



BAMBOO SOCIETY OF INDIA

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Bamboo a Versatile Grass for good economic returns.

I. Introduction:

Bamboo is a collective name for a group of botanical species that all belong to the grass family, the Poaceae (Graminea) hence it's a woody Grass of which many species grow like a tree. The larger species can reach up to 40 metres in height and can have 30 cm thick stems, while the smallest types are small bushes that are no more than 1 cm in diameter. Globally Bamboo has about 1250 species. Bamboos occur naturally in most parts of the world. India (30%), China (15%), Brazil, have the largest areas of bamboo of a global bamboo cover that is estimated to be nearly 50 million hectares.



Bamboo, the versatile grass



bamboo bridge



interiors of a bamboo restaurant

Globally Some of the most important giant bamboo species are:

Phyllostachys pubescens, mainly from China, where it is called 'moso bamboo'. It is the backbone of the Chinese bamboo industry.

Guadua angustifolia, which is especially prevalent in Latin America and has thick, large poles that are used for many uses.

Dendrocalamus asper, which grows predominantly in tropical regions of South and Southeast Asia, and is used extensively in construction.

Some important bamboo species of India: *Dendrocalamus strictus*, *Bambusa bambos*, *Dendrocalamus stocksii*, *Bamboosa balcooa*, *Bambusa tulda*, *Bambusa nutans*, *Dendrocalamus giganteus*, *D hamiltonii*, *Melocanna baccifera*, *Phyllostachys bambusoides*, *Arundinaria spp*, etc

Bamboo Forests India: As per India State of Forest Report 2022 the total bamboo bearing area of the country is estimated as 1,49,443 sq km. 125 indigenous and 11 exotic species of bamboo belonging to 23 genera are found in India. 50% of the species are found in NE India.



Bamboo forest

Characteristics of bamboo:

Bamboo grows rapidly, regenerates annually, is selectively harvested annually without harming the ecosystem or contributing to deforestation. It's very fast growing as several species grow up to 90 centimeters a day. It's Cheap as compared to timber and is renewable as culms are produced every year and older culms of 3 years and above can be harvested every year.

It's a versatile species which grows in temperate' to 'tropical' regions and its habit ranges from clumping of rhizomes and culms to running type with rhizomes and culms placed at some space from one another . The runner type are easy to harvest. The clumping ones with compact thick clumps are difficult to harvest, especially the ones with thorns. Some bamboos are thorny and many are non-thorny. Some have side branches from bottom and some have them a few feet above ground. The thorny ones are difficult to harvest. Similarly the ones with side branches arising from bottom are difficult to harvest. It's highly resilient to climate changes and natural calamities such as fire, snow, drought, flooding for short durations as it can regenerate from its subterranean rhizomes even if the bamboo above ground is destroyed.

It adapts to poor soil or climate conditions, and helps bind soil. Therefore it's an unique and effective tool to control erosion and ensure slope stability and hence it is planted along river banks and on slopes to maintain slope stability and restrain erosion. Thus it's suitable for a range of restoration and land use planning needs. Some can grow in degraded lands including saline/alkaline lands and those which get submerged during rainy season.

On account of its widespread rhizomes and rooting it improves water holding capacity of the watershed areas by 20% to 25%.

It significantly contributes to ecology such as improving wildlife habitats, forest hydrology, forest biodiversity, soil improvement, restoration of degraded lands and improving their productivity, etc.

Bamboos reduce the effect of climate change by releasing 30% more Oxygen (320kg/year in case of *Bambusa bulcooa*) than regular trees and sequesters and store 40% more Carbon (450kg CO₂/year in case of *Bambusa bulcooa*) from air than regular trees and fixes it in its body as well as in soil and helps combat climate change. Therefore large scale bamboo planting is required for a polluting country to remain carbon neutral.

Though bamboo is light weight it's known as "vegetal steel" as it has high natural strength in view of higher tensile strength than steel as the tensile strength of bamboo is 28000 pounds/sq inch and that of steel is just 23000 pounds/Sq inch. Therefore it has traditionally been extensively used for rural housing and is now extensively being used in modern construction replacing steel where ever feasible.

Bamboo has over 1500 uses and applications and hence has great potential for providing opportunities for livelihood development of the rural poor.

II. Following are some of the important Indian Bamboo Species:

1. *Dendrocalamus strictus*:

Clumping, height 6-18m, culm diameter 2.5-8 cm, grows in dry zone, **uses:** by medars for making artefacts, in construction, as poles, etc.



2. *Bambusa bamboos*:



Thorny, clumping, difficult to harvest, height 20-30m, 10-18cm diameter, 20-40 cm internode length, rainfall 2000 mm, **uses:** bridges, ladders, construction, paper pulp, leaves as medicine, etc.

3. *Melocanna baccifera*:

Muli/berry bamboo, NE India, ht 10-25m, 3-7cm dia, rainfall 2000-3000 mm, temperature 15-38°C, diffused clump type, culms when mature yellowish brown. **Uses:** housing, weaving, medicine for respiratory diseases, super paper quality, Average yield about 84 T/Ha in 3 yrs.



4. *Bamboosa bulcoa*:



Found in north east India. Very large, thick walled, thornless, tight clumping bamboo. Height: 6-23 m Diameter: 8-15 cm. Internode length: 20-45 cm. Culm wall thickness: 1.9-2.5 cm. Flowering cycle: 35-45 year. Sporadic and gregarious flowering noticed. After flowering plants die. In sporadic flowering, some culms in a clump or some clumps in flower and die.

Rest remain alive and continue to yield. No seed formation flowered plants is seen. Seeds: Not reported, sterile plant. Climate: tropical – subtropical. Temperature: Best growth 22-28°C. Can tolerate 9 – 35°C. Rainfall: 2500-3000 mm. Tolerates 700-4500 mm. Can tolerate dryer conditions than many other Bamboos. It is a good choice for slope stabilisation. Altitude: 0-700 m. Soil: best suited are heavy textured soils with good drainage. Generally, grows on any type of soil. PH: low of 5.5, tolerates 4.5-7.5. Planting: Planting material: rhizome, culm/branch cutting and tissue culture. Spacement: 5m X 5m, 6m x 6m, 7m X 7m (for growth of bigger diameter culms). Fertilizer: DAP: 60/120/180 grams / plant for 1st and 3rd year respectively. Potash: 45/90/135 grams/ plant for 1st, 2nd and 3rd years respectively. Watering: required after monsoon. First year twice a week and 2nd year onwards once in 15 days. Harvest: Culms mature in 3-4 years. Harvest mature clumps 6 year after planting. Average yield: 20 T/ Acre. Annual production of about 500-700 culm/acre. Average returns: 50,000-80,000 per acre per year 7th year onwards. Uses: Very strong structural bamboo, construction, pulp, Handicrafts, Agarabathi sticks, woven mats, scaffolding, woodchips, etc. Shoots: good food

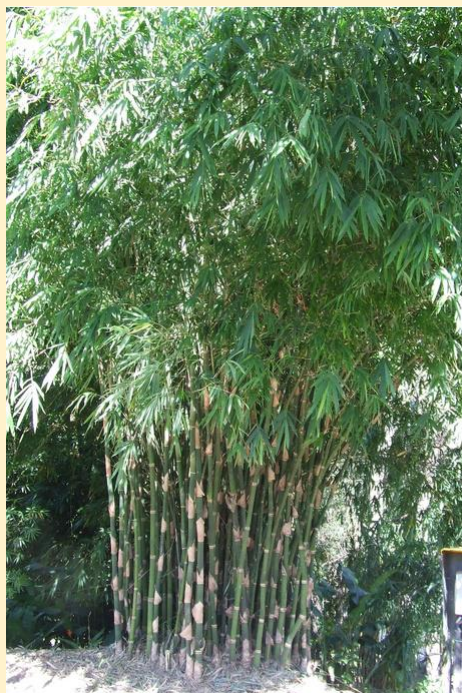
5. *Bambusa tulda*:

Known as Indian timber bamboo, dense clump, native to the Indian subcontinent, can grow 6-20 mt tall and 5-10 cm thick. Has excellent tensile strength of up to 60,000 pounds (27000kg) per Sq. inch. Tall dull green coloured turning greyish green when mature. Has few closely growing culms. Young shoots yellowish green with powdery top. Culms covered with white bloom. Several or many clustered branches. Culms thick walls 10-20 mm. internodes 40-60 cm long. Growth: Fast. 70cm/day. Flowering Cycle: 15-60 years gregarious flowering for 2 years. Climate: Tropical – subtropical. Exposure: Prefers semi shade but also grows in full sun. Soil: Loamy and alluvial soils, fertile and well drained. PH: 5-6. Water need: Average. Altitude: 0-1500 mts. Rainfall: Moist areas. 1200-2500 mts. Temperature: 4 degree C-37C Best: 22 C-28 C. Propagation: By seed (viability by 70%), rhizomes, culm cuttings, branch cuttings and Tissue culture. Planting distance: 5 m X 5m/ 6m x 6 m (for quality culms). For screening: 3m X 3M. Harvesting: Matures 5-7 years. 3-4 years old culms are harvested. 3-6 culms evenly spread to be retained after harvesting for better growth. Harvested poles placed in flowing water for 10-20 day and then air dried 1.5-3.5 months for durability. Average yield: about 12 Tons / year. Uses: Agarabathi, construction, Scaffolding, Furniture, Basketry, Mats, Handicrafts, paper pulp, wind break. Shoots: Edible but taste slightly bitter.



6. *Bambusa nutans*:

Medium sized elegant right clump bamboo. Plants loosely clumped, much branched above, usually unbranched below, straight, green, smooth, not shining, white ring below the node; node slightly thickened, often hairy, lower one bearing rootlets. The culm is good, strong, straight. Height: 15-20 m Diameter: 5-10 cm. Internode Length: 25 -45 cm. Wall thickness: 1.5 cm. Flowering Cycle: 35 years. Soil: Moist hill slopes and flat uplands in well- drained sandy loam to clayey loam soils. pH: 5.5-7.5, acid, neutral and basic (alkaline) soils. Elevation: from 700 - 1,500 meters. Temperature 9-32 deg C. Rainfall 700-4500mm.

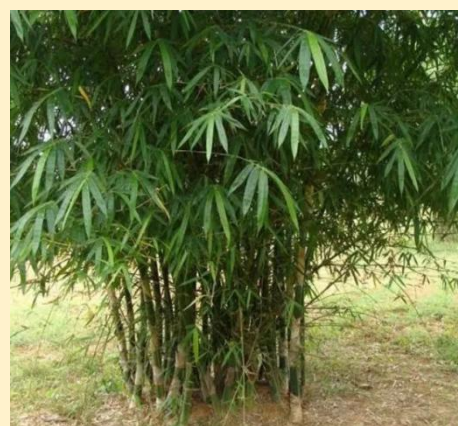


Exposure: It can grow in semi-shade (light woodland) or without shade. It prefers moist soil. Plants: Seed, vegetative propagation, Tissue culture. Planting Spacement: 5m X 5m - 6m X 6m. Average yield: 12-16 T/Acre. Uses: construction, major source for paper, Poles, mats, Agriculture implements, household items.



7. *Dendrocalamus stocksii*:

Thornless, mid -sized, erect, almost solid species endemic to central western ghats of India. Though it's a clumping bamboo, it has loosely spaced culms which makes harvesting easier. Height: 6-12 meters, Diameter: 3-5 cm. Wall thickness: 0.2-1.5cm. Base of pole is solid. Internode 15-30 cm .Flowering: sporadic with no seed set. Soils: deep loamy soils are best. Naturally seen in lateritic soils. But can grow on a wide variety of soils. Altitude: 0-600 meters above sea level. Weather: Humid tropics / Sub-tropics. Propagation: by rhizomes, rooted cuttings, tissue culture. Planting spacing: 4mt x 4mt or 5mt x 5 mt. Higher spacement give thicker and better quality culms. A pit size of 60x60x60 cm is sufficient for initial planting which may be filled with 5 kg compost/FYM + 100 g VAM + 15g phosphorus solubilising bacteria (PSB) + 5g Azospirillum.



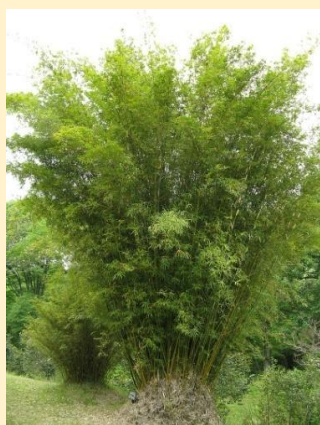
As plant protection measure 0.5 per cent Chloropyriphos solution is added to avoid termite and ant attack. Best time for planting is June. Each clump may be supplemented with 100 gm Nitrogen, 50 gm Phosphorus, 50 gm Potassium along with 5 kg of compost/FYM for initial three years and same dose repeated after every annual harvest of mature culms. Watering: regularly after monsoon compulsory for first three years. First year twice in a week and subsequently once in 15 days. Harvesting: from 5th year onwards. Culms should be 2-3 years old for harvest. Retain 59% mature culms for better growth after harvesting. Time of harvesting: Nov- May. Average yield: 750-1000 poles/ acre per year. Uses: construe, furniture, Basketry, Handicrafts, Food containers, etc

8. *Ochlandra travancorica*:

elephant grass, found in western ghats, ht 2- 6m,dia 2.5-5cm, undergrowth plant , grows up to 1500 m altitude , grows in areas with > 1500mm rainfall, uses: planted along paddy fields as soil binder, mats, baskets, super long fiber for paper, fishing rods, etc



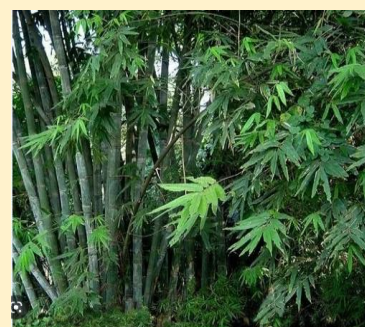
9. *Bambusa multiplex*:



Medium-sized clump with slender culms (stems) and dense foliage. This bamboo is suitable for hedges and live fences and ornamentals. Clumping bamboo, Ht 2 - 7 metres. The thin-walled canes are 10 - 30mm in diameter with internodes 20 - 40cm long. Grows in open places; at elevations from 200 - 1,500 metres, Uses : edible young shoots, used for weaving for mats, baskets; umbrella handles and for fishing poles, handicrafts such as bookcases, paper making etc.

10. *Dendrocalamus hamiltonii*:

Also known as Tama or tufted bamboo. A giant, evergreen, clumping bamboo native to the northeast Himalayas. Culms are dull green covered with whitish-brown hairs, which become dull brownish-green when dry. Whitish bands occur below and above the nodes. Culms are noticeably zig-zag. Branching occurs from the base to top. Culms are often curved and noticeably zig-zag. Height 12-23 m, Diameter 5–18 cm. Internode length 30–40 cm, and Culm walls are 0.5–1.5 cm thick. It prefers a sunny to half-shady situation on moist soil. A plant of the moist tropics, where it is found at elevations up to 1,000 meters. It grows best in day timetemperatures are 20 - 29°C, but can tolerate 15 - 34°C. They do not tolerate temperatures below 1°C. Rainfall 1,800 - 3,600mm, but tolerates 700 - 4,500mm.



Soils: medium to heavy of at least moderate fertility. Prefers a pH in the range 5 - 6, tolerating 4.5 - 6.5. Used for construction, roofing, handicrafts and fuel. The tender shoots are also used as food.

11. *Dendrocalamus giganteus*:



It grows in clumps consisting of a large number of closely growing culms, it can grow up to 40 cm per day. Height 30- 40m, Diameter 10–35 cm Young shoots are blackish purple. Internode length is 25–40 cm. lifespan 40-76 years, uses: Construction, Paper Pulp, Laminated Lumber, Crafts, Furniture.

12. *Bambusa polymorpha*:

Bengal Bamboo, tufted bamboo with tall, clean stems Height: 25-30 m, Diameter: 15 cm; internodes gray-green, 40–65 cm, wall thick; branching only from mid-stem up. Found in Bangladesh, India (NE), Myanmar and Thailand. Uses: edible shoots, handicrafts, house construction, pulping.



13. *Bambusa vulgaris*:



Moderately loose clumps and has no thorns. It has lemon-yellow culms (stems) with green stripes and dark green leaves. Another variety has green culms with yellow streaks. Ht: 10–20 m, Dia: 4– 10 cm, Culm walls are slightly thick, Internodes 20–45 cm. Flowering is not common, and there are no seeds. Fruits are rare due to low pollen viability caused by irregular meiosis. Common bamboo uses, stems as fuel and the leaves as fodder, small construction, paper making, handicrafts, medicine, etc. Working and machining properties of the stems are poor, as they are not straight, not easy to split, and not flexible, but they are thick- walled and initially strong.

Because of high carbohydrate content, stems are susceptible to attacks from fungi and insects such as powder post beetles. as ornamental . Its shoots boiled in water are sometimes used for medicinal qualities. Among all bamboos, only shoots of *B. vulgaris* contains taxiphyllin (a cyanogenic glycoside) that functions as an enzyme inhibitor in the human body when released, but degrades readily in boiling water. It is highly toxic, and the lethal dose for humans is about 50–60 mg.

14. *Dendrocalamus brandisii*: A very large (tallest), evergreen, tufted, thornless, dense clumping bamboo with large leaves. Culms have an ashy-gray to greenish-gray color. Nodes are slightly swollen with rootlets showing on the lowest nodes. Young shoots are dark-gray with a dark-brown shade. It's been growing well in Kodagu, Westernghats. Height: 20-33m. Diameter: 13-20cm. Internode: 30-60 cm. Wall thickness: 1.7-3cm. Flowering Cycle: 45-50 years. Climate: warm moist tropics. Propagation: Seed, rooted cuttings, tissue culture . Seed viability only 2-3 months. Planting: Spacement: 7m X 7m / 6m X 6m (larger spacement yield better quality culms). Altitude: 0 – 1300 m. Soil: Found on calcareous rocks but also grows well on well drained loamy soils. PH: 4.5-7.5. Exposure: full sun or part shade. Water: normal to moist. Irrigate after monsoon. Harvesting: Culms mature in 3-4 years. Culms older than 3 years to be harvested. 6th year onwards. Cut below 30cm above ground and just above 2nd node. Average yield: 20 T / Acre / Year. Uses: Construction, basketry, paper pulp, furniture, farm implements, baskets and other woven wares and handicrafts. This is one of the strongest and largest bamboos for construction purposes. Shoots: Good food.



15. *Dendrocalamus asper*:

It is found commonly in India, Sri-Lanka, Southwest China and Southeast Asia. It's a giant bamboo is an evergreen, clumping bamboo with a short, thick rhizome and densely tufted, erect stems. Height: 25-25 m .Diameter 8-12 cm. Internode: 40-50 cm. Wall thickness: 1.1 – 2.0 cm. Elevation: up to 1,500 meters, though it grows best at an elevation of 400 – 500 meters. Temperature: grows best in 20 - 27°C, but can tolerate 15 - 34°C. Rainfall: range 1,800 - 3,600 mm, but tolerates 1,200 - 4,500 mm. Soil: grows better on heavy soils with good drainage, Sandy clay loam, latent Soils mixed with fine sandy clay. Also succeeds in any type of soil of at least moderate fertility. pH: 5 - 6.5, tolerating 4.5 - 7.



Propagation: Seeds, roofing of cuttings, Tissue culture. Average yield: 20 T/ Average. Uses: Poles, Pulp, laminated boards, furniture, musical instruments, chopsticks, household utensils and handicrafts, musical instruments, paper. Shoots: Young shoots are sweet and considered a delicious vegetable.

16. *Dendrocalamus longispathus*:



It is an evergreen, clump-forming bamboo. Culms are green with white blooms when young, which become greyish-green when dry. Young shoots are yellowish-green in color with shiny black hairs. Culm is straight. Branches spread out from the midculm to top. Aerial roots reach up to few nodes above the ground. Height: 8-10 mts. Diameter: 6-10 cm. Internode: 25-50 cm. Wall thickness: 0.7-1.2 cm. Climate: A plant of the moist, lowland tropics and subtropics. Altitude: up to 1,000 meters. Temperature: It grows best in areas where annual daytime temperatures are within the range 20 - 27°C, but can tolerate 15 - 34°C. Annual rainfall: 1,800 – 3,600mm, but tolerates 1,200 - 4,500 mm.

pH: 5 - 6, tolerating 4.5 –7. Exposure: best in full sun or light shade. Flowering Cycle: 30-35 years. No. of Seeds per Kg: 55,000. Planting material: seed, Vegetative methods. Seed - have a short viability of 2 - 3 months. Sow in containers in a lightly shaded position and provide cover. Germination rates of 33 - 50%, starting to sprout within 2 - 8 days. Planting: 160 Plants / acre. Spacement 5m X 5m or 6m X 6m. Uses: Landscaping, temporary construction, agarbathi, tooth picks, baskets and containers, furniture, mats, etc. This species is generally used as a source of pulp for the manufacture of paper.

III. Bamboo Plantation:

Plantations may be raised from rhizome offsets (most common traditional method for *Stocksii*) or rooted cuttings (macro and micro propagated). A pit size of 60x60x60 cm is sufficient for initial planting which may be filled with 5 kg compost/FYM + 100 g VAM + 15g phosphorus solubilising bacteria (PSB) + 5g *Azospirillum*. As plant protection measure 0.5 per cent Chloropyrifos solution is added to avoid termite and ant attack. Best time for planting is June. Irrigating clumps in post monsoon period for initial two years helps in early clump establishment and reducing casualty. Usually, irrigating the clumps twice a week helps in plant survival. Continuing irrigation good help in good growth and yield.



Each clump may be supplemented with 100 gm Nitrogen, 50 gm Phosphorus, 50 gm Potassium along with 5 kg of compost/FYM for initial three years and same dose repeated after every annual harvest of mature culms. Bamboo poles/culms have short growth cycle (3 to 5 years) with normally 3 year old ones being harvested. Bamboo is self-reproducing as new rhizomes emerge every year monsoon season despite older ones being harvested. This quality makes it financially viable with regular income from 5th or 7th year onwards when the investment made begins to break even. Also another specialty of bamboo is that it is low cost in maintenance and regeneration with relatively less pests and diseases. Regular post monsoon watering with compost/fertiliser application and weeding should be enough. Moreover harvesting can be done at the owners convenience unlike vegetables and fruits which can't wait. It is a versatile plant growing in tropics to subtropics to temperate regions. Summer temp should not be below 15°C. Cold winds are harmful to leaves. Though loamy soils are best suited, some bamboo species are highly versatile and grow in almost all soils including degraded, alkaline/saline soils. However yields in such problem soils are low. Best soil Ph for bamboo growth is 4.5 to 6. However even if soil has higher pH, in time with addition of biomass by way of fallen leaves, roots and rhizomes, the pH reduces. Spacement varies from 4x4 mt to 8x8 mts depending on species. Higher spacement will help grow thicker and better quality bamboos. Some nursery people are advocating close spacement for energy plantations @ 1000 to 2500 plants per acre. From our feedback from farmers, by and large closer spacement with high density planting are a failure and farmers have reported incurring losses. However detailed studies are required to understand the economics and yields of such plantations and the market demand for thin shorter bamboos that such plantations yield. Without such study results farmers should not do high density plantations.

By and large proper studies are required for deciding optimum spacement for maximum yield for each bamboo species. Further proper species recommendations and package of practices for cultivation need to be researched and recommend for different agroclimatic regions of the country so that wrong species with wrong spacement are not planted wasting expenditure of farmers. Spacement of more than 5mx5m give thick bamboos of quality which fetch higher value. Also it would be good to plant some tree species such as Teak, Rosewood, Mahogany, Sandalwood, Melia dubia, etc replacing bamboo here and there with such trees at a spacement of minimum 5 mt between such trees . Semi shade helps growth of most bamboos.

It would be best to plant bamboo on boundary which will give additional income to the crops being grown. Irrigation is required for best yields @about 20 lit/plant/day after monsoon season. Plant protection interventions requirement is minimal. Initial years sucking pests should be controlled. Yields can go up to 10-20 Tons /Acre/yr, 5-10 bamboos of 3 years maturity can be harvested from each clump every year from 6th year onwards till maturity which varies from species to species. Net Returns from plantations could be from 30000- 80000/- per year from 6-7th year onwards. Initially expenditure for 1st year would be about 1lakh /acre. Subsequent years the maintenance expenses could be on an average Rs 20,000/- per acre, per year. Farmers should take up bamboo plantations only after ascertaining marketing tie up of bamboo, especially since many are evincing interest in raising new plantations in view of good returns and low maintenance.

IV. Bamboo Global Scenario:

India has 14.94 million Ha area under bamboo both in forests and in private cultivated lands. China has just about 6.8 million Ha. However China's share in Bamboo market worldwide is about 70% of the \$ 72.1 by (2019) and India's share to just about 5%. Therefore there is tremendous scope for increasing its share and consequently generate significant income to the country and jobs to its people, which should be planned by Govt systematically by supporting Bamboo industry extensively with initial supply of Bamboo raw materials



from forests till farmers are able to grow and supply to the industries, for which Industries should at the time of the initiation of their project encourage farmers to grow the bamboo species they require with buy back agreements. Further the natural bamboo Forests areas need to be scientifically managed with soil moisture conservation, fire protection and timely scientific harvesting every year systematically so that the productivity increases and raw material is available to the industries. Globally major exporters of bamboo and its products are China, Thailand, Vietnam. And major Importers are India, US, The Netherlands, Spain. An idea about bamboo products global market export share:

Woven bamboo products 22%, Bamboo Charcoal 21%, Bamboo shoots 19%, Bamboo Furniture 16%, Industrial Bamboo products 10%, Rest: 14%

V. Versatile Uses of bamboo:

No part of the bamboo plant is wasted.

Shoots are harvested for food; branches for poles; main bamboo pole for fibers/pulp/ charcoal production, lower trunk for construction uses or flooring and engineered bamboo products. Traditionally bamboo has been used for scaffolding, basketry, food, musical instruments, etc. However presently it's being used for several purposes such as furniture, decor, beverages, engineered bamboo products, activated bamboo charcoal, cosmetics, medicines, tea, chemicals, bamboo textiles, organic pesticides / fungicide, paper, ornaments, toys, bio- plastic granules, replacement for plastic, construction including schools, resorts, hotels, houses, architecture , interior decoration, Decoration in vehicles, spectacles, helmets, etc., in post-disaster housing earth quake areas, coastal areas Innovative uses -heavy duty drainage pipes and wind turbines. Ecology environment: combat climate change, phytore mediation, Agro forestry, live fencing, dry bamboo fencing, leaf compost.

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