

Review Article

Bamboo, as Potential Sources of Food Security, Economic Prosperity and Ecological Security in North-East India: An Overview

Anusriti Basumatary¹, Sushil Kumar Middha², Talambedu Usha³,
Birendra Kumar Brahma¹ and Arvind Kumar Goyal^{1*}

¹Bamboo Technology, Department of Biotechnology, Bodoland University, Kokrajhar-783370, B.T.A.D, Assam, India

²Department of Biotechnology, MLA College for Women, Bangalore-560012, Karnataka, India

³Department of Biochemistry, MLA College for Women, Bangalore-560012, Karnataka, India

*Corresponding Author: Email: arvindgoyal210883@gmail.com

The evergreen and versatile plant, bamboo, is intricately associated with humans since decades. It is the fastest growing plant and is estimated to cover 8.96 million ha of the total 63.3 million ha forest of India. The North-East India harbors about 43% of the total bamboo wealth of India. Especially in the rural areas it plays a key role in the life of the people. The utilization of juvenile shoots of bamboo as health food is a lesser known fact as compared to its industrial usage. The shoots having high nutritional and therapeutic values can be opted to make up the deficiencies of nutrients in the diet and utilized to feed the ever increasing human population. Bamboo, the precious gift of nature to mankind, enriches the socio-economic condition of the common people of North-East region of the India. Because of the growth habits and biological characteristics, bamboo is not only an ideal economic investment which can be used in various way but also have enormous capacity for mitigating many ecological problems faced by the world at present. The present review gives an insight into the role of bamboo in the North-East India along with future prospects in view of food security, economic prosperity and ecological security.

Keywords: Bamboo; Bamboo shoots; therapeutic values; Northeast India

North East India is among one of the most diverse and lesser known areas of Asia. The North Eastern region comprising of eight states is recognised as one of the '8 Hottest Biodiversity hotspots' with more than 7000 endemic plant species. Also, this region is listed in 6th place as one of '25 Mega Diversity' hotspots of the world for its diverse flora and faunas (Myers, 2000). Bamboo, for ages, is found to be the most dominant and important flora compared to others. Therefore, this region is also considered as 'bamboo paradise of India'.

Undoubtedly bamboo is long-lived, valuable natural resource of the tropics in

the Indian context with multiple economic possibilities. Being a monocarpic belonging to the subfamily Bambusoideae (Poaceae), bamboos are a group of 1575 species of non-wood forest plants gifted by nature to the mankind (Brahma *et al.*, 2014). It can be found in diverse climates of tropical and subtropical regions as well (Handique *et al.*, 2010). Throughout the globe, bamboo is naturally distributed. Bamboo, apart from India, has always been a central part of each and every type of society mainly rural society in Africa, Latin America and also other parts of Asia (Sundriyal and Sundriyal, 2011). It is native to almost all

continents excluding Europe and Antarctica (McClure, 1966; Liese, 2001).

Around 8.96 million ha of the total 63.3 million ha forest area of India is estimated to be covered by bamboo (Yengkopam, 2013). Among the 136 exotic and indigenous species recorded in India, 50% of the total *Bambusa* sp. is being found in the North-Eastern states like Arunachal Pradesh, Sikkim, Mizoram, Manipur, Nagaland, Meghalaya and Assam followed by state of West Bengal (North Bengal, Himalaya) (Goyal and Brahma, 2014). The whole region is very rich in diversity of bamboo species as well as stock (Bisht *et al.*, 2011). Further, the state of Assam has a geographical area of 78438 km², of which the area of 1813 km² is sheltered by bamboo (Sharma *et al.*, 2010). It has long been recognized as an essential and valuable commodity globally for its highly diverse applications ranging from household construction to utensils to food and medicines.

Besides this, the importance of bamboo has increased much owing to its suitability for manufacturing the so-called 'engineered bamboo' from ordinary bamboo applying modern technology. Closely associated with agriculture and forestry, it is able to deal with the new challenges which world is facing (Nongdam and Leimapokpam, 2014). In Assam, bamboo forms an integral constituent of home gardens that provide villagers with wide range of goods and services and thus, perform an important role in life of the ethnic and indigenous people thriving in Northeastern region of India (Das and Nath, 2008). Due to its multiple use, people of N.E. region is closely interwoven around the bamboo & their products and are therefore addressed with different names in different places such as in China they are also known as 'Friends of the people', in Vietnam -'My brother', and in India -'Green Gold' etc. (Nongdam and Leimapokpam, 2014).

Regarded as small wonders by our ancestors for centuries, bamboos have been prime material in case of progress and prosperity along with protection from attacks of wild animals (Patel *et al.*, 2013).

And because of these, some influential myths have naturally been originated in society during old days including Assam, Vietnam, Philippines and many more. In Assam, bamboo symbolizes the source of 'courage', while in Vietnam, it symbolizes the spirit of Voviram (a Vietnamese martial art) and also the Vietnamese soul- the gentleman like straight forwardness, hard working, optimism, unity and adaptation. On other hand, in Philippino mythology, one of the most famous accounts tell of a first man, MALAKAS (Strong) and the first woman, MAGANDA (Beautiful), which emerged from two halves of a split bamboo stem on the island.

Slowly but steadily, bamboo is gaining importance for being one of the most important renewable natural resource of India presently. In addition to its myriad use, the young bamboo shoots are also used as food in the N.E. region. Juvenile and soft shoots of few mostly preferred sp. are being consumed (Goyal and Brahma, 2014; Nongdam and Leimapokpam, 2014; Yengkopam, 2013).

Bamboo serves as a superior construction material for industrial sectors (Ghosh, 2008). Its trade has gained importance in upliftment of socio-economic status in rural communities (Sundriyal and Sundriyal, 2011). As an option to expensive construction, it has new applications as a substitute to depleting wood resources. The markets for bamboo are booming with estimates putting the worth of industry 25 billion dollars.

Once regarded as 'poor man's timber' is now being dubbed as Green Gold for its vast environmental benefits such as alleviating pressure on tropical forest thereby mitigating climate change and curbing deforestation (Ogunjinmi *et al.*, 2009; Goyal *et al.*, 2010). Thus, it is absolutely worth mentioning that the use of bamboo is endless and therefore, it is an indispensable resource for the rural people of North-East India.

This article gives an insight into the global scenario of bamboo and its role in providing food security, economic

prosperity and ecological security in the North-eastern region of India.

Role of bamboo in food security

For food security, production, procurement, and distribution are the three pillars. In the world, especially in developing countries, it is estimated that about 1.2 billion people do not have enough food to meet their daily requirements and further 2 billion people are deficient in one or more micronutrients (Kotecha, 2008).

According to the report of the year 2005 of World Bank, the situation in India is worst. The prevalence of underweight children in India is amongst the highest in the world and is almost double than that of sub-Saharan Africa. North-Eastern region is abundant in nutritious crops such as bamboo shoots, local rice, buckwheat, flax and many more wild pulses. Traditionally, underutilized crops are being used by the local households to meet their needs. Usually, the food and nutritional insecurity and poverty to both rural and urban communities are due to farmer's dependence on few highly selective crop & loss of agrobiodiversity resulting in narrow food baskets. Therefore, bamboo shoot, the neglected commodity resource, if utilized properly, can help to meet the increasing demand for food and nutrition, energy, medicine and industrial needs (Yengkopam, 2013).

Though it is popularly known for its industrial usage, the utilization of juvenile bamboo shoots as food which can be consumed canned, fresh, fermented or pickled is relatively a lesser known fact. Shoots refers to the young, edible bamboo plant that have newly emerged from the ground. They are usually 20-30 cm long with tapering at one end and weigh approximately a pound with a sheath covering the shoots (Farely, 1984). Considerably their weight is dependent upon location, rainfall, watering and drainage conditions, soil fertility, depth and nutrition of the soil, temperature and pH (Choudhury *et al.*, 2011). They are rich in carbohydrate, proteins, minerals and

moisture. Comparatively, the content of cholesterol and fat is found less. Fresh shoots of species like *D. giganteus* are far more nutritionally rich and healthier with better organoleptic qualities (Choudhury *et al.*, 2012).

The matchless taste and flavour makes the edible bamboo shoot a rare of its kind in case of cuisines (Pande and Pandey, 2008). Apart from India, there are many countries where bamboo shoots forms a traditional delicacy among which few are Japan, US, Thailand, Nepal, Australia, Bhutan, New Zealand, Korea, Malaysia and Indonesia. Ethnic people from Nepal and Bhutan consume it as a pickle or chutney, while in Indonesia, the shoot is added with thick coconut milk and spice to make gulei rebung etc. and Sikkimese prefer to consume it as non-fermented curry called tama (Choudhury *et al.*, 2011; Tamang, 2000). Thus, for feeding ever increasing human population, bamboo shoots can positively be utilized. Also due to the therapeutic and nutritional values, it will prove beneficial to make up the dietary deficiencies of micronutrients in the diet resulting in the global food security, safety and nutrition.

Bamboo for economic prosperity

A large section of society in North-East India heavily relies or depends on bamboo for their livelihood.

As the demand on wood has been uninterruptedly increasing over the time along with increase in the world population, there is a sudden rise in pressure on our global resources. As a result, to keep pace with growth of population and their demands and other conventional materials accompanied by rising cost make it imperative to increase the use of bamboo (Li and Miki, 2004).

Bamboo has traditionally been used for a variety of purposes. Due to its speed of growth and sustainability, it has received renewed attention worldwide (Vengala and Lindt, 2013).

In economic development, because of its high annual yield, bamboo performs a

vital role. It is used for both modern and traditional uses. It, traditionally, has been used to hold up scaffolding, simple suspension bridges, supplemental or decorative element in buildings and split or woven bamboos. It also serves as a superior material for utensils, weapons, fuel, fodder, food, firewood, furniture, mats, chopsticks, toothpicks, handicrafts, musical instruments etc (Ghosh, 2008). Recent improvements and processing technologies allow bamboo to be utilized for high end products such as decking, flooring, panels and veneers & structural beams. In modern uses, bamboos are being converted into engineered products such as bamboo mat board, laminated bamboo board, ply bamboo, bamboo curtain board etc. (Bansal and Zoolagud, 2002). It has also been reported that laminated based panels are superior than wood based panels in almost all performance indexes. In fact it has been proved valuable from top to rhizomes (Yang and Du, 2010).

With more than 1,500 documented uses in total (Goyal et al., 2012), it is an enduring and versatile natural resource that has become notable for its economic and cultural significance in Southeast Asia, South Asia and East Asia mainly. The archaeological evidence suggests that some 5,300 years ago, bamboo had already been used to weave baskets, mats and other useful articles in China during Stone Age. Moreover, for recording and writing, the culms were split into slices (Li and Mikio, 2004). Throughout the tropical and sub tropical regions of the world, bamboo, has a long and well established tradition for being used due to its high tensile strength and very good weight to strength ratio. Its tensile strength is around 28,000 lb per sq. inch. as compared to 23,000 for steel (mild) (Swamy, 2011) which supports its application as a resilient material against forces created by earthquakes and high velocity winds. Further, this type of construction has been observed in seismically active regions of India (Vengala and Lindt, 2013).

Foreign trade is inevitable in the modern economic environment and globalised world for a country's development and economic growth as it expands the external markets for the product resulting in making more profits. Demand for bamboo based products are highly increased in developed countries like UK and USA (Logu and Kottaiveeran, 2014). The market potential is estimated at 450 million Indian rupees which will increase to 26,000 million rupees by 2015 thereby enabling 5 million families crossing the poverty line (Farooquee et al., 2007).

In sum, bamboo's excellent growth, environmental, mechanical, engineering properties and potential for different value added products and application make it extremely important reliable source for generating greener economy and man power followed by sustainable development.

Bamboo for ecological security

Bamboo with its vast ecological benefits alone is quickly becoming more than just a poor man's timber. In recent time, bamboo is also seen as the 'wonder plant' of the 21st century (Kalaiarasi et al., 2014). It stands as an ideal species capable of achieving eco-restoration of degraded lands, conservation of soil, moisture and providing economic security as well (Swamy, 2011). It can mitigate the pressure on natural forests as well as contribute conservation of biodiversity. India has undergone a series of ups and downs due to the ecological conditions playing havoc in years of abnormality. Many droughts in 18th and 19th centuries have been faced by the people (Gupta and Acharya, 2014).

Bamboo has not only being a traditional economic crop for North-east region but also is proven to have tremendous biogenomic resilience in combating the brunt of climate change. In exploited landscapes, it can accumulate organic matter, counteract soil and thus have reversed soil degradation (Zeng et al., 2006). Also through bamboo, regulation of water flows, filtering of waste water,

controlling of sedimentation and pollution from agricultural runoff can be done (Schoonover et al., 2006). Bamboo undoubtedly plays a prime role in promoting the ecological security.

The role of bamboo is manifold. Its biological characteristics make it a perfect tool for reducing carbon dioxide levels in atmosphere. As a carbon sequestration agent, it can also retard pace of climate change. It could be a unique and ideal eco-friendly species as carbon credits (Mishra et al., 2014). Altogether, it is an atmospheric and soil purifier, generating more oxygen than equivalent strands of trees. It also protects against ultraviolet rays and helps in lowering light intensity. The fastest growing canopy, bamboo, tolerates extreme precipitation from 30-250 inches of annual rainfall. The great diversity of species makes bamboo adaptable to many environments, needing relatively few nutrients to grow. Moreover, thriving on degraded lands, it restores them into functional forest ecosystems.

The root and rhizome of bamboo grow shallowly into the soil and can horizontally extend widely. For instance, the root of *Bambusa tulda* can extend horizontally to a distance of 5.2 m. Their root mats are tightly woven, that has a significant capacity to bind the topsoil. For thousands of years, the rich volcanic soils on steep hillside in north-central Andes have been under cultivation which has been possible only due to the bamboo plantation (Zhou et al., 2005). With its extensive root system, it can conserve soil by preventing the erosion. Furthermore, it conserves water in catchments areas, controls floods in valleys and plains, minimizing the siltation.

Bamboo is very much effective in protection of sea banks, river banks, dam sites and canal banks. It is planted along stream and river banks that grow particularly well due to abundant and even supply of moisture. As a result, the soft banks are binded by fibrous mass of roots and the thick culms arrest strong currents during flood periods. Furthermore, landslide, one of the most severe types of

land degradation that causes serious topsoil loss and greatly threatens land productivity, is also prevented by bamboo. Thus, it helps to control landslides, keep flooded rivers along their natural course and slow the speed of water flow and trends of desertification (Gupta and Acharya, 2014).

Conclusion

In day-to-day life of human beings bamboo is a plant species which incorporates several economic, ecological and health benefits. Considering the above factors, it is indeed highly needed to put emphasis on mass plantation of bamboo in large scale in North-Eastern India. This will hopefully help to go a long way in mitigating the erosion of biodiversity, climate change, dietary deficiencies and insecure economy. It will provide ample scope towards engagement of unemployed directly or indirectly through marketing as well as production of raw bamboo and its value added products thereby enhancing the food, economic and ecological security of the said region.

Acknowledgments

The authors are thankful to the Agriculture Department, Bodoland Territorial Council Secretariat, Bodofa Nwngwr, Kokrajhar for the project vide letter No. BTC/Agric-91/2013/15 dated 19th June, 2013.

Reference

- Bansal AK, Zoolagud SS. 2002. Bamboo composites: Material of the future, J Bamboo Rattan. 1(2): 19-130.
- Bisht MS, Chongtham N, Haorongbam S. 2011. Nutritional properties of bamboo shoots: Potential and Prospects for Utilization as a health Food, Compr Rev Food Sci F. 10: 153-169.
- Brahma BK, Basumatary A, Basumatary J, Narzary D, Mwshahary N, Jamatia S, Basumatary P, Goyal AK. 2014. Inventorying bamboo diversity of Kokrajhar District, BTAD, Assam, India with emphasis on its uses by the Bodos tribes, Int J Fund Appl Sci. 3(3), 30-34.

- Choudhury D, Sahu JK, Sharma GD, 2012. Value Addition to Bamboo Shoots: a review, J Food Sci Technol. 49(4): 407-414.
- Choudhury D, Sharma GP, Sahu JK, 2011. Bamboo Shoot Based Fermented Food Products: A Review, J Sci Ind Res. 70: 199-203.
- Das AK, Nath AJ, 2008. Bamboo Resources in Homegardens of Assam: A case study from Barak Valley, J Trop Agric. 46(1): 58-61.
- Farely D. 1984. The Book of Bamboo, (Sierra Club Books), San Francisco, California
- Farooquee NA, Dollo M, Kala CP. 2007. Traditional Wisdom of Apatani community in the management and sharing of Natural Resources in North Eastern India. In: Misra KK (ed) Traditional knowledge in contemporary societies: challenges and opportunities. Pratibha Prakashan, Delhi, pp.110-126.
- Ghosh GK. 2008. *Bamboo: The Wonderful Grass*. APH Publishing, New Delhi, India. pp 44.
- Goyal AK, Brahma BK, 2014. Antioxidant and nutraceutical potential of Bamboo: an overview, Int J Fund Appl Sci. 3(1): 2-10.
- Goyal AK, Ghosh PK, Dubey AK, Sen A. 2012. Inventorying bamboo biodiversity of North Bengal: A case study, Int J Fund Appl Sci. 1(1), 5-8.
- Goyal AK, Middha SK, Sen A. 2010. Evaluation of the DPPH radical scavenging activity total phenols and antioxidant activities in Indian wild *Bambusa vulgaris* "Vittata" methanolic leaf extract, J Nat Pharm. 1(1): 40-45.
- Gupta M, Acharya SK. 2014. Climate Change and Bamboo: The Issues of Income, Productivity and Livelihood in North-East India, J Agric Eng Food Tech. 1(1):17-22.
- Handique P, Rethy P, Dutta BK, Das AK, Doley B. 2010. Role of Bamboo Resources in Socio Economic Development of the tribal people of Arunachal Pradesh with special reference to Nyishi tribe of Papum Pare District, J Biosci Res. 1(3): 216-226.
- Kotecha PV. 2008. Micronutrient Malnutrition in India. Let us say "no" to it now, J Commun Med. 33: 9-10.
- Li Z, Mikio K. 2004. Plantation Future of Bamboo in China, J Forest Res. 15(3): 223-242.
- Liese W. 2001. Advances in bamboo research [J], J Nanning Forest Univ (Nat Sci). 25(4): 1-6
- Logu A, Kottaiveeran K. 2014. Foreign Trade of India, A case of Bamboo based Products, Indian Streams Res J. 3: 1-6.
- McClure FA. 1966. The Bamboos- A fresh perspective, Harvard University Press, Cambridge USA. pp- 347.
- Mishra G, Giri K, Pandey S, Kumar R, Bisht NS. 2014. Bamboo: Potential resource for eco-restoration of degraded lands, J Biol Earth Sci. 4(2): B130-B136.
- Myers N, Mittermeier RA, Mittermeier CG, Fonseca GAB, Kent J. 2000. Biodiversity hotspots for conservation priorities, Nature. 403: 853-858.
- Nongdam P, Leimapokpam T. 2014. The Nutritional Facts of Bamboo Shoots and their Usage as Important Traditional Foods of Northeast India, Int Sch Res Notices. DOI: 10.1155/2014/679073.
- Ogunjinmi AA, Ijeonah HM, Aiyeloja AA. 2009. Socio-economic importance of bamboo (*Bambusa vulgaris*) in Borga local government area of Niger state, Nigeria, J Sust Dev Afr. 10(4): 284-289.
- Pande SK, Pandey S. 2008. Bamboo shoots for the 21st century, Int Forest Rev. 10(2): 134 -146.
- Patel PA, Patel JA, Magdallawala SH, Maiwala AR, Gajera VJ. 2013. Design of Bamboo Reinforced Concrete Water Tank resting over firms ground. Int J Eng Business Enterprise Appl. 4(2): 113-117.
- Schoonover JE, Williard KMJ, Zaczek JJ, Mangun JC, Carver AD. 2006. Agricultural Sediment Reduction by Giant Cane and Forest Riparian Buffers, Water, Air Soil Poll. 169(1-4): 303-315.
- Kalaiaarasi K. Sangeetha P, Subramaniam S, Venkatachalam P. 2014. Development of an efficient protocol for plant

- regeneration from nodal explants of recalcitrant bamboo (*Bambusa arundinacea* Retz. Willd) and assessment of genetic fidelity by DNA markers. *Agroforestr Syst.* 88: 527-537.
- Sharma H, Sarma AM, Sarma A, Borah S. 2010. A case of gregarious flowering in Bamboo, dominated lowland forest of Assam, India: phenology, regeneration, impact on rural economy and conservation, *J Forest Res.* 21(4): 409-414.
- Sundriyal M, Sundriyal RC. 2011. Bamboo Trade and Future Prospect in Central Himalaya: A Case study of Traditional Artisans of Uttarakhand, India, *Ethnobot Res Appl.* 9: 445-454.
- Swamy C. 2011. Employment Generation by Bamboo Resource Development and its impact on Rural Communities, *Int J Rural Stud.* 18 (1): 1-6.
- Tamang JP. 2000. Traditional fermented foods and beverages of the Sikkim Himalayas in India: indigenous process and product characterization. In: Director, Cftri (Eds.), *The Proceedings of the 1997 International Conference on Traditional Foods*, March 6-8, 1997, CFTRI, Mysore, pp. 99-116.
- Vengala J, Lindt JW. 2013. Seismic performance of Single Family Dwellings constructed using Bamboo-Mortal Composite, *Asian J Civil Eng.* 14(1): 33-45.
- Yang HC, Du F. 2010. *China's Bamboo: Culture, Resources, Cultivation and Utilization.* Colour Max Commercial Printing Co.Ltd., Hong Kong.
- Yengkopam RD. 2013. Bamboo Forest Resouces of India and its Role in Food Security- A review, *Agricult Rev.* 34(3): 236-241.
- Zeng DH, Singh AN, Chen FS. 2006. Effect of young woody plantations on carbon and nutrient secretion rates in a redeveloping soil on coalmine spoil in a dry tropical environment, India, *Land Degrade Develop.* 17(1): 13-21.
- Zhou B, Fu M, Xie J, Yang Z, Li Z. 2005. Ecological functions of Bamboo forest: Research and Application, *J Forest Res.* 16 (2): 143-147.