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AGROFORESTRY PROSPECTIVE, STRATEGIES AND FUTURE ASPECTS



AGROFORESTRY

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AND FUTURE ASPECTS

Dr. (Ms.) Neelam Khare | Dr. Sandeep Rout | Mr. Gyanaranjan Sahoo
Mrs. Monika Ray | Mrs. Meenakhi Prusty | Dr. Ajay Kumar Prusty



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**Dr.(Ms.) Neelam Khare, Dr. Sandeep Rout, Mr. Gyanaranjan Sahoo,
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Agroforestry techniques used in Bamboo production as Future strategies, Challenges in Cultivation and Need of Agroforestry

Mukul M.Barwant

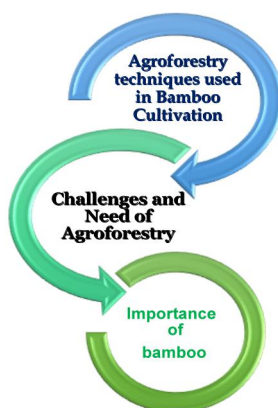
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Abstract :

Bamboo is one of the many purpose tree. Bamboo (Bambusoideae) is a subfamily of tall tree-like grasses in the Poaceae family with over 115 genera and 1,400 species. Bamboos are found all over the world. Bamboo has number of application which enhance the economy of country so it is consider as the green gold. Bamboo plants have a range of benefits, including the ability to produce wood, which is useful for heavy metal phytoremediation. Bamboo cultivation also decreases heavy metal soil stress. Another benefit is that they show high biomass productivity, which indicates that metal from the soil can be deposited in tissue Agroforestry has been described in a variety of ways by various writers, including: a phrase used to describe land-use regimes that include woody perennials. This plant cultivated for generally of its wood beside their are number of application in human society and industries . Now days the as production will be increases within the short area by using the different agroforestry techniques like as the intercropping of number of agricultural plants such as maize, tea, important economic fungus, fish fodder and number of medicinal plants. Another some agroforestry techniques also used such as the bamboo can cultivate in home garden, agrisilviculture system, block system and also cultivated windbreak resource

Keywords : Agroforestry, Bamboo Cultivation, Challenges in cultivation ,Need of Agroforestry

Graphical Abstract :



Introduction :

Bamboo plants are a multipurpose plant with many application with a high Agro forest System (AFS) potential, as they can be used for self-dependent growth as well as a economic crop. Bamboo is a highly adaptable plant that can provide people with environmental, economic, and livelihood protection. Bamboo can develop in three years, and the mean annual increment (MAI) of medium and large bamboos is comparable to, if not greater than, that of many other fast-growing tree species (Bannerji et al., 2009). MAPs are one of the many important stream of nontimber forest products (NTFPs), Food and beverages, fodder, perfumes, cosmetics, fibre, gums, resins, and ornamentals, as well as dyeing and tanning materials, plant health, cutlery, and handicrafts, are all included (Kahinda et al., 2008). For centuries, Plant-based goods have been used by a huge number of individuals in poor countries, especially from forests, to treat human and livestock ailments. A number of aromatic plants are also widely used in both domestic and commercial settings. Medicinal and aromatic plants are the collective terms for them (MAPs). Approximately 12.5 percent of the world's 422 000 plant species are recorded (Rao et al., 2004) Bamboo (*Bambusa pallida* L.) is a grass that belongs to the family Bambusaceae. Bamboo is divided into three categories: form, species, and variety. Bamboo comes in over 1200 different varieties, each of which is identified by its flower. Bamboo (Bambusoideae) is a subfamily of tall tree-like grasses in the Poaceae family with over 115 genera and 1,400 species. Bamboos are found all over the world. Bamboo produce rich source of oxygen, low light intensity and protects from the ultraviolet rays and is also considered to be an act as atmospheric and soil

purifier. Furthermore, it conserves water and greatly reduces soil erosion (Amneth, 1996). Agroforestry combines forestry and agriculture to increase land production, profitability, and long-term sustainability. It is thought to be more economical and sustainable than monoculture farming and forestry (Nair et al., 2009). Agroforestry is the intentional planting of trees to of side agricultural crops on the same piece of land in a temporal and spatial mixture or series for the purpose of obtaining benefits and services. Water penetration rate, soil porosity, and soil water-retention ability can all be improved by using bamboo species (Wang et al., 1995). Bamboo is an important natural resource for rural people's livelihood and rural industry. From the "child's cradle to the dead man's bier," this green gold is both low costing and abundant enough to meet the overwhelming needs of humanity. It's for this reason that it's often referred to as "poor man's wood. Bamboos are used in building, paper pulp, scaffolding, food, agricultural equipment, fishing rods, weaving material, rattan replacement, plywood, and particle board manufacturing, among other things. Bamboo shoots are regarded delicacies in many regions of the world, whether pickled or stewed. To increase livelihood protection, new land-use choices are required. While also reducing vulnerability to climate and environmental change. On an area of 771821 square kilometres in India, 125 indigenous and 11 alien bamboo species belonging to 23 genera are found naturally and/or under cultivation (Pathak et al., 2015 & Reddy et al., 2016). India's Bamboo Tree Distribution According to the Forest Survey of India, bamboo has been planted over 8.96 million hectares (12.8 percent of the country's total forest area) (FSI). The North Eastern States account for more than a quarter of this, with Madhya Pradesh accounting for 20.3 percent, Maharashtra for 9.90 percent, Orissa for 8.7%, Andhra Pradesh for 7.4%, Karnataka for 5.5 percent, and the rest in other states. It is the second most varied country in terms of bamboo genetic diversity after China, with 136 species in 75 genera (Biswas et al., 2016). Bamboo forest covers 3.2 percent of the total forest area on the planet. Bamboo has a natural distribution across a large range of environments (humid tropical, subtropical, and temperate region) on all continents except Europe and Antarctica (Behera et al., 2016)

Bamboo plants have a range of benefits, including the ability to produce wood, which is useful for heavy metal phytoremediation. Bamboo cultivation also decreases heavy metal soil stress. Another benefit is that they show high biomass productivity, which indicates that metal from the soil can be deposited in tissue. There are some benefit of wood of bamboo trees has been reported. Using wood pulp from, Bamboo, Common, and other species as a raw material, agroforestry and social forestry programmes have been implemented and promoted on a large scale in various districts across Uttar Pradesh. Rural people have been planting trees alongside crops in their farms and homesteads to meet household needs for wood poles, fuels, timber, and medicinal plants, as well as to urge others to do so (Rajput et al., 2019). Due to bamboo's unique contribution to bio-energy production and other ecological benefits, several national economies have developed bamboo plantations (e.g. soil preservation and water conservation through fibrous root system) (Partey et al., 2018). Goods are gained even in the early phases of plantations under this strategy due to the development of diverse intercrops, and the income is substantially more than with a single bamboo plantation. Some reports on the production of spices utilising agrotechniques that are critical in terms of yield, productivity, and quality are available. Although each of the spice-growing countries has age-old and standardised agrotechniques (Anitha 2018). As a result of intercrop culture, bamboo has been identified in various plant relationships, such as bamboo-rubber. Bamboos (*Bambusa pallida* L) may grow in both grasses and trees, making them potential rivals for water and soil quality, such as nutrient mineral water. A perennial crop grown predominantly in Asia, Another example is the rubber tree (*Hevea brasiliensis* L), a perennial crop produced predominantly in Asia that is important economically and socially. The fast growth of plantation lands at the expense of tropical forest is producing major ecological concerns. When compared to tropical forests, rubber monoculture is associated with poor biodiversity (Puran et al., 2018 & Li et al., 2006). Bamboo cultivation production and enhancement will promote economic and environmental growth, mitigate deforestation and illegal logging, prevent soil erosion, and restore degraded lands in India's villages and cities. For the biomass production capability of several bamboo species, one report is the *Dendrocalamus strictus*, *Bamboosa bamboos*, *B. nutan*, *B. asper*, *B. bulgaris*, *B. tulda*, and *B. balcooa* (Pathak et al., 2015) The potential for higher productivity in agroforestry may be due to the capture of more growth resources, such as light or water, or to increased soil fertility. Agroforestry, according to several studies conducted in various parts of the world, is more lucrative for farmers than agriculture or forestry for a specific area of land (Toky 1997 & Samara et al., 1999).

Because tree roots are forced to grow deeper and into the water table by competition with crops, the agroforestry system may be more useful in terms of water utilisation. This improves the system's sustainability. (Whittle et al., 2015). Agroforestry is significant, and a cost-benefit analysis of bamboo intercropping versus monocropping systems revealed marginal profitability. Based on the findings, integrated systems with crops may be encouraged

in areas where bamboo is a priority woody perennial Bamboo agroforestry mono cropped usually affected by inter cropped culture enhance the soil fertility and crop productivity (Akoto et al., 2020)

Agroforestry Techniques :

Agroforestry is a collective word for land-use systems in which woody perennials (trees, shrubs, etc.) are grown in conjunction with herbaceous plants (crops, pasture), or livestock, in a spatial arrangement, rotation, or both, according to various writers. 'Agroforestry is the production of trees and non-tree crops or animals on the same piece of land,' according to a simple definition. The crops are cultivated in tandem, either in rotation or on distinct plots when components from one are used to benefit another (Hasan et al., 2017). Bamboo is the fastest growing plant species, growing 30–100cm every day throughout the growing season and reaching heights of 30m with a 30cm diameter. Bamboo, unlike other timber species, is a self-regenerating natural resource that produces new shoots every year, guaranteeing that raw material is available when mature culms are taken (Igbokwe et al., 2016 & Singh 2002). Bamboo based Agroforest system as follows (Tewari et al., 2015)

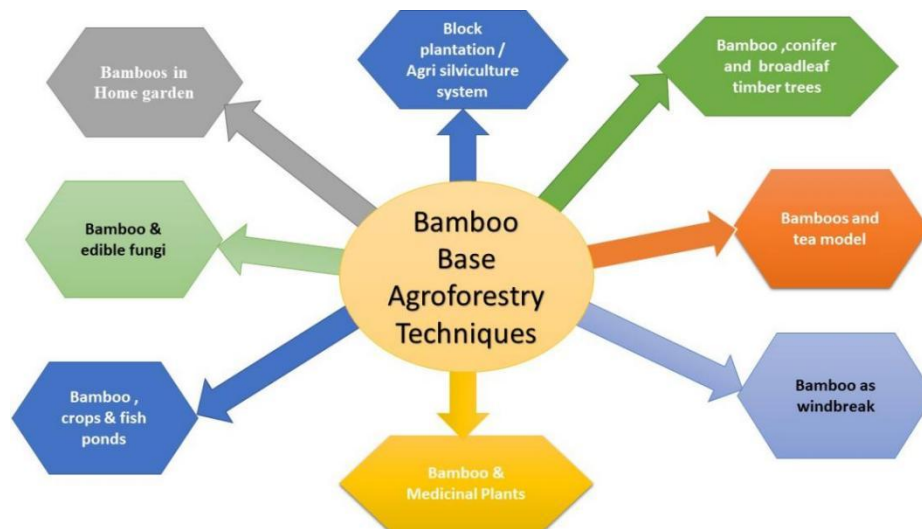


Fig No:1 Techniques in Agroforestry of Bamboo

- **Bamboos in Home garden** Bamboos are one of the most valuable crops for the farmers in the village homelands, occupying mostly the backyard and periphery of the holdings. In nature, most of the species in home gardens are clump forming, with large, tall branch culms. Bamboos grow well as an inter- and under-crop with several different types of trees. In the damp humid zones of north-east India, West Bengal, and Odisha, the genus *Bambusa* is most frequently farmed. *B. balcooa*, *B. bambos*, *B. nutans*, *B. tulda*, and *B. vulgaris* are among the bamboo species present in this area. 13 sample villages in five districts of M.P. were surveyed for their home gardens. In India, it was reported that 15.13 % of families had *D. strictus* in their fields. Drought-tolerant species such as *B. bambos* and *D. strictus* are grown in drier areas such as Punjab and western Maharashtra. *Pseudoxyten anthera stocksii* is cultivated in Karnataka, Goa, Andhra Pradesh, and western Kerala, but not elsewhere in India (Tewari et al., 2015).
- **Block plantation / Agri silviculture system:** Bamboos are planted at different spacings in this model, ranging from 4 m x 4 m (for small bamboos) to 9 m x 9 m (for large bamboos) (for large sized species). On plain ground, complete soil preparation can be used when planting bamboos. To avoid water and soil erosion on sloping ground, strip preparation with alternate unprepared strips is recommended. Until planting, make sure there is enough fertiliser in the pits. *Soya bean*, *niger*, *mustard*, *wheat*, and *arhar* are some of the essential intercrops in the early stages of this agrisilviculture scheme. In Jabalpur, Madhya Pradesh, seedlings of *B. bambos*, *B. nutans*, and *D. strictus* were effectively intercropped with maize or soya bean. In Thailand, bamboo species are also intercropped with maize and peanuts. Farmers in Sikkim cultivate *D. hamiltonii* and *D. sikkimensis* in agriculture areas all over irrigation channels and stream banks to meet the feed demands of their livestock. On homesteads in Bangladesh, *B. vulgaris* and *B. nutans* have been grown. (Banik, 2000 & Banik et al., 2008).

- **Intercropping Bamboo with conifer and broadleaf timber trees:** This model can be implemented by transforming or planting new semi-naturally mixed stands. The ratio of bamboos to trees in semi-naturally mixed stands can be as high as 7:3 or as low as 8:2 for bamboos and broadleaf trees. Tree species that are good for bamboo crops include *Albizia sp.*, *Gmelina arborea*, *Tectona grandis*, *Lagerstroemia parviflora*, *Anogeissus latifolia*, and *Phyllanthus emblica*. *Eucalypts*, *poplars*, *Zizyphus xylocarpa*, *Bombax ceiba*, *Stereospermum suaveolans*, *Melia azedirach*, *Aegle marmelos*, *Lannea grandis*, *Spondius pinnata*, *Erythrina indica*, *Zizyphus xylocarpa*, *Bombax ceiba*, *Stereospermum suaveolans*, *Dalbergia sissoo*, etc., growing to their peculiar deciduous light crown
- **Intercropping Bamboo with tea model:** Bamboos are commonly planted at a 6 m x 4 m spacing, while tea plants are planted at a 2 m x 0.5 m spacing in this model. For one to three years after planting, seasonal agriculture crops like soya bean and vegetables can be intercropped. However, it's important to leave enough room for bamboo and tea plants to grow unhindered.
- **Bamboo as windbreak:** Bamboos can be used to create windbreaks along the edges of agricultural fields and orchards to shield them from high winds. Farmers in various parts of the world engage in this activity on a daily basis. Mango orchards in Nepal's tarai regions are intercropped with agriculture crops, with one or two rows of *D. sissoo* and *D. strictus* planted along the orchard's boundaries. *B. balcooa*, *B. bambos*, and *B. nutans* clumps have been cultivated in near spacing in one to two rows along the north western sides of rice fields in India's Cooch Behar, Dinajpur, Haldibari, Mayanaguri, and Jalpaiguri regions as windbreaks against the dry and cold wind blowing from Nepal and Bihar (Banik et al., 2008).
- **Intercropping Bamboo with Medicinal Plants:** The model is suitable for hilly places with a mild climate and adequate rainfall in the subtropical monsoon climatic region. The medicinal plants are chosen to complement the geography of the place. According to market need, shade-loving plants from the Araceae and Zingiberaceae families can be intercropped (Banik, 2000). Shade-tolerant species such as *Aloe vera*, *Catharanthus roseus*, *Cassia angustifolia*, *Curcuma domestica*, *Plantago ovata*, *Withania somnifera*, and others can be grown as intercrops due to their adaptability.
- **Intercropping Bamboo with crops & fish ponds:** This style is commonly used in the construction of fish ponds on the plains and marshes. One to three rows of shoot-producing sympodial bamboos can be planted along the pond's banks, with crops such as soya bean and rye intercropped between bamboo clumps to establish a full food chain. Crops can be harvested for fish feed or human use. In the winter, pond bottom mud can be dug up and used as fertiliser for bamboo clumps. South Asian cultivating bamboo species (*B. balcooa*, *B. mabbosa*, *B. nutans*, *B. vulgaris*, and *D. strictus*, among others) can be replanted at 20-25 years of age to increase productivity (Shanmughavel et al., 2001).
- **Intercropping Bamboo with edible fungi:** Many edible fungus can be found in southern China. (*Dictyophora tomentosa*, *Planrotus ostreatus*, and *Auricularia auricula-judoe*) These are considered natural foods with a high content of vegetable proteins. Inoculation with *Dictyophora sp.* occurs in September for varieties that grow at a normal temperature and in May-June for types that require a higher temperature. Harvesting takes four to eight months, depending on the fungus species. Inoculated *P. ostreatus* is harvested two months after inoculation. *Auricularia judoe* must be cultured in bags filled with growth medium and hung on bamboo.
- **Challenges of Bamboo Cultivation:**
 - There is a lack of knowledge on propagation, setup, and harvesting methods. There is no systematic or trustworthy documentation of natural and planted stands for commercial bamboo harvesting and use anywhere in the world. Bamboo stands are dwindling as a result of the changing land use structure and the drive for urbanisation. Commonly located along riverbeds and in green belt areas, these stands have been decimated, creating a major environmental concern. Commonly found along riverbeds and in greenbelt areas, these stands have been reduced, posing a risk to the ecosystem (Igbokwe et al., 2016 & Ongugo et al., 2000).
 - Policies: Because bamboo is classified as a secondary forest product, it is not on the priority list of crops for cultivation in the agricultural and forestry sectors of the economy.
 - The agricultural sector, sometimes known as the poor or low-income earners of society, is the greatest user of bamboo, which is used in fish cages, poultry buildings, crop props, and other applications. Bamboo has yet to develop the technology that will allow it to compete with wood and gum in the furniture and handicraft

industries (plastic).

Importance of cultivation of Bamboo :

- Because of its multiple economic applications, bamboos are known as 'green gold,' 'poor man's timber,' 'bamboo, friend of the people,' and 'cradle to coffin timber.'
- Bamboo shoots, without a doubt, hold a unique place in the plant food spectrum, boosting life's grandeur while also giving aesthetic and nutritional benefits.
- From the cradle to the grave, this green gold is cheap and plentiful enough to meet the enormous wants of the human population.
- It's a terrific alternative to wood and, by sequestering carbon, it can help prevent greenhouse gas emissions, global warming, and climate change. Bamboo is presently used for a variety of uses, including wall panelling, floor tiles, fuel briquettes, raw material for home construction, and rebar for reinforced concrete beams(Xaio 2002)
- Bamboo leaves are widely utilised as feed during droughts. Bamboo's net-like root system creates an important watershed defence mechanism, sewing the soil together along vulnerable riverbanks, deforested areas, and locations susceptible to earthquakes and mud flows.
- Because bamboo is a fast-growing plant, it can be a rich source of phytosterols; thus, including plant sterols into meals could be a beneficial public-health approach for future food and nutritional protection(Law 2000).
- Although the traditional use of bamboo for scaffolding, shade houses, fencing, ladders, yam and vegetable stakes, slat chairs, and other purposes generates revenue in Nigeria, the quality of the revenue generated is far less than 0.01 percent of what could be achieved if the plant is grown sustainably and its industrial potentials are fully realised.
- The employment of bamboo clums in Nigeria's manufacturing industry is still in its infancy. There is only one sophisticated bamboo processing company in Nigeria that produces floor tiles. Capacity building for craftsmen whose abilities are confined to a few fundamental items and who are unable to compete in the global market is also constrained.
- The Tenth Plan, for example, calculated the economic and social benefits of activities related to bamboo-based value added goods and applications to be 8.6 million new jobs, in addition to developing large bamboo resources and business opportunities worth Rs 6,500 crore with Rs 2,600 crore in investment, allowing 5 million artisans and farmers to escape poverty(Jamatia 2012)

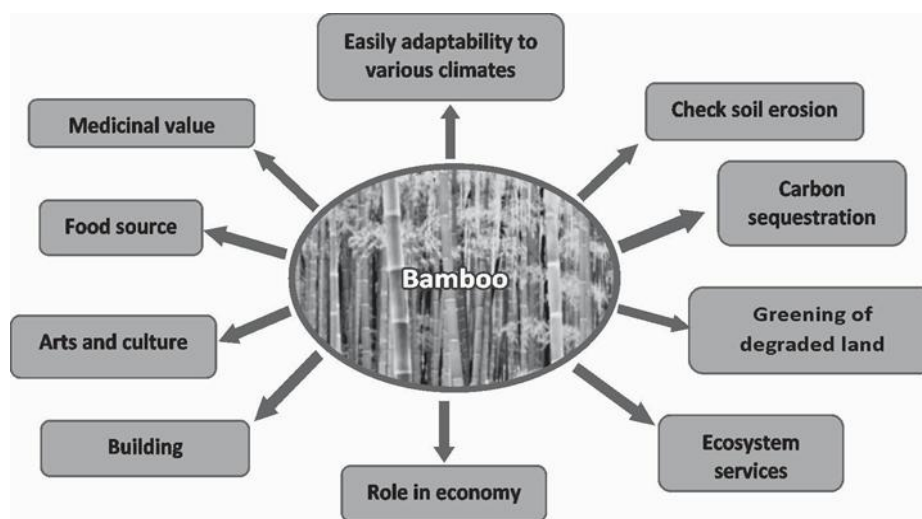


Fig No 2: Application and Uses of Bamboo Tree (Tewari et al.,2015)

Need of Agroforestry (Prasad 2003)

- To supply the growing population's demand for fuel, feed, and lumber.
- To alleviate biotic stress on existing forests.
- To get the most out of a given amount of land in terms of yield.
- Planting suitable tree species with agricultural crops to develop wasteland/degraded lands.
- Planting tree species to reduce pollution in the environment.
- To help prevent soil erosion.
- Planting nitrogen-fixing tree species to improve soil fertility.
- To increase raw material availability for wood-based industries.
- To provide local people with employment opportunities and to boost the financial return on investment by increasing crop production.

Conclusion

Bamboo is one of the plants that is ideally suited to India's climate. It is possible to grow it using agroforestry techniques. It is recognised as green gold because of the many applications it has, many of which have improved the economy and ecology of the country. Bamboo can be grown using a variety of intercropping techniques. They will help farmers increase their income while still conserving capital. However, due to intense above-ground rivalry with intercrops, the systems are not widely used. As a result, competition must be minimised by selecting appropriate species, implementing broader spacing, or employing canopy management techniques. In order to scale up bamboo cultivation in the region, interactions in bamboo-based agroforestry must also be investigated.

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