	3530
5	ITC LTD.,	17500
6	IP-APPM	7200
7	TNPL	6300
8	SPB	2400
9	WCPM	7600
10	Mysore	470
11	Orient	7600
12	Star Paper	9800
13	Century	950
	Total	75175

### Promotion of clonal plantations of other species

*Eucalyptus* is the main source of raw material. Majority of raw material in coming from *Eucalyptus* plantation. Beside *Eucalyptus*, Many other pulpwood species were also developed by the industries looking to their site specificity and adaptability in a particular environment. Industries and various research organization did a good job to develop site specific clones of species like *Casuarina*, *Acacia*, *Teak*, *Shisham*. Encouraged by the success of clonal plantations of *Eucalyptus*, ITC Bhadrachalam Paperborads Limited and Andhra Pradesh Forest Department started development of clones of Casuarina.<sup>12</sup> Indian Institute of Forest Genetics and Tree Breeding has also developed clones of Casuarina and released 4 clones of Eucalypts after field trials. Current planting level of Casuarina clones is about 4000 ha per annum in coastal Andhra Pradesh mainly by Andhra Pradesh Paper Mills (now IP-APPM) and ITC Limited. Subabul (*Leucaena leucocephala*) clones have also been developed by ITC Limited and current planting level is about 3000 ha per year.<sup>13</sup> Mysore Paper Mills, Bhadravathi, in Karnataka developed and deployed clonal planting stock of selections from natural hybrids between *Acacia mangium* and *Acacia auriculiformis* and later these clones were also adopted by West Coast Paper Mills, Dandeli in Karnataka. However because of fungal pathogens the area under Acacia clones is insignificant. Research Institutes under ICFRE and some of the

state forest departments have also been working on development, testing and deployment of clones of other important species including *Tectona grandis*, *Gmelina arborea* *Dalbergia* sp. etc. However area under clonal plantations of these species is very small. Further research work on development and deployment of superior clones of such important species, amenable to vegetative propagation, needs to be intensified.

### Wood demand and supply scenario

Forest Survey of India has estimated total annual consumption of wood by housing and construction, furniture and fixtures and agricultural implements as 48 million cum round wood equivalent. Total number of sawmills is estimated to be 55731 using 22.9 million cum logs. There are 3457 plywood and veneer units using 19.9 million cum logs as input annually. Total round wood used by these sectors is thus around 90.8 million cum.<sup>14</sup> However, FSI does not clarify what

portion of the logs input of 22.9 million cum used by saw mills is included in the estimates of consumption of 48 million cum by the first three sectors mentioned above. Moreover, this data does not provide estimates of consumption of logs by many other industries like safety matches, packaging, sports goods, pencils, toys, and body building of vehicles etc. These estimates also do not include pulpwood requirements of wood based pulp and paper mills in the country.<sup>15</sup>

In India more than 700 Paper mills are manufacturing variety of papers and paper products using various types of raw materials viz. wood, bamboo, recycled fibre, baggase, wheat straw, rice husk, etc. Approximately 35% are based on chemical pulp, 44% on recycled fibre and 21% on agro-residues. To date in the country around 27-30 mills are based on Wood and Bamboo as main source of raw material. Pulp production and raw material requirements of some paper mills are shown in Table 2.

**Table 2** Indian paper industries wood requirement

S.No	Company's Name	Wood pulp production (MT)	Wood Requirement (MT)		Total (MT)
			Bamboo	Wood (MT)/Wood chips* ( <i>Eucalypts, Poplar, Acacia, Subabul, Casuarina</i> etc.)	
1	ITC	240000	160000	640000	800000
2	TNPL	100000		400000	400000
3	Century Paper	100000	60000	240000	300000
4	JK Paper	150000	130000	420000	300000
5	Orient Paper	50000	120000	100000	220000
6	Star Paper	60000	100000	130000	230000
7	Sirpur Paper	70000	100000	230000	330000
8	BILT	370000	300000	1100000	1400000
9	SPB	100000	-	400000	400000
10	IP-APPM	240000	160000	640000	800000
11	WCPM	270000	-	960000	960000
12	Hindustan	200000	700000	150000	850000
13	Mysore Paper	60000	30000	190000	220000
	Total	2010000	1860000	5600000	7460000

\*Wood chips of *Eucalyptus* spp. imported from ASEAN countries by WCPM First time in the history of Indian Paper Mills in 2013

The estimated annual production of wood from forests in India is 3.17 million cum. Contribution of wood supplies from trees outside forests, comprising largely of agroforestry plantations, is many times larger with potential production of wood estimated at 42.77 million cum per year. Wood is the prime source for industries like Ply wood, Pole, Furniture and Pulp and Paper industries. Mismatching in Demand and supply always remained a big concern of wood based industries. This situation drastically observed during 2012-13 year where there was a short fall came in availability of raw material. Recent expansion programmes by many paper mills have created this situation where farmers were under pressure and had no option to cut the plantation prior maturity which created a huge loss in crop and economic loss as well. Looking to that situation Industry like WCPM started import of wood and woodchips through its OGL (Open General License) in 2013-14 and first shipment received in June, 2013 at Marmagoa Port, Goa. Further, other industries like JK, ITC started procurement of

imported woodchips at their nearby Port from ASEAN countries on basis. WCPM is still procuring the woodchips from ASEAN countries and meeting its 50-60% requirement from imported woodchips. Such new initiatives taken by the industries would certainly be an impact on the raw material availability. It shows that plantation is still a major requirement of every one especially by the paper industries which is under pressure to meet out their raw material requirement from the available sources.

In general Industries procuring the wood from Private sources, own plantations and from Government sources. It is also a important fact that only 10-15% of wood is coming from the government sources. Various industries like ITC, BILT, JK, STAR, Orient, WCPM, IP-APPM, TNPL and others also launched various Social and Farm Forestry programmes to promote agroforestry among the farm communities through their plantations schemes. Industries

provided superior quality planting material to farmers after set up Hi-tech clonal nurseries in their areas and distributed the seedlings/plants on subsidized rates with a moral or some time with Buy Back guarantee to purchase the wood on maturity.

## Results and discussions

Today Agroforestry has become an essential and much need necessity for everyone. Further, a brain storming session is required with the technologists, Foresters, Scientist, Agriculturist and person from the industry side to take immediate actions which can help in favour of agroforestry. Need of awareness about clonal plantations with agriculture crop is also a must to ensure the net productivity from both Plantation and crop. The R&D programmes towards development of new clones of important commercial species is much needed and Attention is required from Government side. Awareness among farm communities about benefits from Agroforestry is required through some national level programmes/meeting in all the states. It is quite true that till now there are few states where there is an urgent need of such awareness programme/workshops in between farmers. Government should also frame some beneficial schemes for farmers and commercial growers so that farmer can avail such benefits and adopt best agroforestry models for their lands. Recent development of National Agroforestry Policy 2014 can serve much better in this direction but still there is a big gap between the farmers and the policy makers. We need to go in the grass root of the system and make the policy is much familiar for the farmers so that he can understand the policy and schemes in a very simple way. Apart from this future research is much needed on Clonal Propagation of high yielding clones of commercially important species. Now a day's industries especially the paper sectors are lack behind in their production target and facing a huge economic loss due to unavailability of quality raw material. Continuous research should be carried out in collaboration with Industry and Institute so as to come out with new quality planting material after proper field evaluation e.g. Multi-locational Trails.

It has no doubt that superior quality planting material proved a better option to get desired results in terms of better yield and gains from plantations adopting clonal materials. Wood based Industries have also launched various awareness programmes for farmers to get more benefits from their land after adopting various models of Agroforestry with plantations with best silvi-culture practise to get better yield. For this wood based industries have set up an annual target for plantation promote Social and Farm forestry in their catchment area to develop raw material for their own use in a sustainable manner. Such dialogues/commitment from Industry side boosted farmers and encouraged them to adopt plantations on their farm land with agriculture crop to get extra income and assurance of purchasing of wood by the Industry also gave support to farmers to dispose off their crop on prevailing mill rate. Such efforts would surely be helpful for agroforestry development on farm lands of farm communities. Innovative Policy reforms to address major constraints which are standing in front of Agroforestry development in the country and to promote use of genetically improved certified planting stock and strengthening of extension services backed by strong Research and Development as well as institutional and budgetary support are critically important for harnessing vast untapped potential of agroforestry.

## Conclusion

It is true that in India, *Eucalyptus* is recognized as a commercial agriculture crop. It has received much attention among commercial

growers and agriculturists and they are going for its plantations on mega scale either alone or with intercrop of various other agriculture crop like Wheat, Sugarcane etc to get maximum return from the land. *Eucalyptus* plantations promoted by the private companies receive generous incentives such as technical know-how for establishing the trees on the farmer's land and contracts with the farmer to buy some or all of the first harvest for an agreed upon price at the time of harvesting, sales tax exemptions on the pulpwood, procurement through Agricultural Market Committees, no middle man involvement hence farmer can sell his produce directly to the end users and various tax holidays and tax exemptions for extended periods apart from element of subsidies on the *Eucalyptus* clones given by the company. These incentives put *Eucalyptus* at an advantage compared to other agricultural crops (including perennials), which receive no such promotion. Beside *Eucalyptus*, promotion of other commercial species and their plantations are required more attention so that farmer can use them as an alternative looking to their site suitability and available market. Government should also come forward and launch beneficial policies and schemes for farm communities with a fare commitment of financial and technical supports. Agriculture banks and institutions can also play a major role in this direction by providing them financial out puts through their schemes i.e. Agriculture loans. Crop Insurance of such commercial crop is also a need of the hour. In case something goes wrong at any stage then farmers could remain in a safeguard position. Further, Market for such produce from plantations is required without any interference of middle man. Farmer should come directly and disposed of their crop and gain the right value for the crop. This step is very important to promote agroforestry on big scale because ultimate aim of the farmer is to get the right value of their produce at right time in a defined manner. Such efforts are immediately required by the Centre and State Government especially Agriculture department. In this Role of Forest department may not ignore. Forest department can play a vital role to give relaxation and easy permission on such crop which are exempted from any transit permit and pass. Farmer will declare the produce with crop name and if he will get the support from Forest department in easy manner and further receiving the permission timely he can sell his crop and cut whenever he required money for his need.

In last, to overcome the financial burden of small farmers they can adopt agroforestry models which allow growing of intercrops along with the trees crops which can fetch some immediate returns in the first two years. Looking to the overall scenario of available sources of wood it is now must to go for major plantations.

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## Conflicts of interest

The author declares there are no conflicts of interest.

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