

BAMBOO : ITS DISTRIBUTION, PRODUCTION, HABITAT AND AGROFORESTRY POTENTIAL

V. NATH, RAJAT S. PAL AND S.K. BANERJEE*

*Tropical Forest Research Institute,
Jabalpur (Madhya Pradesh).*

Introduction

Bamboo is an important Non-Timber Forest Produce (NTFP), which grows across the country. It is one of the fastest growing plant species, which occurs in a wide variety of climatic and edaphic conditions. It is an extremely versatile, strong, renewable and environment friendly plant species. It can be grown quickly and easily, and sustainably harvested in 3 to 5 years cycle. It grows on marginal and degraded lands, elevated grounds, along fields bunds and river banks. It adapts to most climatic conditions and soil types and acts as a soil stabilizer. It is an ancient medicinal plant, a food source and is a critical element of the economy, intricately involved in arts and culture. It is an excellent alternative to wood and has the potential of being an effective carbon sink thus helping in countering the emission of green house gases, global warming and climatic change.

India, China and Myanmar have 19.8 million hectares of bamboo reserves which is nearly 80 per cent of the world's bamboo forests; of this India's share is 45 per cent. Nearly 75 genera and 1,250 species are distributed all over the world (Soderstrom and Ellis, 1988). India is second to China in bamboo resources with

about 24 genera and 134 species. Bamboo occurs almost ubiquitously in the country, except in Kashmir and covers about 12.8 per cent of the forest area occupying over 9.57 million ha. Bamboos form an important constituent of the deciduous and evergreen forests and are spread from tropical to temperate regions extending from alluvial plains to high mountains, ascending to altitudes 3,000 m above mean sea level (Varmah and Bahadur, 1980). Areas particularly rich in bamboo are the North-eastern region, Western Ghats, Bastar region of Madhya Pradesh and the Andaman and Nicobar Islands. Sixty six per cent of the growing stock of bamboo is occurs in the North-eastern states and the rest in the other parts of the country .

Bamboo forests occupy nearly 15,000 km² in Madhya Pradesh and Chhattisgarh, which is the second largest bamboo growing area in the country. The bamboo rich regions are Bastar, Balaghat, Hoshangabad, Mandla, Raipur, Umaria, Chhindwara, Shadol, Sarguja, Raigarh, Bilaspur, Hardwa, Seoni, Khandwa, Ambikapur, Rajanandgaon, Sidhi, Jabalpur, Bilaspur etc. The main species of bamboo growing in Madhya Pradesh are *Dendrocalamus strictus*, however *Bambusa bambos*, *Gigantochloa rostrata* and *Schizostachyum pergracile* are also

* Scientist 'F' (Retd.), Tropical Forest Research Institute, Jabalpur (Madhya Pradesh).

found sporadically in some localities. In Chhattisgarh, bamboo occurs in almost all the districts and *D. strictus* is spread over large areas. The annual estimated production of bamboo in the Madhya Pradesh and Chhattisgarh is approximately 0.316 million tonnes (Tewari, 1992). *Bambusa bambos* prefers alluvial flats along perennial streams. *D. strictus* occurs principally as an understorey in Moist and Dry Deciduous Forests especially on the middle and lower slope of hills and well drained valleys. The area occupied by bamboo in Chhattisgarh is given in Table 1.

In Maharashtra, three main bamboo species viz. *D. strictus*, *B. bambos* and *Pseudoxytenanthera* spp. are found among which *D. strictus* is economically the most important species and occurs extensively in the Moist and Dry Deciduous Forests. *Pseudoxytenanthera* occupies steep ridges

of the Western Ghats. *B. bambos* grows in moist localities in small proportion. The total area under bamboo in the state is estimated to be 0.85 million ha (Tewari, 1992).

Orissa contains some of the richest bamboo forests and *D. strictus* is the most important species and occurs extensively. *B. bambos*, *Schizostachyum pergracila* and *Gigantochloa rostrata* are the other important species found in the state and grows in the valleys along the coastal tract. The total area under bamboos in the state is estimated to be 1.05 million ha (Nagariya and Puri, 1997). The production is about 0.49 million tonnes (Tewari, 1992). The production of bamboos in different states and the area covered by bamboo forests are given in Table 2.

In normal conditions, the production of bamboo in India varies from 0.2 to 0.4 MT/ha. The production of some of the bamboo species in different regions is given in Table 3.

While India possesses the second largest bamboo resource in the world (Pathak, 1989) and many people are dependent on it for their livelihood, there is still a substantial need to promote the utilization of bamboos to the extent possible. The diversified applications of bamboo such as building materials, activated charcoal, fuelwood, edible bamboo shoots etc. has brought attention to preferring bamboo as a better substitute for other forest products. Central India has several varieties of bamboo and has immense potential of providing self employment and income in rural areas by producing bamboo based value added products including handicrafts cannot be overstated.

Table 1

District-wise area occupied by bamboo in Chhattisgarh

Sl. No.	District	Area (km ²)	Per cent in Chhattisgarh
1	Bastar	3100	31.00
2	Ambikapur	2150	21.50
3	Balaghat	1150	11.50
4	Bilaspur	950	9.50
5	Raipur	850	8.50
6	Raigarh	800	8.00
7	Rajanandgaon	600	6.00
8	Durg	400	4.00
Total		10000	100

Source : Nagariya and Puri (1997)

Table 2*Production of bamboos and area covered in different states*

Sl. No.	State	Area covered (km ²)	Production/yr (million MT)	%
1	Andhra Pradesh	19790	0.255	5.530
2	Arunachal Pradesh	7779	0.200	4.340
3	Assam	10000	1.210	26.540
4	Bihar & Jharkhand	5296	0.200	4.340
5	Gujarat	1936	0.046	1.010
6	Himachal Pradesh	104	0.003	0.060
7	Karnataka	5000	0.475	10.420
8	Kerala	631	0.108	2.360
9	Madhya Pradesh & Chhattisgarh	14864	0.800	17.350
10	Maharashtra	8500	0.300	6.590
11	Manipur	2500	0.200	4.340
12	Orissa	10500	0.489	10.720
13	Tamil Nadu	5368	0.009	0.200
14	Tripura	2844	0.215	4.720
15	Uttar Pradesh & Uttarakhand	4000	0.041	0.899
16	West Bengal	164	0.008	0.176
Total		1,00,299	4.559	

Source : Nagariya and Puri (1997)

Table 3*Production (tonnes/ha) of some bamboo species in different states*

Species	Production (MT/ha)	State
<i>Melocanna baccifera</i>	5.00	Assam
<i>Bambusa tulda</i>	3.10	Assam
<i>Dendrocalamus strictus</i>	3.00	Karnataka
<i>Bambusa bambos</i>	6.00	Karnataka
<i>Bambusa vulgaris</i>	10.00	Madhya Pradesh

Source : Nagariya and Puri (1997)

Most bamboo species produce edible shoots. In many parts of India especially the North-East, bamboo shoots forms a part of the traditional cuisine whether fresh, dried, shredded or pickled. There is a growing market for processed and packaged shoots, representing an opportunity for the establishment of commercially run processing units. However in India, there is no significant cultivation of bamboos for its shoots nor is there an organized market or supply chain of raw shoots for processing. Plantations have however begun to be established. The preferred species for

raising such plantations are *Dendrocalamus asper*, *Bambusa balcoa* and *D. hamiltonii*.

According to an INBAR report, *B. balcoa*, *D. hamiltonii*, *D. giganteus*, *D. brandisii*, *D. strictus* and *Melocanna bambusoides* are most suited for developing a bamboo shoot industry in India. Bhatt *et al.* (2005) have conducted a study to find out commercial edible bamboo species and their market potentiality in three Indian tribal states of the North-eastern Himalayan Region. Considering the market potentiality of young shoots, *Melocanna baccifera* has been identified as the most commercial important bamboo species in Mizoram, *D. hamiltonii*, *M. baccifera* and *Bambusa balcoa* in Meghalaya and *D. hamiltonii* and *Chimonobambusa hookeriana* in Sikkim.

The most commonly planted species in Western India are *Bambusa bambos*, *B. nutans*, *B. vulgaris*, *Dendrocalamus hamiltonii* and *D. strictus*, and in Central India and Deccan Plateau, *D. strictus* and *B. bambos*, the former occurring on slopes while the latter in moist valleys. The other species found in this region are *B. tulda*, *Schizostachyum pergracile* and *Gigantochloa rostrata*. In the Western Ghats where semi-evergreen forests occur, species of *Gigantochloa* and *Ochlandra* are found. Four species of *Indocalamus* occur in the higher reaches of Nilgiris and Palni hills. In West Bengal, Assam and North-East Himalayas, the principal bamboo species are *D. hamiltonii* in the North, *B. tulda* in the central and *Melocanna baccifera* in the southern localities. The most common bamboo species of Andaman and Nicobar Islands are *Gigantochloa rostrata*, *Dinochloa arundinacea* and *Schizostachyum kurzii*.

Ecological factors, plant associations and other factors such as shade, competition, etc. are the important consideration governing the distribution and development of bamboos as well as their regeneration status in the different forest types (Tewari, 1992).

Habitat

Bamboos grow well in high rainfall areas having mean annual rainfall ranging from 1,250 to more than 5,000 mm. However, it also occurs in Dry Deciduous Forests of low rainfall areas (750 to 1,000 mm). It withstands varying temperatures starting from -5°C to 46°C . Snow has practically no influence on its growth. Other conditions necessary for best performance of bamboos are humidity, soil texture and structure, drainage pattern, soil moisture, altitude and physiographic location. Each species has its own characteristic habitat depending upon the edaphic and climatic conditions. Bamboo species prefer deep loamy soils, sandy loam and fertile clay loams although they may grow in slopy hilly areas having very thin soil layers. They may also grow in degraded soils having low fertility. It prefers well drained soils though some species flourishing along river banks, nallahs, stream beds and other moist sites. The climatic and edaphic conditions suitable for the growth of some of the important bamboo species are given in Table 4.

Bamboo-based agroforestry systems

Bamboos are a versatile group of plants capable of providing ecological, economic and livelihood security to the people. Till recently, it has remained confined mostly to the forests. With increasing demand all over the country,

Table 4*Climatic and edaphic conditions suitable for growth of some important bamboo species in India*

Sl. No.	Species	Soil	Topography	Climatic conditions & Occurrence
1	2	3	4	5
1	<i>Arundinacea racemosa</i>	Gravelly loam & clay loam	Slopy upland & high relief	Moist, Eastern Himalayas 2200-3050 m alt.
2	<i>Bambusa bambos</i>	Plain catchment, river sand, fertile soil	River bank, hilly moist area	Moist, except dry land and arid regions of India
3	<i>Bambusa tulda</i>	Catchment, Sandy fertile soil	Plain land near water source	Moist, Assam, W. Bengal, Central India, Moist Deccan pleateau, Deciduous forest areas.
4	<i>Bambusa nutans</i>	Gravelly loam, sandy fertile	Valleys & Sub-Himalayan tract	Semi-dry, Yamuna eastwards to Arunachal Pradesh, Orissa and W. Bengal
5	<i>Bambusa vulgaris</i>	Sandy fertile	Coastal region, plains	Moist. North-East, M.P. and other moist area.
6	<i>Dendrocalamus hamiltonii</i>	Fertile loamy soil	Hilly and river bank	Moist, North-Western Himalayas, Eastern India upto 1000 m alt. in moist deciduous forest areas.
7	<i>D. brandisii</i>	Fertile loamy soil or sandy loam.	River bank, nallahs.	Moist, Kerala, Karnataka, Tamil Nadu
8	<i>D. balcooa</i>	Fertile, loamy, sandy loam.	Foothills and plain lands	Moist, entire North-East, W. Bengal, Bihar, Eastern U.P. upto 600m altitude
9	<i>D. giganteous</i>	Fertile sandy loam, loam.	Plain land and also hilly areas	Moist, Arunachal Pradesh, Assam, Manipur, Nagaland and W. Bengal.
10	<i>D. strictus</i>	Gravelly degraded land, shallow soil.	Slopy hills & dry degraded plain land	Dry, all over India upto 1000 m alt.
11	<i>Melcanna baccifera</i>	Fertile, loam.	Slopy hills, bunds of cultivated lands	Moist, entire North-East, W. Bengal and hilly areas.

Contd...

1	2	3	4	5
12	<i>D. longispathus</i>	Fertile loam.	River bank and nallah sides	Moist, W.Bengal, Assam, Kerala and in moist mixed deciduous forests of Tamil Nadu.
13	<i>Gigantochloa rostrata</i>	Fertile loam.	Moist land, near water sources.	Moist, Orissa, Assam, Central India, Deccan Plateau, Andaman and Nicobar Islands and in moist deciduous forests
14	<i>Drepanostachyum falcatum</i>	Fertile loamy and clay loam mixed with kankar.	Slopy hill lands.	Moist, Western Himalaya in altitudes of 1300 to 2200m.
15	<i>Ochlanda travancoria</i>	Fertile loamy, gravelly clay loam.	Slopy land under flowing water and moist plains	Moist, Western Ghats, in moist evergreen forests at an altitude upto 1600m
16	<i>O. scriptoria</i>	Fertile loam or sandy clay loam	Slopy hills and river banks.	Moist, Western Ghats, Karnataka, Tamil Nadu, Kerala.
17	<i>Pseudoxytenanthera ritcheyi</i>	Shallow upland and stony soil	High hills	Dry, Western Ghats and hilly areas in mixed tropical forests.
18	<i>Schizostachyum pergracile</i>	Loose moist loamy soil or loamy sand	Lower hilly areas	Dry & moist tropical forests of Assam, Central Daccan plateau.

Source : Nagariya and Puri (1997)

the importance of this crop as a source of raw material, particularly for industrial and domestic uses has made it imperative for its cultivation on farm lands. It is considered to be the most suitable species for practicing agroforestry on degraded lands. Ecological benefits of bamboo are numerous (Behari *et al.*, 2000). Studies have shown that bamboo develop the fastest growing canopy for the re-greening of degraded areas. However, there is lack of adequate information on its potential for reclamation of degraded land through bamboo based agro-forestry systems.

Opportunities for the development of degraded land through agro-forestry have

been reviewed by Baumer *et al.* (1990). Application of agro-forestry principles in the developed countries can be separated into ecological, economic and social components (Lassoie and Buck, 1991). The primary objectives is perhaps, in utilizing agro-forestry to obtain ecological benefits and resultant environmental protection (Nair, 1993; Pal and Banerjee, 2007). Bamboos generate plenty of oxygen, low light intensity and protects against ultra-violet rays and is an atmospheric and soil purifier. Furthermore, it conserves water and greatly reduces soil erosion (Amneth, 1996; Ramirez, 1996). The increased permeability of the soil reduces water run-off, with the result that more water

penetrates the soil. The impact of bamboo on water resources is highly positive. Thus, bamboo plantations lessen evaporation, allow better water penetration into the soil and increase the drainage capacity of the soil (Anon., 1994). Sharma *et al.* (1992) have also reported that bamboo conserves soil moisture and mitigates adverse drought effects on flora and fauna. Thus, development of bamboo-based agroforestry systems in this context holds great promise in augmenting the supply of bamboo products in our country without adversely affecting the agricultural land environment.

Different bamboo-based agroforestry systems have been developed in India and reviewed by Singhal and Gangopadhyay (1999) and Behari (2001). The researchers concluded that the systems are technically feasible and economically viable. Some of the agroforestry systems being adopted in the country are :

- Soybean with *D. strictus*
- Pigeon pea with *Bambusa bambos*
- Soybean with *Bambusa bambos*
- Ginger with *Bambusa bambos*
- Turmeric with *Bambusa bambos*
- Soybean with *Melocanna baccifera*.
- Soybean with *D. longispathus*.

Behari *et al.* (2000) established appropriate agroforestry systems with three bamboo species, namely, *Bambusa bambos*, *B. nutans* and *D. strictus*. Seven bamboo-based agroforestry systems have been developed on degraded lands. They are : Bamboo-soybean, Bamboo-niger, Bamboo-moong, Bamboo-mustard, Bamboo-wheat, Bamboo-urad and Bamboo-arhar. They concluded that degraded agricultural lands may be ecologically restored fast owing to the adoption of bamboo-based agro-forestry

systems associated silvicultural and agricultural operations. Environmental impacts of bamboo cultivation are summarised in Table 5.

There are many traditional bamboo based agro-forestry practices being adopted in the Central Indian region, which are economically viable but require in-depth understanding for enlarging the area under agroforestry systems.

With the increasing demand of bamboos as industrial raw material, they

Table 5

Environmental impact of Bamboo cultivation

Sl. No.	Impact	Magnitude
1.	Erosion	++
2.	Sedimentation	++
3.	Soil fertility	++
4.	Physical soil structure	++
5.	Drainage	+
6.	Soil micro-flora	++
7.	Soil micro-fauna	+
8.	Laterisation of soil (pH)	0
9.	Ground water level	0
10.	Ground water quality	0
11.	Micro climate	++
12.	Local climate	0
13.	Regional Climate	0
14.	Global climate	0
15.	Fire hazard	0
16.	Flora : species diversity	++
17.	Fauna : feeding area	+
18.	Fauna : habitats	0

++ : Impact of major positive magnitude;

+ : Impact of minor positive magnitude;

0 : No visible impact.

have gained further importance for cottage industry and for large industries like pulp and paper. Keeping in view the vast untapped potential of bamboos, the Government of India has decided to implement a Centrally Sponsored Scheme under the National Bamboo Mission for addressing the issue relating to the development of bamboos in the country. The main objectives of the Mission are :-

- To promote the growth of the bamboo sector through an area based regionally differentiated strategy;
- To increase the coverage of area under bamboo in potential areas with suitable species to enhance yield.
- To promote marketing of bamboo and bamboo-based handicrafts;
- To establish convergence and synergy among stake holders for the development of bamboos;
- To promote, develop and disseminate technologies through a seamless blend of traditional wisdom and modern scientific knowledge;
- To generate employment opportunities for skilled and unskilled persons, especially unemployed youths.

To achieve the objectives, the Mission has decided to adopt the following strategies :

- Adopt a coordinated approach covering production and marketing to assure appropriate return to growers/ producers;
- Promote Research and Development (R & D) of genetic superior clones of suitable species and technologies for enhanced production;
- Enhance acreage (in forest and non-forest areas) and productivity of bamboo through species change and improved cultural practices;

- Promote partnership, convergence and synergy among R & D and marketing agencies in public as well as private sectors, at all levels;
- Promote where appropriate, cooperatives and self help groups to ensure support and adequate returns to farmers;
- Facilitate capacity building and Human Resource Development;
- Set up National, State and sub-State level structure to ensure adequate return for the produce of the farmers and eliminate middlemen to the extent possible.

Bamboo resources in recent years, however, have shown perceptible decline, owing to over-exploitation by industries and effect of other factors such as forest fires, grazing and shifting cultivation in the North-Eastern States, invasion by weeds and gregarious flowering have also contributed substantially towards the reduction of bamboo production and bamboo growing areas in the country. As a consequence of which, the paper and pulp industries which were earlier largely dependant upon bamboos are now using other softwoods as raw material.

The important bamboo species for production of commercial bamboo shoots are *Melocanna baccifera*, *Dendrocalamus hamiltonii*, *D. gigantea*, *Chimnobambusa hookeriana*, *Bambusa balcooa* and *Bambusa nutans*. Trials conducted for introduction of *D. asper* by different institutions in India have revealed that this species can be successfully cultivated under sub-tropical and tropical conditions.

Conclusion

The rapid increase in the demand for

bamboos in the industrial sector and increase in local demand due to rising population have caused depletion of the natural bamboo bearing forests, calls for mounting concerted efforts for raising the awareness of the masses to raise bamboo plantations on lands hitherto barren, degraded or in association with agricultural crops. The bamboo plantation efforts constrained due to the non-availability of quality planting stock may be overcome through the research and developmental activities of Indian Council of Forestry Research and Education. A new technology has been developed (Kumar,

1991, 1992, 1995; Kumar and Pal, 1994) at Forest Research Institute, Dehra Dun for mass propagation of sympodial bamboos. This technology ensures that each propagule possesses shoot, root and rhizome parts even at the time of propagule production, ensuring rapid establishment and practically maximum survival of the propagated material. Detailed plans are being formulated for continuous production of plantable saplings of vegetative origin through macro-propagation thereby eliminating the dependence on bamboo seeds for raising plantations coupled with vigorous activities.

SUMMARY

Bamboo is one of the fastest growing plant species which occurs under varied climatic and edaphic conditions. In the present review the distribution and productivity of different species of bamboo in India have been discussed. The climatic and edaphic conditions suitable for the optimum growth of some important bamboo species have also been described along with bamboo based agro-forestry models.

Key words : Bamboo, Distribution, Production, Habitat, Agroforestry potential.

बांस : इसका वितरण, उत्पादन, प्राकृतावास और इसकी कृषिवानिकी संभावनाएं
वी० नाथ, रजत एस० पाल व एस०के० बनर्जी
सारांश

बांस सबसे अधिक तेजी से बढ़ने वाली उन पादप जातियों में आते हैं जो अनेक प्रकार की जलवायु और मृदा दशाओं में उगती मिल जाती हैं। प्रस्तुत समीक्षा में भारत की विभिन्न बांस जातियों का वितरण और उनकी उत्पादकता विवेचित की गई हैं। कुछ महत्वपूर्ण बांस जातियों की इष्टतम बढ़वार के लिए उपयुक्त जलवायु और मृदा दशाओं को भी, उनके बांस आधारित कृषिवानिकी मॉडलों (प्रतिरूपों) सहित इसमें वर्णित किया गया है।

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