National Consultation on Opportunities and Challenges for Bamboo in India

25-26th February 2021

Concept Note
The inferences and analysis made by Invest India in this report are based on information collated through primary research, secondary research, discussions with key stakeholders, Departmental reports and our knowledge about the program and its objectives. We are grateful to the authors whose work helped us compile this report. This work product is for information purposes only and the content is not to be construed in any manner whatsoever as a substitute for professional advice.
“Skilled artisans are making bottles, tiffin boxes, and various other essential products with bamboo in Assam, Tripura, and Manipur. These products made with bamboo are of high quality and are very useful”

-Shri Narendra Modi  
Hon’ble Prime Minister of India

“India is moving towards increasing exports of bamboo products, support is being given by National Bamboo Mission to local artisans and it will actualize PM’s goal for progress of local industries”

—Shri Narendra SinghTomar  
Hon’ble Union Minister of Agriculture
Foreword

India is a country harbouring immense capacity for growth and development. While the last two decades have been characterized by rapid urbanization, coupled with a meteoric rise in the citizens’ standards of living, the focus is now on rejuvenating rural economy by tapping the potential through a whole range of inter sectoral transformations. One of the potent, yet untapped keys lie with bamboo.

Various States in the country, beyond the North East, have the appropriate climate to facilitate large-scale production of bamboo. This is evidenced by the fact that India holds the position for having the largest area under bamboo cultivation of more than 15.69 million hectares, and second largest diversity in species, with 136 types of bamboo. Being one of India’s most valuable resources, a strategic leveraging of bamboo can lead to immense improvement of rural and tribal livelihoods, potentially alleviating poverty, empowering women, and benefitting the local environmental conditions. While bamboo is one of the most suitable crops for commercial forestry, the commercial viability of certain species of bamboo requires to be worked upon. The recognition of bamboo as an area of potential is reflected in the Government’s National Bamboo Mission bringing together expertise of 14 Ministries and Departments of GoI. The goals of this Mission are to promote the holistic growth of the bamboo sector and promote its cultivation and marketing for a plethora of industrial and handcrafted products.

The restructured National Bamboo Mission has embarked on tapping the versatility of this unique gift of Nature and developing the value chain for domestic and global markets. Bamboo can be used as a raw material in the production of a variety of products, including agarbatti, construction, fibre, paper, biofuel, lifestyle products (by honing the skills of our traditional craftsperson to contemporary markets), charcoal, activated carbon, bikes, handicrafts like toys and dolls, musical instruments, and emerging areas for uses in automobile and aircrafts. Bamboo shoots, vinegar, wine, charcoal used for generations in the NER have a global consumer waiting. With the emergence of popular retail chains that deal with furniture, such as IKEA, as well as the DIY sector, the demand for bamboo has grown globally. Producing high quality bamboo products, using the niche expertise and specialized styles of rural and tribal craftsmen adds to the uniqueness of India’s bamboo industry.
The National Bamboo Mission, anchored in Department of Agriculture Cooperation and Farmers Welfare, is privileged to be partnering with NITI Aayog and Invest India for this 2-day manthan to deliberate on the Opportunities and Challenges for Bamboo in India. New possibilities arise each day for the development of the Indian economy and its people. This National Dialogue will build upon the gains of the Mission since its launch in 2018-19 to further delve into the immense potentialities of India’s rural industries, to bring in greater investment, development, and betterment of the lives of India’s rural and tribal populations, who depend greatly on these resources for their livelihoods. The nascent bamboo industry will also be strengthened by a structured forward and backward linkages making Indian bamboo competitive in global markets as well, contributing to the Make in India mantra through promotion of Vocal for Local.

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Chapter 1
Bamboo: The Green Gold

Bamboo is a tree-like grass belonging to the Poaceae family. Bamboo is the fastest growing perennial, tall, wide-spread, and versatile species with the ability to produce culms every year. It is an easy substitute for timber owing to its eco-friendliness and large bio-mass production besides its usefulness in the maintenance of soil health and checking erosion. Bamboos have multiple utilities that include food, fiber, fuel, construction & engineering materials, panel products, charcoal, medicinal products, paper, flooring, screens, etc. It is divided into three categories based on its morphologies: monopodial bamboo, sympodial bamboo, and amphipodial bamboo. It is one of the fastest-growing species in the world and takes a much shorter period from plantation to processing, which is only 3 to 5 years, compared to 30 to 50 years of most tree species in the tropics and subtropics. Therefore, it is perceived as one of the most important Non-Timber Forest Product (NTFP) in the world. It is amenable to multiple uses, and is, therefore, well suited to value addition activities, generating thereby several employment opportunities in the rural sector. Bamboo grows not only in forests but is also widely raised in homesteads and farms. Shade-loving crops such as colocasia, ginger, and turmeric can be grown as inter-crops in bamboo-based agroforestry systems. Its leaves may be used as green fodder throughout the year for the ruminants in the fodder deficit areas.

The market for bamboo products is largely in high-income countries, while global supply is dominated by China. Three countries, namely, China, India, and Myanmar account for 80 percent of the total bamboo area in the world. It is estimated that India is the second-largest country in the world with ~ 40% of the total bamboo forest area after China. The industrialization of bamboo is at a relatively low level in India, suggesting that on the supply side, products are not being produced in significant quantities. As a result, exports of bamboo-based products are very low and have been stagnant for many years. Despite India being abundant in natural bamboo resources, it is a net importer of bamboo. Globally, the market for sustainable products has been on the rise, as there has been an increasing awareness about sustainable consumption. The public and private sectors thus have a role to play in identifying the bamboo clusters within the country and in developing the necessary ecosystem for their full utilization.
Understanding the Value Chain

*Processing facilities, both small and large scale, can further help the farmers in realising better value on the surpluses that cannot be consumed in fresh form in both near and far markets*

-Report of the Committee on Doubling Farmers’ Income

The market study of bamboo reveals that there is an unorganized market in the country where products such as agricultural poles, basketwork, construction materials, incense sticks, and handicrafts are produced. Private wholesalers operate depots in the country consisting of a small office building or sheds with a storage yard where bamboo poles and residue are stacked after sorting. Bamboo is purchased by wholesalers to their depots in large lots and sold in bulk. In the wholesale trade, there is a difference in prices charged by various depots for the same length, diameter, and quality of poles. The availability of poles also varies among depots.

To maintain high yields and regular supply to the market, the plantation sector requires several inputs and needs the support of extension services depending upon the supply of high-quality inputs from the nursery sector. Ideally, the pre-processing units should be located near bamboo plantations and engage the local crafts person thereby generating rural employment as well reduce cost of transportation. Following pre-processing, Common Facility Centres are being set up with assistance of NBM for primary processing. These are important for ensuring complete utilisation of bamboo poles to produce primary processed material for a range of...
bigger units/industry. ‘Waste utilisation’ has been the bane of bamboo use in India and hence NBM is giving a focussed attention to integrated units for value addition to all the left over from the major use, based on the premise that there is nothing that can be termed as ‘waste’ in bamboo. It is most important to equip the CFCs and integrated clusters with machines/equipment suited to Indian bamboo to increase efficiencies, and quality of output meeting the requirement of industry/markets. A variety of other complementary inputs (such as adhesives) are supplemented with standard testing, quality control, and fine-tuned to the specifications of the export market.
Chapter 2
National Bamboo Mission

The restructured National Bamboo Mission (NBM) was launched in 2018-19 to catalyse the ecosystem by assisting the holistic development of the complete value chain as natural corollary to the amendment of the Indian Forest Act, 1927 in 2018 whereby bamboo was removed from the definition of ‘trees’, hence freeing bamboo grown outside forest areas from requirements of felling and transit regulations. Out of the 130+ species available in India, not all are commercially suitable. Hence NBM, in consultation with industry and States has identified 10 crucial species to be encouraged to be planted by farmers and others to make the country self-sufficient in the supply of raw material to our industry. These are found in most parts of the country, though majorly in the North-Eastern Region. States are also planting and utilizing other species suited to local requirements.

The Mission is promoting holistic growth of the bamboo sector by adopting the area-based, regionally differentiated strategy and increasing the area under bamboo cultivation, processing, branding, and marketing. Under the Mission, steps have been taken to increase the availability of quality planting material by supporting the setting up of new nurseries and strengthening existing ones. Guidelines for accreditation of bamboo nurseries and certification of planting material have been released by NBM and States are in the process of accrediting all nurseries – Government and Private.

To address forward integration, the Mission is taking steps to strengthen the marketing of bamboo products, included industry produced as well as the rich Indian tradition of handcrafted articles moulded to contemporary markets. Correspondingly the area under bamboo plantation is being increased in non-forest Government and private lands to supplement farm income, make available quality raw material to industries and contribute towards resilience to climate change as well. The bamboo plantations are being promoted predominantly in farmers, fields, homesteads, community lands, arable wastelands, and along irrigation canals, water bodies, etc. The Mission is being implemented in States where it has a social, commercial, and economical advantage, particularly in the States of North-Eastern region and Madhya Pradesh, Maharashtra, Chhattisgarh, Odisha, Karnataka, Uttarakhand, Bihar, Jharkhand, Andhra Pradesh, Telangana, Gujarat, Tamil Nadu, and Kerala.
Chapter 3

Bamboo for Atmanirbhar Bharat

*The way ahead lies in LOCAL-Local Manufacturing, Local Markets, & Local Supply Chain...Local is not merely a need but a responsibility!*

-PM Shri Narendra Modi

A clarion call to the Nation was given by kick-starting the Atmanirbhar Bharat Abhiyaan (Self-reliant India campaign) during the COVID pandemic gripping the world. The aim was to make the country and its citizens independent and self-reliant in all senses. Five pillars of Atmanirbhar Bharat identified are:

Self-reliance is a step closer to the globalization of the indigenous industries. For bamboos, the edaphic and climatic conditions in India are most conducive which is amply illustrated by the fact that India has the highest area (13.96 million ha) under bamboo and ranks second in terms of diversity with 136 species. Though the States of North East India is a treasure trove of luxuriant bamboo clumps, the other States are equally important in terms of the natural resource base and with tremendous scope for industries to be strengthened/set up with backward linkages to farmers and forest bamboo.

The bamboo-based industries which exist and have a huge potential in the domestic and global markets are summarised as follows:

3.1 Agarbatti

While the agarbatti industry is perceived to be a small cottage industry, export figures speak a different story. Indian Agarbatti Industry is one of the most vivacious cottage industries that
employs around 20 lakh people across the Nation. The Indian Agarbatti Industry exported its products to countries worldwide with staggering revenue that was close to Rs. 1000 crore in the financial year 2018-19. India’s Agarbatti Export Industry has shown an upward spike at a Compound Annual Growth Rate (CAGR) of 15% and is expected to cross Rs. 12,000 crore mark in next 5 years.

In 2009, the industry got a boost in India after agarbatti was classified as a handicraft product. With this change, the industry became eligible for duty drawbacks apart from being entitled to a 5% incentive under the Merchandise Exports from India Scheme (MEIS). Moreover, schemes such as Market Access Initiative (MAI) and Market Development Assistance (MDA) have come in handy to exporters in marketing their products across the globe. Indian agarbatti (incense stick) manufacturers are increasingly heading to the North East looking to source bamboo to substitute imports from other Asian nations like Vietnam and China. The North East is home to Bambususatulda (jati, mritinga) that is a species of choice in incense stick making. However, this is coming up well in other States also and hence there is a focus on bringing more area under this species since it is also preferred for many other uses also. Plantations are being raised in all States including Maharashtra, Karnataka, MP, Uttarakhand. Moso bamboo is feasible in Sikkim, Arunachal, Mizoram and HP and these States are being encouraged to raise this to the maximum.

The Indian agarbatti and dhoop industry is a highly export-oriented industry, which provides a high profit. The Indian export of agarbatti and dhoop is increasing every year, which helps in balancing the trade deficit of India. While rising exports suggest more market opportunity, observing this many of the new players are entering into the agarbatti and dhoop business. Case analysis of domestic supply versus imported raw bamboo sticks for Agarbatti was commissioned to Indian Institute of Foreign Trade (IIFT) by NBM in 2017. The report of IIFT helped in taking two important decisions for the sector namely,

i. Import policy of Agarbatti and other odoriferous preparations which operate by burning under Exim code 33074100 and “Others” under Exim code 33074900 of ITC (HS)2017 is revised from “Free” to “Restricted” in August 2019.

ii. Import duty of bamboo increased uniformly to 25% from June 2020.

These measures have given a boost to rejuvenating the traditional agarbatti manufacturing units in NER as well as other States. There has been a positive impact on the traditional sticks manufacturing units vizagarbatti clusters of Tripura have scaled up production and traditional
clusters being revived. As a result, these units are getting returns of Rs 110-120/kg as against Rs 70-80/kg earlier. Agarbatti majors namely Cycle and ITC are partnering with NBM and States proactively to convert to complete Make in India shortly e.g Cycle Brand has entered into an agreement with Assam Bamboo Mission. The traditional Kumarghat cluster of Tripura is being strengthened when the domestic production of round bamboo sticks will be stepped up further to 28000 – 30000 MT in 3 years.

Jiggat is another component which is being imported majorly. R&D projects have been given to KFRI and TFRI for increasing our own plantations of Litsea spp. Agarbatti units can have captive plantations of these species so that imports are reduced. Captive plantations by agarbatti units as well as sustainable harvesting is the need of the hour.

Keeping the competition in mind, Indian incense sticks have brought innovations such as prayer kits and aroma incense boxes that come with accessories. A set, comprising two bags of incense sticks, four bags of incense cones, a candle, and incense holders is appealing to western customers. Recently NR Group has launched an incense stick namely ‘Iris’ to suit the needs of the international customer. It comes along with African prints or pastels carrying forward the design trends of the year. Bangalore-based Mokshagarbattis too has brought in ‘better packaging and modern designs for the export market.’

Of late, there has been witnessing an increase in exports business. This is mostly because of the growing influence of Ayurveda, yoga, khadi, Indian culture, mysticism, and more. Burning an agarbatti almost immediately helps one connect with eastern culture and spirituality. This is one of the few products from India that has no competition in the international market because products from India are perceived to be premium and exclusive.

3.2 Furniture

With a population of 1.3 billion inhabitants, India is one of the largest economies in the world that has experienced remarkable development in recent years. According to CSIL, India is the 4th largest furniture-consuming country and the 5th largest furniture producer at a global level. The Indian domestic furniture market is expected to expand at a CAGR of 12.91% during 2020-24. Various furniture companies such as Pepperfry, FabFurnish, HomeTown, Urban Company, and others are creating huge demand from these online channels. Ease of doing business
policies in India is giving rise to new business investments across the country. This is believed to bolster the growth of the Indian furniture market over the forecast period.

Further, the growth of the real estate sector in India is anticipated to boost the demand for modular furniture in urban areas in India. Apart from this, rising investment in the retail sector by various national and international entities is anticipated to foster the growth of the furniture market in India. Moreover, technological advancements such as the availability of high-speed internet networks such as 4G and spiked absorption of smart gadgets are boosting the e-retail sector in India. These advancements further provide ease to the customers to buy furniture through online channels. Also, the rising number of smartphone users across the country and online shopping is encouraging the furniture industry players to introduce their products through online channels. The players such as Pepperfry, Urban Company, and others are generating significant revenue through online platforms. 100 percent FDI policy for townships and settlements development project is attracting more foreign investors in the real estate sector which increases the quality of residential apartments.

Over the past few months, the pandemic and the resultant lockdown have created disruptive trends that have altered the personal and professional lives, across sectors. From home offices, home schools, and the need for individual space to accommodate peaceful extended indoor time in a family home has given a rise to the need for multi-functional, convenient, and customised furniture that can make ‘living’ comfortable and functional. This coupled with the slowing down of international trade and the thrust in ‘local for vocal’ and ‘Make in India’, as well as a rise in e-commerce for furniture, have all further given a boost to the Indian furniture manufacturing sector.

With the changing consumer trends about design and functionality, as well as sensitivity to climate issues, bamboo furniture holds huge potential. With furniture having been identified by DPIIT as one of the critical ‘manufacture in India’ sectors, introduction to bamboo furniture designers and manufacturers to major buyers including Fab India, IKEA India, William Sonoma, Obetee. etc has been initiated. These are to be taken forward for traditional bamboo cane furniture, contemporary knock down ‘pack in a box’ furniture as well as from bamboo wood.

One of the key aspects to drive the growth of manufacturing and retail is a robust logistics and supply chain infrastructure. With the government's focus on developing a robust road, rail, and international freight network, coupled with a thrust on technology-enabled supply chain and
warehousing ecosystem, the country is set to witness rapid development in the logistics and supply chain sector. The e-commerce rise, on the other hand, is also driving the growth of the sector, with efficient last-mile deliveries, reverse logistics, and speedy deliveries that are also enhancing the supply chain networks, ensuring robust infrastructure support for a booming manufacturing sector. NBM is also working with Inland Waterways Authority of India for using more economical waterways for transportation especially outbound from North East.

3.3 Lifestyle Product

The Indian Bamboo Products Market is driven by the growing popularity of these products as a substitute for tropical timber on account of their numerous benefits. Additionally, government initiatives aimed at tackling the problem of erosion in forests and increasing awareness for the use of environment-friendly resources are further expected to propel the market during the forecast period. From artifacts to sustainable architecture, bamboo remains a favourite as it is fast to grow, low on maintenance, and has versatile potential. Rural communities engage with bamboo handicrafts, textiles, artifacts, and household utilities. Examples include Tripura bamboo silks, heritage cuisines with roasted and pickled bamboo shoots, cultural symbols like the Assamese ‘Jaapi’ (made of bamboo, cane, and palm), widely popular bamboo tree houses, machans, besides modern sustainable architectural concepts and musical instruments.

According to the Forest Survey of India (2011), more than 50 percent of bamboo species are found in eastern India, including in states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, and West Bengal. Bamboo utensils, fishing nets, jars, vases, and baskets make it a quintessential cultural tradition in the region. A popular process known as ‘Do’oBrenga’, where chicken is cooked inside the hollow of a fresh, green bamboo is popular in north-eastern states. Spicy ingredients are stuffed inside the bamboo and placed on fire for distinct flavours. Bamboo ‘sticky’ rice containers are popular in these regions. Baskets, fishing nets, storage vessels, mug-handles used in ‘Longpi’ pottery from Manipur are other uses. Touted as Asia’s cleanest village, people in Mawlynnong, Meghalaya use bins, brooms, and baskets woven from bamboo to keep its ecology in harmony. Urban uses range from facial steamers found in spas, for their traditional, aesthetic, and ecological quotients.

Because of commercial cultivation and economic utilization of bamboo as a substitute for the fast-depleting timber resources, a comprehensive program of bamboo for sectional upgradation, enhancement of employment opportunities for artisans, promotion of value-addition
through better and well-designed product development, optimum propagation and conservation, and diversifying production and processing activities through organized community action has been taken up.

Major players operating in the Indian Bamboo Products Market include Kerala State Bamboo Corporation Ltd, Epitome Bamboo wood Products, Ballarpur Industries Limited (BILT), Amlai Paper Mill, Green Gold Bamboo Tech Pvt. Ltd., Kolan India, Green Gold Bamboo Tech Pvt. Ltd., among others. Established in 1996, Uravu Indigenous Science & Technology Study Centre commonly known as Uravu is a not-for-profit bamboo-based developmental organisation that strives for rural empowerment through sustainable solutions. With an exclusive collection of more than 500 products, Uravu has a pioneering role in setting benchmarks in the bamboo industry. Though little known to the outside world, Uravu’s womenfolk are trained and equipped to create wonders in bamboo – from Masks and Lampshades to Bamboo pens and Baskets, the creativity of the artisans knows no limits! From being considered as a sustainable construction material to an essential ingredient in traditional cuisines, the versatility of bamboo can be seen from its diverse usages.

**Engineered Bamboo**

Engineered bamboo was first developed in India in 2016, at the Indian Plywood Industries Research and Training Institute (IPIRTI), an autonomous body under the Ministry of Environment, Forest, and Climate Change based in Bengaluru. IPIRTI discovered bamboo lumber and based on further testing, approved its expanded use. The Central Building Research Institute in Roorkee has also tested engineered bamboo for strength and longevity and found its potential to be promising. This has been beneficial to India’s booming construction industry that is widely dependent on teakwood and which has also needed to import timber to meet its demands. At INR 3,600 per cft, teakwood is also more expensive than engineered bamboo lumber which costs INR 2,700 per cft. This holds tremendous promise for bamboo in India’s construction sector which is experiencing a boom. With a CAGR of 15.7 percent, it is expected to reach USD 738.5 Bn by 2022. Furthermore, the Indian construction sector is expected to emerge as the third-largest globally by 2025; its output is also expected to grow at an average of 7.1 per cent every year till 2025.
Engineered bamboo is of two kinds: bamboo scrimber and laminated bamboo. Scrimber retains 80 per cent of the raw input and is used in outdoor applications while laminated bamboo retains only 30 per cent of the raw input and is primarily used indoors for surface applications or furniture. Bamboo Mat Boards, or BMB, on the other hand, a plywood-like wooden board made from layers of woven bamboo mats that have been pressed together. It is usually made of three layers of mats and is about 3 mm thick. Very resistant to pest attack, extreme climatic conditions, and fire, BMB is as durable and stable as wood-based plywood. It can be used in panelling, ceilings, prefabricated shelters, packing cases and storage bins, roofs, doors, and door panels, furniture, and household utensils such as trays and plates. BMB is also used in concrete formwork.

BMB is gaining in popularity and there are currently two BMB manufacturing factories in operation in India. China, the largest manufacturer, and exporter in the world has 16. BMB production is labour intensive and difficult to mechanise but it holds enormous income-generating potential for rural India, and particularly for women who make up most weavers. Flattened bamboo boards are increasingly in demand in the Indian Railways which is now emphasising the use of high-strength materials in coachbuilding. At present, the Railways depends on expensive imported timbers which can be suitably replaced by flattened bamboo boards.

**Bamboo Paper & Pulp**

India’s domestic paper industry is worth INR 80,000 crore. On average, Indians consume 14 kg of paper a year, a number that is expected to become 17 kg by 2024-2025. However, most of this demand is met through imports. In the last nine years, the import of paper and paperboard has risen at a CAGR of 11.34 percent in value terms, from INR 3,411 crore in 2010-11 to INR 8,972 crore in 2019-20. Under the Atmanirbhar Bharat project, India will strive towards meeting its paper demand domestically.

Bamboo has been used to make paper for hundreds of years. It is made using bamboo pulp which is a kind of paper pulp that falls between wood fiber and straw fiber in morphology and length. Since all material is pulped, waste from other industries in the bamboo sector can be effectively used to produce paper. This zero-waste approach complements the efforts towards switching to bamboo for sustainability purposes. Quite like the resource itself, the bamboo
paper is strong and has wide applications. Bleached bamboo paper is used in offset paper, typing paper, and high-grade culture paper. Unbleached bamboo paper, on the other hand, is generally applied to package paper making. Bamboo pulp and wood pulp can also be mixed to make cable paper, insulation paper, and cement bag paper.

Indian paper industry accounts for only 3.7 percent of the global paper market, with more than 800 paper mills. Of these, 25 paper mills are wood-based, 60 are agro-residue-based mills and the remaining 715 paper mills are based on recycled or wastepaper. Of the total produced in India, 70 percent paper and board are produced by the non-wood sectors of the industry, including bagasse, wheat straw, rice straw, wild grasses, etc, and wastepaper (recycled fiber). The striking absence of bamboo must be rectified so that India can not only prevent expensive imports of raw material and cheap imports of paper but also so India’s bamboo paper industry can attain its potential.

Two other changing trends are contributing to the shift towards greater use of bamboo in manufacturing paper and paperboards. First, the paper is replacing single-use plastic products like straws, crockery, and cutlery. If fashioned from bamboo, not only will these items be more durable and stronger, but also reusable. Second, the meteoric rise of the global packaging industry has mandated a switch to a more environment-friendly and lightweight material. Bamboo, due to its lightweight property, high strength to weight ratio, and high tear index is a convenient material for packaging, loading, and unloading.

Charcoal and Activated Carbon

Bamboo charcoal has widespread use in reducing indoor pollution, purifying drinking water, adjusting humidity, promoting metabolism and food circulation, in air filters, mattresses, and pillows as a deodorizer, and for certain industrial purification uses. A more environment-friendly fuel, bamboo charcoal has traditionally also been used as a substitute for wood charcoal and mineral coal. It has a calorific value that is nearly half that of oil of the same weight. Bamboo charcoal is also an efficient fuel, absorbent, and conductor with an absorption capacity that is six times that of wood charcoal of the same weight. A research pilot was undertaken by the Centre for Indian Bamboo Resource and Technology (CIBART) in Gujarat and Rajasthan also shows that charcoal collection and producing briquets from primarily solid wastes such as wood, bamboo, and agro-residue present tremendous livelihood opportunities.
Pieces of the bamboo plant harvested at least after five years are decomposed at high temperatures of 800°C to 1200°C (pyrolysis) or decarbonised to make bamboo charcoal powder. The process imparts high adsorption properties to the bamboo charcoal powder, making it useful for absorbing impurities. With its high surface area and ability to reach high temperatures (the surface temperature of bamboo charcoal can reach 700°C), bamboo is an excellent resource for charcoal.

Technological developments and the push towards a cleaner and renewable fuels are enhancing the popularity of charcoal. Charcoal briquettes compressed from biomass materials produce less ash and reduce greenhouse gas emissions. The global charcoal market, valued at USD 5.88 Bn in 2018, is projected to surpass USD 6.57 Bn by 2024, growing at a CAGR of 1.9 percent between 2019 and 2024. Asian countries, particularly China, where bamboo grows naturally are global leaders in the production of bamboo charcoal. The primary consumers are Japan, South Korea, and Taiwan but bamboo charcoal is also rapidly expanding in Europe and North America. This is for three reasons. First, bamboo grows faster and has a shorter rotation compared with tree species. Second, it has a calorific value and absorption properties like or better than those of wood charcoal. Third, bamboo charcoal is cheaper and easier to produce. Furthermore, increasing environmental awareness is driving up the demand for more sustainable alternatives. These market factors present a wide opportunity for India’s bamboo sector. Given its localised production, industrial-level manufacturing of bamboo charcoal will be beneficial to India’s MSME sector and help local economies, provide skill development, and sustain environmentally conscious subsistence methods.

Biochar

The global biochar market reached a value of USD 436.4 Million in 2018 and is projected to reach a value of USD 870.7 Million by 2024, registering a healthy CAGR of 12 percent during 2019-2024. The growing agriculture industry is one of the key factors driving the global biochar industry. Rising demand for organic farming and high crop yields due to growing populations continues to propel biochar market growth. Besides organic farming practices, biochar is rapidly being utilised in other farming practices, including zero tillage farming, biodynamic agriculture, and mixed farming, significantly impacting the market growth.

Based on technology, the biochar market is categorised into gasification, pyrolysis, and hydrothermal carbonisation. The pyrolysis segment expects to hold the largest market share.
over the forecast period owing to high yield and process stability. By regions, North America anticipates holding the largest market share over the forecast period. On the other hand, Asia Pacific is expected to exhibit significant CAGR in the coming years due to India’s and China's agriculture industry's growth.

While the forest coverage in tropical and subtropical is decreasing, the bamboo forest area is increasing. According to the International Journal of Biomaterials report in 2019 on Potentials of Biochars Derived from Bamboo, biochars from bamboo leaves is a potential energy source and be synthesised by annealing in an oxygen-free environment. Biochar in emerging and developing economies is gaining much attention. In India, conversion into biochar through slow pyrolysis is gaining importance for more effective management and disposal of the crop and agroforestry residues. A global joint venture of Fortum, Indian state-owned oil refinery company Numaligarh Refinery Limited (NRL), and Chempolis, a Finnish biorefining technology company in 2019 had performed the ground-breaking ceremony for building and operating a bamboo-based biorefinery in Assam. Aiming to use biomass more resource-efficient, the plant will use bamboo to produce bioethanol, biochemicals, and excess electricity.

Biofuel

There is an urgency to produce more renewable energy, to replace fossil fuels, especially in a developing country like India where the energy demand is rapidly growing and it has been a challenge for the government to cater to the huge energy demand for an ever-increasing population. In recent years, stress has been given to self-sufficiency in petroleum products by replacing fossil fuels with renewable resources and one of the major thrust areas has been to replace petrol gasoline with ethanol produced from biomass. Production of cellulosic ethanol from agricultural wastes and residues has been encouraged.

In line with national policy on biofuels, the government has approved ‘Pradhan Mantri JI-VAN (JaivIndhan- VatavaranAnukoolFasalAwasheshNivaran) Yojana’ for providing financial support to integrated Bio-ethanol projects using lignocellulosic biomass and other renewable feedstock, with a total financial outlay of INR 1969.50 crore for the period 2018-19 to 2023-24 can further boost the production of biofuel using bamboo. The global biofuels market size is expected to at USD 44.6 Bn by 2021 at a CAGR of 44 percent. With the government’s push to broaden the energy mix, there will be a significant increase in biofuel adoption. Bamboo
shares several desirable fuel characteristics with certain other bioenergy feedstocks, such as low ash-content and alkali index, making it an attractive alternative energy source.

There is significant interest from foreign companies who are exploring bamboo as a potential energy source. A joint venture company namely Assam Bio-Refinery Pvt Limited, the first of its kind has been incorporated with three promoters viz: Numaligarh Refinery Limited along with two other foreign companies Fortum and Chempolis from Finland. The biorefinery is based on formico-technology developed by Chempolis and the key raw material is bamboo. Further boosting the bamboo economy, a Memorandum of Understanding (MOU) was signed on 27th June 2019 between Forest Development Corporation of Mah. Ltd., Maharashtra State Bamboo Development Board, and Vtara Energy Group Private Limited. The MOU was signed to supply the bamboo/wood-based biomass to Vtara Energy Group, an Australia-based company for the 1st phase to produce 2G ethanol in the Industrial Biotechnology Hub at Mul, Chandrapur District.

Food Items

In India, even though it is the second-largest producer of bamboos after China, not much importance has been given to the use of bamboo shoots as food due to lack of awareness of the shoots’ edible characteristics. Consumption of tender shoots is confined mainly to India’s North-eastern states where they are part of the traditional cuisine. Canned and preserved bamboo shoots currently dominate international trade, and due to increased consumer demand for non-processed food, it is projected that the share of fresh shoots will also significantly increase soon.

Based on the nutritional analysis, bamboo shoots are known to be a good source of food energy and can be considered a new healthy food. It is because bamboo shoots are endowed with many health-enhancing properties. There are nearly 200 species that can provide edible and palatable shoots. Bamboo shoots can provide further entrepreneurial opportunities to communities through cultivation, processing, and packaging as value-added economic activities.

Similarly, Bamboo vinegar, a natural liquid derived from the condensation produced during bamboo charcoal production, has been used in agriculture and as a food additive. It is known to support whole-body well-being and carry anti-bacterial properties. Bamboo Rice, also known as Mulayari, is the seed of a dying bamboo shoot produced at the end of its life span. It is a major income source for tribals living in the forests, particularly tribal communities living in
Wayanad Sanctuary, interiors in Kerala. This rice is commonly not available because it takes many years for an aged plant to flower from which this short-grain rice is extracted. A study conducted on bamboo rice says that it is high in protein content than rice and wheat and hence, beneficial in joint pain, back pain and rheumatic pain as well. It is also known that for those suffering from cholesterol issues, regular consumption of bamboo rice helps lower cholesterol levels and has anti-diabetic properties too.

Quality standardisation by agencies including the BIS such as AGMARK for agricultural produce, FPO mark for food processing, Hallmark for gold and silver, etc. can lead to a better quality of bamboo food products delivered to the market. To reach more bulk buyers across the nation and globe, the food products must be registered under different B2B online platforms like India Mart, Go for Global, Trade India, and Exporters India, while online platforms like Flipkart, Amazon, Nature Baskets, and Grofers can support bamboo food products' retail growth.
Chapter 4
Promoting Exports & Global Branding

Global Production

The three main centers for bamboo production are the Asia-Pacific Region (~45% of the world’s bamboo forests), Latin America, and Africa. The UN 2030 Agenda for Sustainable Development, which took effect from 2016, and the UN Strategic Plan for Forests 2017-2030, which was adopted in 2017, set out strategic goals and action plans to alleviate poverty, develop economies and address climate change through the sustainable management and utilisation of forests. The International Bamboo and Rattan Organisation estimates the total annual output value of the global bamboo and rattan sector at around USD 60 billion, in 2017, whereas the world export of bamboo and rattan products was estimated at USD 1.7 billion.

![Global export of bamboo and rattan products in 2017](image)

Industrialised bamboo products, which includes bamboo flooring and panels, comprised the main type of export in 2017, with an export value of USD 360 million, accounting for 21% of the total. The second most popular product categories were canned bamboo shoots (19 percent) and bamboo and rattan furniture (16 percent). Although China is the main exporter of almost all individual bamboo products, the extent of its share in total world exports varies across products. Indonesia is the dominant exporter of seats and an important exporter of furniture; Italy is also a significant player in bamboo furniture. The United States is the largest market
for several of the product categories, including plywood, furniture, seats, basketwork, and plaits. Countries in Western Europe are also large buyers of bamboo products across categories. The largest importer of bamboo raw material is India (17 percent of world imports), followed by the United States and the Netherlands.

The global production of wood-based articles has been steadily rising and has exceeded the pre-2008 crisis levels to keep up with rising demand. As technological applications evolve, bamboo will increasingly be able to replace wood in many of its uses. It also has the potential to substitute for many steel and plastic products.

Global trends that impact the nature of demand

The demand for housing construction material, including wood and bamboo, and the demand for furniture are positively correlated with population and economic growth. There is a growing middle class with aspirations that could influence demand. As population and income levels increase, so does the demand for housing, home improvements, and furniture. The size of the middle class is extremely large and growing rapidly. This group has historically fueled consumption demand and could potentially be a very significant factor in the demand for bamboo and related products. Recent surveys have found that a substantial proportion of adults were willing to pay a premium for products from companies that were committed to environmentally and socially conscious practices. Bamboo plays an important role as a carbon sink: it sequesters carbon in its biomass at rates comparable to or even better than many tree species. Products made from bamboo are likely to appeal to this consumer.

Some promising examples indicate that there could be a domestic market for bamboo products based on bamboo’s eco-friendly attributes. Bamboo India, a firm based in Maharashtra, substitutes bamboo for plastic and other materials and produces products such as toothbrushes, audiospeakers, and others. The demand for bamboo toothbrushes is reported to have gone up exponentially since the 2018 ban on single-use plastic in Maharashtra. Godrej Interio, a leading...
furniture company, introduced processed bamboo in the formal furniture market in India under its green eco-friendly line of furniture, and this is being retailed through its large network of showrooms and dealers. Manasaram Architects design their projects on the principles of sustainability and climate change mitigation, by using naturally occurring, renewable, low-cost, and locally available materials. They have worked on more than 100 projects in which bamboo is the principal material and have replaced 70 percent of the steel and wood with bamboo in the construction they have designed. KONBAC in Maharashtra is a leading organization excelling in new-age prefabricated structures, having bagged projects abroad also. These examples illustrate that although the market for bamboo-based products based on the material’s eco-friendly characteristics may currently be small in India, it has the potential to expand, particularly in urban centers. It is expected to increase as incomes rise and people become more conscious about the environment and embrace sustainable products and lifestyles. However, it is to be targeted that all the feedstock and primary processed material are all sourced/processed in India and this National Bamboo Mission invites partnership to establish the required backward and forward linkages to take this agenda forward.

India’s Bamboo Production

India is reportedly home to about 125 indigenous species and 11 exotic species of bamboo from 23 genera. The total bamboo bearing area in the country is estimated to be 16 m ha. The top five bearing states are as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>Area (in million ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madhya Pradesh</td>
<td>2</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>1.54</td>
</tr>
<tr>
<td>Arunachal Pradesh</td>
<td>1.49</td>
</tr>
<tr>
<td>Odisha</td>
<td>1.18</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>1.10</td>
</tr>
</tbody>
</table>

As reported, India’s annual bamboo production potential is estimated at 3.23 million tonnes. The poor yield of Bamboo is one of the perennial problems in India. In contrast to China’s average yield of 50 MT/Ha, the maximal yield range in India lies in the range of 10-15 MT/ha since it has not till recently been ‘cultivated’ as any other agri crop. Yields are targeted to be increased by the propagation of quality planting material of the correct species and thereafter giving the right inputs like irrigation and fertilisers. It is also equally important to educate the farmers about the right processes for harvesting and sorting as per the particular use they intend.
to target. Despite being the second largest cultivator of bamboo in the world, India’s share in the global bamboo trade and commerce is low at 4 percent. NER is rich in bamboo resources. Over 50 percent of the bamboo species in India are found in NER and makeup approximately 8 percent of the geographical area of India, yet NER has approximately 35 percent of the bamboo-bearing area and 38 percent of the pure and dense bamboo-bearing area in the country.

**SWOT Analysis of the Indian bamboo industry**

- **Strengths**
  - Abundance of bamboo resource
  - Fast growing, quick returns
  - Multi-purpose species
  - Price competitiveness
  - Low investments
  - Low management cost

- **Weakness**
  - Weak data on resource base
  - Lack of awareness, knowledge & know-how for ecological oriented bamboo development
  - Lack of high quality skilled bamboo manpower
  - Lack of advanced R&D
  - Weak cross sectoral synergy

- **Opportunities**
  - Industry oriented skilling
  - Incremental market demand
  - Landscape restoration
  - Climate change mitigation
  - Suitable climate & topography

- **Threats**
  - Bamboo industry development of neighboring countries
  - Wrong notions on longevity of products
  - Comparing prices to cheaper mass produced articles (plastics etc)
  - Product substitution from wood

**Understanding China’s Strategy**

China’s dominance in production and exports can be attributed to several reasons. The country is home to more than 500 bamboo species in 39 genera, and estimates suggest that it has almost 7 million hectares under bamboo forests. China has the first-mover advantage, given that it was one of the initial countries to undertake massive industrialization of the bamboo sector. The industry in China utilizes every single part of the bamboo, with minimal waste. It transformed the supply chain in bamboo where farmers undertake pre-processing near the source of bamboo. They split the bamboo culms into parts and feed the different parts into separate product chains. The industry in China was also at the forefront of introducing new technologies in production and developing new products. Just as Germany has its mighty Mittelstand, the backbone of its economy, so China has a multitude of vigorous, (very) private entrepreneurs: a fast-growing thicket of bamboo capitalism. Around 40 Bn pairs of disposable chopsticks are made from bamboo twigs annually in China, for use with everyday meals. Steel scaffolding is still often shunned for bamboo on skyscrapers under construction in even the ritziest parts of Hong Kong. Before paper, Chinese wrote on bamboo slips; they used bamboo tubes for irrigation,
and later stuffed them with gunpowder to ignite muskets. In Shengzhou, among the most prolific regions in Zhejiang province in eastern China, about 95% of bamboo handicrafts are exported.

**Key Facts of Industry**

- China’s bamboo resources, area, growing stock, and trade volume all rank first in the world
- About 7.55 million farmers are involved directly in bamboo production and processing
- The bamboo sector is expected to value around US$ 48 billion in 2020
- China National Bamboo Research Center works actively on the promotion of bamboo products
- Chinese people have been utilizing bamboo in their traditional ways for centuries and modern technologies have further developed bamboo

**Trade trends**

According to trade data from China Customs, China’s export of bamboo and rattan products reached around USD 2.22 billion in 2018. During the same period, China’s import of the products reached around USD 31 million.

The European Union is China’s largest trading partner for bamboo and rattan products. In 2018, China exported USD 540 million-worth of bamboo and rattan products exported to the EU, accounting for 24 percent of China’s total exports. This was followed by exports to the USA and Japan, which accounted for 23 percent and 15 percent of the total, respectively. The next largest importers of Chinese bamboo and rattan products were Taiwan (China), Vietnam, India, South Korea, Australia, Thailand, and Canada, respectively.
Chapter 5
Availability of Feedstock – Management of Nurseries & Plantations

Shri RSC Jayaraj, Director Rain Forest Research Institute, Jorhat, Assam

Introduction

The global bamboo market was valued at USD 68.8 billion in 2018, expected to grow at a CAGR of 5% from 2019 to 2025, though it might have suffered some setbacks due to the COVID-19 pandemic during 2020-21. The Indian bamboo market needs improvement on many fronts to contribute to the local economy and export market. One such area that needs intervention is the supply of feedstock or raw material for industrial and domestic uses.

Though India has a large growing stock of bamboo, much of it is in forest areas. Even within the forest, it is largely in protected areas, steep slopes and catchments, and inaccessible areas. The statistics of bamboo growing stock projected consists of more than 135 species, a majority of which are not commercially useful. The productivity of bamboo in natural forests is quite low, to the extent of just is 2-3 tonnes/hectare, due to various biotic and anthropogenic disturbances. Therefore, there is a need for largescale cultivation of bamboo in farmlands, riverbanks, roadside, etc., so that quality feedstock can be made easily available for domestic and industrial use. Bamboo being a fast-growing crop can be harvested in a cutting cycle of 3-4 years and will be a source of steady income to the farmland holders. The productivity of plantations also ranges from 10 to 20 cum/ha, and there is scope for increasing this up to 50-100 cum/ha by use of high-yielding, fast-growing genotypes and also by adopting appropriate silviculture. There are examples of such improvement using selected genotypes of *Phyllostachys pubescens* (moso) in China and *Bambusabalcooa* in India. This needs to be adopted on a large scale in the case of all the plantations in the country.

Bamboo cultivation, if done as an organized plantation, can yield uniform raw material for many bamboo-based industries, such as paper and pulp, rayon, ethanol, bamboo ply, bamboo wood, particle, and chipboard, etc., which consume a large quantity of bamboo. The captive plantations for such industries, when located in rural areas, can boost the local economy and increase farm income, to a large extent.

The first step in the bamboo production system and the whole value chain is the nursery of the bamboo species, where the quality of the planting stock needs to be improved. Secondly, the
Silviculture of the bamboos needs to be followed with appropriate nutrient management, pest and disease management, harvesting procedures, and post-harvest management. These steps can increase the availability of bamboo for industrial and domestic uses, and boost the economy to a great extent.

**Improvement in the production system**

Improvement in the production system of bamboos can be brought about by various means. Though the use of quality planting material is the first step, this needs to be followed up with appropriate silviculture in the plantations. In the forest areas, which still yield the major share of bamboo in use, management of clumps by decongestion, soil working, and organic matter addition is required. The area under bamboo can be increased outside the forests by raising captive plantations linked to industries, riparian buffers, agroforestry systems, and windbreaks. Silviculture of bamboo can be further improved by raising separate plantations for poles and shoots under different silvicultural systems, as the intensity of management and extraction varies with the use.

National Bamboo Mission has formulated Guidelines for Accreditation of Bamboo Nurseries and Certification of Planting Material and are available at [Guidelines_accreditation_Nurseries_10062019.pdf (nbm.nic.in)](Guidelines_accreditation_Nurseries_10062019.pdf)

**Choice of species**

National Bamboo Mission, based on consultations with States and industry advises large scale plantations of 10 commercially important species of bamboo namely *Bambusatulda, B. bambos, B.cacharensis, B.polymorpha, B.nutans, Dendrocalamus asper, D. hamiltonii, Thyrostachysoliveriiand Melocannabaccifera*. They have their areas of natural distribution in the country, and their suitability is localized to a large extent. However, some species have shown adaptability to much wider areas even outside the area of natural distribution. The species that have been found to have country-wide planting prospects are *Bambusabalcooa, B. bambos, B. nutans, B. tulda, B. vulgaris, Dendrocalamushamiltonii, and D. giganteus*. Certain species have better prospects of growth and productive potential in selected regions of the country. For instance, *Dendrocalamusstrictus* grows well all over India in dry areas, but is not suited to wet locations; *Dendrocalamustradescantii* grows well in Karnataka and Maharashtra; *Melocannabaccifera* all over Northeast India; *Thyrostachysoliveri* in Tripura and West Bengal; and *Ochlandratravancorica* in Kerala. Among the species introduced into India,
Dendrocalamus asper grows well in Kerala, Uttarakhand, and all-over Northeast India; Phyllostachys pubescens in Arunachal Pradesh and Himachal Pradesh; and Guadua angustifolia in Kerala (Haridasan and Tewari, 2008). Many a time, the loss of productivity of bamboo plantations is due to the plantation in unsuitable areas, just keeping in mind its commercial value, ignoring its adaptability to the site.

Propagation methods of Bamboos

Though bamboos can be easily propagated using seeds, the availability of seeds is constrained by the irregular seeding habit of bamboos, at long intervals as well as source and viability, both of which would impact the yields and quality. Hence the most common methods adopted are the asexual or vegetative means of propagation. These methods include the planting of rhizome cuttings (offsets), culm cuttings, branch cuttings, or air layers all collectively known as macropropagation or using tissue culture plants known as micropropagation. Each of these methods has its distinct advantages and disadvantages. The use of seed as the source of propagules is advantageous due to less expenditure involved, the ability to produce a large number of seedlings and mainly providing information on the probable year of the flowering of the planted material, as it starts from zero age. Since bamboo dies on flowering, this information is very useful in planning the management of the plantation and its extraction. However, the disadvantages are the lack of uniformity among the seedlings due to natural genetic variability, non-availability on regular basis due to long flowering intervals, and mainly the chance of mix-up of the species in the nursery either inadvertently or intentionally, due to the similarity in the appearance of the seedlings of most of the species of the bamboos. This confusion is taken advantage of by many unscrupulous nurseries, mixing the seedlings of Bambusabambos or Dendrocalamusstrictus, which flower and seed profusely at some region or the other every year, due to distribution over large areas, with seedlings of other species that are desirable for planting or in demand. Hence it is of utmost importance that mother material is from a certified credible source. States have started accreditation of bamboo nurseries, information for which is available on www.nbm.nic.in/Accredited_nurseries.aspx

Macropropagation is advantageous due to the uniformity of the planting material produced and the ability to mass-produce selected material. However, the disadvantages are due to the large nursery space required and a smaller number of propagules produced per cycle of production. Micropropagation (tissue culture) has the major advantage of production in large numbers, besides uniformity and the propagation of selected material for which quality standards are
available. The disadvantage of tissue culture is the high expenditure, need for constant power supply, availability of trained manpower, and additional infrastructure for hardening of the plantlets.

An ideal method of propagation is a combination of techniques. Initially, the selected material can be multiplied by tissue culture to get enough base material for propagation. Thereafter, the plants can be multiplied by macroproliferation, where every third or fourth month the plants can be split into two or three plants. This can help in the production of many qualities planting stock in a shorter period compared to all the other methods.

<table>
<thead>
<tr>
<th>Bamboo seeds</th>
<th>Macropropagation using culm cuttings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue culture of bamboo</td>
<td>Tissue culture plants of bamboo</td>
</tr>
</tbody>
</table>

**Quality in bamboo planting stock**

What determines the quality of any planting stock is its genetic quality, physical quality, and physiological quality. The genetic quality is to be ensured by the selection of high-yielding, fast-growing plants from the base population. The selection has to be carried out in the areas
of natural distribution, where the variability would be high. In bamboos, breeding is not possible due to irregular flowering habit and the only way genetic superiority can be used in improving productivity is by the intensive selection, followed by testing across multiple locations of diverse environmental conditions, so that the materials that are stable across locations can be planted on a large scale. The availability of high-yielding genotypes of the priority species of bamboo with various institutes of the Indian Council of Forestry Research and Education is furnished below.

<table>
<thead>
<tr>
<th>Species</th>
<th>FRI</th>
<th>TFRI</th>
<th>RFRI</th>
<th>IWST</th>
<th>IFP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. strictus</td>
<td>24</td>
<td>34</td>
<td>-</td>
<td>22</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>B. bambos</td>
<td>-</td>
<td>27</td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>B. vulgaris</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>B. tulda</td>
<td>-</td>
<td>15</td>
<td>7</td>
<td>-</td>
<td>9</td>
<td>31</td>
</tr>
<tr>
<td>B. nutans</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>B. balcooa</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>D. hamiltonii</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

Nine out of the ten bamboo species prioritized by the restructured Bamboo Mission are found naturally in the northeastern region of the country and it is, therefore, the only place suitable for selection, except Bambusabambos and B. balcooa which are also found outside the region. Only in the case of Dendrocalamusasper which is not naturally found in India, germplasm may have to be imported from southeastern Asia, where it is naturally found. The details of the distribution of priority species of bamboo are in the table below.
<table>
<thead>
<tr>
<th>Species / State</th>
<th>Assam</th>
<th>Arunachal Pradesh</th>
<th>Meghalaya</th>
<th>Manipur</th>
<th>Mizoram</th>
<th>Nagaland</th>
<th>Tripura</th>
<th>Sikkim</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bambusabalcooa</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>B. bambos</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>B. cacharensis</strong></td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>B. nutans</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>B. polymorpha</strong></td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><strong>B. tulda</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Dendrocalamus asper</strong></td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td><strong>D. hamiltonii</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Melocannabaccifera</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Thyrostablemopsis</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

+ Available; - Not available

The physical and physiological quality of the planting stock needs to be ensured by taking samples from batches. The planting stock should have 3-5 tillers, with the main tiller having a thickness of 1 cm and at least 60 cm height after trimming, a well-developed rhizome, and hardened for 4-6 months in the nursery. Failure of many of the tissue culture plants in the field is due to planting at a young stage, without a sufficiently developed rhizome. The industries dispose of young plantlets to cut the cost of production, and this leads to heavy mortality in the field, bringing a bad reputation for the technique. The planting stock should be free from pests and diseases, and also nutrient deficiencies. The physical and physiological quality can be maintained only with good nurseries, that are maintained with adequate hygiene, nutrition, and use of organic matter and biofertilizers which bestow their benefits even after planting in the field.
Current issues in QPM in bamboo planting

There are many diverse issues that the planting programmes of bamboo are facing across the country. There are huge targets for planting, but sufficient quality planting material is not available. If planting is done with available material, which is inferior or unselected, the productivity would be compromised. For the production of quality planting material, sufficient accredited nurseries are not available, as many are in the stage of establishment and may be able to start the supply only in the next one or two years. Tissue culture plants of selected materials are mostly in the multiplication stage. Whatever tissue culture planting stock is available, in sufficient quantity with various agencies, does not have sufficient genetic diversity, and planting using them has the inherent risk of loss due to an epidemic level pest or disease problem or sudden flowering of the entire stock.

Way forward

To deploy quality planting material in the bamboo plantations, certain issues need to be addressed, both technical and administrative. Technically, more selections are required to maintain the genetic diversity of the planting stock. The existing, as well as new selections, need to be tested across multiple locations by collaborative arrangements between the research organizations engaged in the selection and the bamboo missions, which can make land available in the farmlands or forests. After testing, the clones of bamboos need to be released following the procedure for clonal release in forestry and then registered. Plantations need to be done with divergent clones in any locality.

Administratively, linkages are required to be established among the nurseries, farmers, and the industries consuming bamboo, so that bamboo farming is promoted with quality material. The research organizations and the bamboo missions should collaborate and mass-produce tissue culture planting stock, engaging the large labs available with the private sector.
Ironically, communities that grow or conserve Bamboo diversity in our country are among the poorest. One of the key reasons could be lack of adequate R&D support, tools and techniques for in situ value addition, characterization of Bamboo diversity for multiple high-value products like composites for industrial use, and diversity of bamboo-based food, nutrition, and health products.

Some of the urgent areas thus needing attention are listed here:

a) There is sufficient literature on bamboo for construction, hardboards, furniture, crafts, incense sticks, etc., though the diffusion of innovative machines to facilitate these uses is still highly limited.

b) Characterization of Bamboo diversity for High value uses such as immuno-boosting and other human and livestock medicines, nutraceutical, food, and nutrition substances like vinegar, shoot and leaf extracts, etc., needs urgent attention.

c) The use of bamboo charcoal, composites, fibres, and other derivative products in the industry, water treatment, and other industrial and environmental applications requires a major effort to analyze species, space, and season interactions with social practices of managing cultivation areas.

d) Soil conservation, fire management, and numerous other applications have been researched. But more precise location-specific recommendations need further work.

e) Folk Classification and other kinds of traditional knowledge of Bamboo have to be systematically mapped to the modern systems of classification and utilization. Perhaps new areas of fertile collaborative research will emerge through the close involvement of local communities protecting their IPRs/knowledge rights.

f) Local biotechnological, mechanical, and electronic innovations in processing bamboo for conventional as well as new applications needs focused attention to mobilize and initiate action research experiments through thousands of community-based enterprises. A few pilots here and there will not do.
g) Social science including management science applications in institution building for bamboo-based social and market enterprises, DIY knowledge databases, and other open-source multi-language, multi-media databases are urgently needed.

h) A major all India coordinated action-research and learning project to document, validate and value add in local knowledge, address unmet needs, and trigger local enterprises is needed.

i) Despite huge resources having been spent in Bamboo research, we don’t have a GIS grid-based summary of findings so that any community can figure out what is relevant for it and how can it benefit from it. A Pincode-based research utilization system is needed for the country and then for south Asia.

j) A micro-venture innovation fund of at least -1000 Cr needs to be set up to translate knowledge for and from grassroots into high-risk enterprises.

k) All the design and technology institutions may be involved in a Design and Innovation Network for Bamboo (DesIN bamboo) to develop innovative tools and processing machinery for different scales.

l) Attractive Innovation Challenge awards may be announced for solving intractable problems.

m) Dedicated incubators for bamboo-based enterprises need to be set up in tribal and other regions for promoting innovation-based enterprises.

n) Postgraduate fellowships, summer schools on inclusive innovations, and other such platforms need to be activated at tried by the Honey Bee network to address the problems which have not attracted formal R&D system adequately.

o) Cultivating ideas and capitalising the strength of innovation across sector a network of incubation centres could really help develop entrepreneurial mindset among youth. This would support startups towards sector rejuvenation and bringing new innovation towards self-reliant India with equal participation from Industry to Academia and stakeholder connect while developing future road map for bamboo-based agroforestry models.
Innovation and Commercialization in Bamboo

Shri Anubav Mittal, CEO & Co-Founder, Bio Craft Innovation Pvt Ltd

Present challenges in Bamboo sector are that of demand side. Right now, in India we do not have large consistent demand of bamboo as a raw material. Bamboo produce is a buyer’s market, which means producers do not get reasonable value for the harvest that justifies the gestation period of the plantation and windfall economic benefit once harvesting commences. Because of this bamboo has become a “subsidy crop” and desired economic benefits are not realized by the growers.

We need to create a demand side ecosystem, that in past had been tried by copying technology from China, Taiwan etc and implemented in India. But that did not work as those technologies were developed based on supply of standardized bamboo from plantation which was not the case in India. Also, our species and plant properties were different than that of what was commercialized in China. We need to use bamboo which is present in India and across regions.

To connect bamboo with industrial ecosystem, we need to identify:

a) Bamboo based products being imported into India (easy to commercialize as market exists within the country
b) Develop bamboo as a source of cellulose and other by products that are well established in the industry and presently being derived from wood or other forms of biomass.

So, following can be a possible solutions

1. Access to grants and subsidy of NBM without need for bank loan (for startups) quantum can be smaller like upto 50 lakh, example Birac BIG Grants.
2. Like BIG scheme - Involve IITs as technical cum incubation centers for giving necessary support to startup to setup and commercialize the business.
3. Create a CFC model to provide Sheds for Startups to setup the project on lease basis. This will help form bamboo cluster and unnecessary duplication of machinery can be avoided, faster implementation of idea from lab to commercial stage.
4. Connect products and Proof of concepts to industry / consumers via trade shows, govt procurement, industry focus events.
5. Each startup can generate employment of at least 20-30 people directly and support large farmer groups for their captive bamboo requirements. Since these will be new technologies, the product margin will be good and therefore more sustainable business than traditional bamboo business that have very low margins.

6. Seed Fund can be then given to more successful startup to scale further and this can be done as match grant together with Nedfi or Nabard leading the round for scaling up.

7. Facilitate Product validation, testing and patent IPR developed by the startup.
Chapter 7  
Skill Development

Skill development activities require professionals and technicians with high levels of human capital. The primary processing and processing stage engages skilled workers graduating from industrial training institutes and on-the-job training. Similarly, the nursery sector, as well as extension services, demand graduates from agricultural universities to ensure high upstream productivity. Therefore, there is a need for investment in and expansion of universities and tertiary educational institutions as well as vocational training programs. Firms need to adopt more sophisticated managerial practices to compete efficiently. Evidence suggests that upgrading managerial capabilities can result in substantial improvements in firm productivity. This can be done through SME programs on managerial training as well as facilitating the development of the market for consultancy services through the development of platforms.

One of the key objectives of the National Bamboo Mission is to promote skill development through the up-gradation of traditional artisanship and the introduction of new skills. The provisions for skill development under National Bamboo Mission include:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Incentive</th>
<th>Pattern of Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training of farmers/ artisans</td>
<td>Project-Based</td>
<td>100% Govt</td>
</tr>
<tr>
<td>Training of field functionaries</td>
<td>Project-Based</td>
<td>100% Govt</td>
</tr>
<tr>
<td>International training/ visit for exposure of NBM staff/ field functionaries including farmers and entrepreneurs</td>
<td>Project-Based</td>
<td>100% Govt</td>
</tr>
<tr>
<td>Training of Entrepreneurs</td>
<td>Project-Based</td>
<td>100% Govt</td>
</tr>
</tbody>
</table>

National Skill Development Corporation (NSDC), a not-for-profit public limited company set up by the Ministry of Finance as the Public Private Partnership (PPP) model, aims to promote skill development by catalyzing the creation of large, quality, and for-profit vocational institutions. Further, the organization provides funding to build scalable and profitable vocational training initiatives.
**State-Level Initiatives for Skill Development**

**Assam Bamboo and Cane Policy**

Under this program, skill development/training of farmers, field-level workers, and Entrepreneurs will be taken up. Appropriate training is required to be imparted to the farmers for the adoption of scientific measures (pre-and post-harvest management) for high-yielding plantations of bamboo and harvesting as per respective end utilization. These important activities are to provide resource material to the trainees and acquaint them with various farming techniques through exhibitions and demonstrations. This activity will be carried out both by the government as well as the private sector and NGOs following the National Skill Qualifications Framework (NSQF) and respective Sector Skill Councils. Training bamboo farmers on the scientific harvesting of bamboos and bamboo shoots will also be encouraged.

**Nagaland Bamboo Policy**

The State Bamboo Policy will give focus on the following areas for entrepreneur development in the State for development of Bamboo as a resource and as an industry.

- Inclusion of Bamboo in the School syllabus and as specialized subjects in college and university studies.
- Impart training and skill on bamboo-related activities.
- Identification and capacity building of entrepreneurs in Bamboo technology with the training programmes confined to the specialized area of usage.
- Appropriate policy to promote the transfer of technology and transplanting it in the region.
- Facilitate the growth of entrepreneurship skills through several means such as education and training, promoting group formation, providing supports such as funding, credit, leases, tenurial security, and consultation with people’s groups, and involving them in management committees.

**Manipur Bamboo Policy**

The resource of various Government machinery, as well as private parties, shall be extensively utilised to impart Information, Education, and Communication (IEC) on the various aspects of bamboo.

- Awareness programmes, campaigns, workshops shall be used to disseminate the various aspects of bamboos.
• A structured curriculum in bamboo to be developed. It is expected that with the thrust being given to bamboo production and manufacturing, requirements of various levels of skilled manpower will have to be met.

• The policy shall ensure that skill training set up in the State shall put in place a certificate or diploma course in bamboo. The State ITIs shall also develop required skilled manpower in the field of the bamboo industry.

• To set up a Bamboo Research Institute in the State. This institute will serve the research and development required to harness the potential of bamboo as envisaged under this policy. The Department of Forest and Environment shall set up this institute under their administrative control.

• The State shall also collaborate actively with experts and institutions (national and international) such as National Institute of Bamboo and Rattan Development, Indira Gandhi Forest Research Institute, National Institute of Design, Forest Survey of India, Central Agriculture University, Indian Council for Agricultural Research, World Bamboo Organisation, International Association of Bamboo and Rattan and other similar institutions to meet the objectives of this policy.

Maharashtra
The forest department has set up a centre of excellence for bamboo at Chichpalli, Chandrapur and artisans have received skill enhancement training on bamboo. Realising its importance and its future value, the Government has already set up a Maharashtra Bamboo Development Board in August 2016.

Tripura Bamboo Policy
Improved designs for using bamboo as a building material would be developed along with technical specifications and skills in collaboration with Indian Plywood Industries Research and Training Institute (IPIRTI), Bangalore, Building Material and Technology Promotion Council (BMTPC), the Housing and Urban Development Corporation (HUDCO), and International Network of Bamboo and Rattan (INBAR).

Product Level Support for Skill Development
The products can be broadly categorized into two groups. The first category is traditional products such as bamboo baskets; incense sticks; preserved bamboo shoots; bamboo poles used for scaffolding, fencing, and agriculture; temporary construction; low-cost housing, basic furniture; handicraft items; pulp for paper, and energy pellets. Products with hard technical skill specifications fall into the second category. These include bamboo wood, high-end
furniture, bamboo plywood, flooring and panels made from bamboo, home products, biofuels, bamboo fiber and textiles, car interiors, material for 3D printing.

**Furniture**

Furniture & Fittings Skill Council (FFSC) is a Not-for-Profit organization, intending to focus on establishing an effective and efficient eco-system for development and imparting of skills for the Furniture & Fittings industry including relevant curriculum, courses, information database, delivery system, standardization, accreditation and certification processes to enhance the employability of the Indian workforce globally.

**Construction**

- Construction Skill Development Council of India (CSDCI) aims to develop, establish, standardize and sustain Industry Competency Frameworks, Skills Levels, Occupational Standards, Build, create and deliver Capacity, Investment, and Skilling outcomes that shall meet or exceed customer expectations.
- The Centre for Green Building Materials and Technology is an Indian Non-Governmental Organisation that works to promote a sustainable way of living. Offers following bamboo-based Workshop and webinars: Sustainable Living 02 – Hands-on workshop, Scrap culture & Handicraft workshop, World Bamboo Workshop, Bamboo Application Technology, Experiencing Bamboo Workshop series, Bamboo Product Design, Bamboo Workshop for Women Empowerment, Bamboo for Disaster Housing, Bamboo in Indian Architecture.
- The Building Material and Technology Promotion Council (BMTPC) has been established to bridge the gap between research and development and large-scale application of new building material technologies.

**Handicrafts**

The prime task of the Handicrafts & Carpet Sector Skill Council (HCSSC) is to develop the skill ecosystem for the sector. HCSSC is responsible for structuring and managing the whole skill development process for the Handicrafts and Carpet sector. Offers following bamboo-based qualification packs: Bamboo Mat Weaver (aimed at training candidate's basics and techniques for the job), Bamboo Basket Maker, Bamboo Utility Handicraft Assembler (Training for cutting out and processing material to achieve quality bamboo utility handicraft)

**Plywood**

Indian Plywood Industries Research and Training Institute (IPIRTI), its objective is to undertake research, advice on standardization of wood and wood products, impart training to
improve skills, upgrade product quality and optimize production cost. Offers the following bamboo-based courses: Bamboo primary processing, Bamboo primary processing and Mat making, Preservative treatment for Bamboo, Processing of Bamboo Mat Board, Bamboo based housing system.

Others

- National Bamboo Mission has partnered with Premier institutions like National Institute of Design Bengaluru, Ahmedabad and Jorhat; North East Cane and Bamboo Development Council Assam, Rain Forest Research Institute Jorhat; Bamboo and Cane Development Institute Agartala, Export Promotion Council for Handicrafts for upskilling farmers and traditional craftsmen in tune with contemporary markets
- MoUs are in the offing with Handicraft Sector Skill Council (SSC) and Furniture and Fittings SSC under the Skill India Mission. Discussions have also been held with Construction, Retail and Beauty Wellness SSCs also
- Green Skill Development Programme aims to develop green skilled workers having technical knowledge and commitment to sustainable development, which will help in the attainment of the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), National Biodiversity Targets (NBTs). Offers following bamboo-based courses: Propagation and Management of Bamboo (factual knowledge of propagation, processing, and management of bamboo) and Value Addition & Marketing of Non-timber forest products (knowledge of various post-harvest methods of NTFPs viz. preservation, processing, drying, and storage methods)
- Agriculture Skill Council of India, ASCI works towards capacity building by bridging gaps and upgrading skills of farmers, wage workers, self-employed & extension workers engaged in organized/unorganized segments of Agriculture & Allied Sectors. Offers following bamboo-based courses: Bamboo Grower, Forest Nursery Raiser, Non-Timber Forest Produce Collector.
- Industrial Training Institute, Udaipur, offers the following bamboo-based courses: Bamboo Works (NSQF), COE-Bamboo Technology – BBBT.
- IDC School of Design at the Indian Institute of Technology (IIT Bombay) has academic programs in the areas of Industrial Design, Visual Communication, Interaction Design, Animation, and Mobility & Vehicle Design.
Chapter 8
Access to Institutional Credit

Credit is an important component for cultivation, procurement, and marketing and access to institutional credit at affordable rates would ease the practice of agriculture at the farmers’ level. Empirical evidence suggests that the output elasticity of farm credit is significant and positive; roughly every 1 per cent increase in agricultural credit producing a 0.29 per cent increase in agricultural GDP and consequently aiding increased income. Credit in the form of loans is used as working capital at the beginning of the growing season, as also at later stages of production & harvesting to purchase material inputs, prepare land or invest in farm machinery, as well for the harvest, processing, transport and to market the produce.

Regional imbalance in the disbursement of agriculture credit has persisted over the years. Despite the healthy growth achieved in agriculture credit, the disbursement discrepancies remained uncorrected. The ratio of credit to state GDP is extremely low in the North-Eastern region. Although the average credit-to-GDP ratio for the country was around 0.60 in 2013–14, in Assam, Mizoram, and Tripura, the ratio was 0.20, 0.17, and 0.16, respectively. The Eastern Region with a 14.65 per cent share in Gross Cropped Area and 8.63 per cent share in Agri GDP (2015-16 at current prices) accounted for hardly 9.47 per cent and 11.32 per cent of the total agriculture credit disbursed in the country during 2014-15 and 2015-16 respectively. The % share dropped to 8.15 per cent during 2016-17. These low ratios could reflect the limited supply of credit in the region as well as demand-side constraints, such as the low demand from firms or the ineligibility of firms for formal finance.

Constraints in Financing Bamboo growers

1. Lack of proper Record of Right
   In a security-oriented system of lending (especially in the case of agriculture credit), followed in India, the inadequate availability of collateral is considered as the major reason for low penetration of institutional credit (particularly investment credit) amongst SMF and landless farmers. Often smallholders are not able to use their holdings as collateral due to the absence of proper titles or Record of Rights (ROR).

2. Increased share of tenant farmers
   Ever-increasing urbanisation and migration from rural areas, along with fragmentation of landholdings, have accelerated the proliferation of tenant farming in the country.
3. The notion of high NPAs

Besides higher transaction costs, another reason often cited for the tepid response to agriculture loans, especially to small farms, is the prevalence of non-performing assets (NPAs) in the sector.

4. Anomalies in the Priority Sector Lending (PSL) in Agriculture

There is a substantial increase in the share of agricultural credit outstanding from urban and metropolitan branches of banks. Loan size or credit limit per borrower being allowed to be large with norms that are constantly increasing the limit is said to be taking away agriculture credit meant for farmers, that too smallholder farmers to non-farmer borrowers. With loan limits increasing, it is apparent that other borrowers end up occupying larger space in agriculture PSL.

Bamboo continues to play an important part in the development of enterprises and the transformation of rural environments. Its attributes and potential are being increasingly recognized all over the world. Rural communities with their skills evolved over centuries of usage have been putting the material to aesthetic yet functional use. The people are also a repository of traditional knowledge, which can be extremely useful in developing the sector for generating income and employment, especially in remote areas and amongst communities, which have tended to be economically and socially disadvantaged. For tribal communities and forest dwellers, ‘bamboo for living’ and ‘living with bamboo’ is still the norm, which offers an excellent entry point in increasing employment, income generation, and improving the nutritional status of the rural poor.

Strategies for Financing

1. Farmers’ mobilization

Farmers’ Producer Organisations (FPOs) help in overcoming the challenges of high transaction costs, security stipulations of loans and also support smallholders in gaining access to markets, public services, better price, etc., through collective action. SFAC also has been promoting FPOs. NABARD and SFAC with active support from state governments need to ramp up farmers’ mobilisation. 40 bamboo FPOs have been approved for formation under the new scheme of Dept of Agriculture Cooperation and Farmers Welfare in 2020-21
2. **Joint Liability Groups (JLGs)**

JLGs have proved to be the best medium for financing landless farmers, tenant farmers, sharecroppers, and oral lessees. There is a need to look at JLGs as potential stable institutions of farmers and not look at them only as institutions for a limited credit period time window. For this, investments in promoting and strengthening JLGs and system-building within JLGs are important. Such investments have happened with the women’s SHGs in the country which translated into significant SHG-Bank Linkage that led to the inclusion of the left-out.

3. **Digitisation of land records**

The computerisation of land records is primarily a facilitative process with a much broader objective. Access to computerised Record of Right (RoR) has reportedly reduced the time taken for submitting a copy of RoR to banks, which in turn, has helped the farmers in availing bank loans quickly. Banks are also able to access information on property rights by viewing/checking records, including abstracts of past transactions and RORs online.

4. **Strict adherence to target group stipulations**

There is a need to place a sub-limit about loans to tenant farmers and sharecroppers, and appropriate credit targets could be fixed for tenant farmers and sharecroppers to make this mechanism more inclusive.

5. **Infrastructure and common assets**

Access to common resources is crucial in reducing the cost of cultivation and accelerating private investment; thereby, provide better and stable net income. There is a need to fine-tune the current subsidy purveying system so that the vulnerable sections. Channelling incentives (in the form of subsidies), to SMF groups for custom hiring centres, will lead to improvement of productivity per unit of crucial inputs and improve net income of small farms.
Chapter 9
International Cooperation

Over two-thirds of the world population lives in under-developed regions where freedom from hunger and poverty has been the prime goal to attain for most of the population. Governments are continually seeking ways of making public spending more effective and more efficient, to tackle the challenges and tap the opportunities for the sustainable development of agriculture and rural areas. They are also endeavoring to provide an adequate response to the commitments assumed in global forums and to changes in the context of international competition. To advance toward meeting the goals associated with the SDGs, a set of coherent, multi-objective, effective, and efficient policies are required that are managed at various levels of intervention. The objectives of the policy should be clearly defined, recognizing that some of them may be conflicting, while others may be complementary. The challenge is to increase productivity and make bamboo farming more competitive while responding effectively to problems relating to poverty, employment, income distribution, and environmental sustainability. The strong interaction between these objectives demands coherent policies to guarantee their efficiency and effectiveness. The approaches to evidence-based policies should be strengthened, by generating and using fully and efficiently all the existing information and knowledge, including the best available evidence of what works and what does not work in the management of bamboo.

Ongoing collaborations

Asian Development Bank: ADB is working to develop Integrated Bamboo Parks to optimize utilisation of the bamboo resource of the NER to rejuvenate rural economy - connecting farmers to markets, enhance the supply of raw material to industry, and bring Indian products into both domestic and global markets. The public sector shall encourage the private players to make an investment for the major bamboo-based industries as well as ancillary units to utilise the ‘leftovers’. The ADB study on North East Economic Corridor commissioned by DEA also included bamboo. Based on this report and further discussions at NITI Aayog, DONER etc. a preliminary project report for a bamboo value chain project for NER is under discussion.

UNIDO: In a major boost to India’s cane and bamboo sector, the North Eastern Council (NEC) of India and the United Nations Industrial Development Organisation (UNIDO) initiated the Cane and Bamboo Networking Project in the northeast. It primarily targets technology issues
of bamboo processing and demonstrates modern technologies for bamboo processing to benefit artisans and small and medium enterprises (SMEs) in the region.

**Japan:** Established, by a specific law, as an independent administrative institution under the Government of Japan, the Japan International Cooperation Agency (JICA) aims to contribute to the promotion of international cooperation. To boost ties between India and Japan in the bamboo craft sector, the Project for Sustainable Forest Management Project in Tripura was initiated in 2018. Because of the significance bamboo plays in the region, strong emphasis is given on enhancing the production base and value addition of bamboo. Bamboo is an important component of the India Japan Act East Forum, discussions for which are underway.

**Way forward for India**

The approach to agricultural trade policy should encompass a mind-set to capture international demand for ‘Made in India’ bamboo produce. The policy may be structured such that the bamboo-based economy has more freedom to build external markets, which is needed to benefit from the plans to enhance production through increased productivity. Frequent and surprise closure of export windows deprives producers and agri-traders of planning long-term targets for international trade. It is recommended that a long-term perspective be adopted for bamboo export promotion and that no interventions are disabling the associated trade relationships. To facilitate small & marginal farmers to integrate with an organised marketing structure, primary retail markets nearby of their farm gates are essential. This initiative can be expected to answer the current challenge of the unorganized bamboo market where transacting small lots of marketable surpluses, at low cost evolves into a farmer collective FPO.
Chapter 10
Success Stories

Bamboo in Furniture – SangaruDesigns
Sandeep Sangaru, is a furniture designer who is an alumnus of National Institute of design, Ahmedabad. His bamboo furniture collection “Truss-me” was awarded the Red Dot Best design award – considered the Oscar of product design – in 2009. During his stint as a faculty member at NID, Sangaru happened to visit Tripura where he was visiting the Tripura Bamboo Mission to teach technical drawing to traditional craftsmen. It was here that he was introduced to look at bamboo as an integral part of people’s lifestyle. He observed that most households in the north east use bamboo for multiple uses ranging from baskets to buildings. Inspired by the simple designs and tools used to craft day to day products, Sangaru designed the triangular mono legged stool which was the basic building block of the award winning “Truss Me” collection.

A sad perception that designers like Sangaru face is the portrayal of bamboo as a poor man’s timber. Catering to predominantly European markets and Asian high-end clients, furniture designers like Sangaru are redefining the perceived value proposition of bamboo. His studio works with traditional craftsmen to blend tradition design knowledge with industrial design and changing market demand.

Bamboo in housing – Bamboo House India
Bamboo House India is a Hyderabad based pre-fab construction company that predominantly uses bamboo for construction of houses. Founded by Aruna K and Prashant Lingam, Bamboo House India is working with rural and tribal communities with bamboo-centered sustainable livelihood opportunities while promoting bamboo as a low-cost ecofriendly substitute for wood, steel, and plastic.

Bamboo is sourced predominantly from the north east where the harvested bamboo and after factory treatment, it is transported to Hyderabad where a team of trained builders, carpenters and electricians put together elements of predesigned bamboo houses. On an average, each bamboo house is estimated to generated work opportunities for approximately 100 people. Having struggled with access to finance, technical knowhow and markets initially, Bamboo House India has now done numerous housing projects predominantly in the states of Andhra Pradesh, Telangana, Tamil Nadu and Maharashtra. A couple of their unique projects include a bamboo gazebo for the US consulate at Hyderabad, a boathouse at the Google Hyderabad
office. As per the founders, claim social media (Facebook) was a major tool for customer outreach and business expansion of their social enterprise.

**Bamboo in daily commodities – Bamboo India**
Banker turned agri-prenuer, Yogesh Shinde from Maharashtra started his venture Bamboo India to reduce plastic usage by substituting simple household items with bamboo-based products. Daily usage hygiene items like toothbrushes, tongue cleaners, shaving kits, earbuds, soap cases etc that are made of plastic go unnoticed when they are being disposed on a regular basis. While staying at his village Velhe near Pune, he observed that farmers who mostly grow rice for 4 months of the year remain short of work during rest of the time. Having observed that bamboo was available in abundance near Velhe with more than 5000 truckloads of bamboo being exported to Mumbai and Pune annually, he decided to work with local artisans to create value added products out of bamboo.

Working with artisans he realized the necessity of aesthetically pleasing products out of bamboo so his initial experiment started with creating an acoustic speaker out of bamboo and a mobile docking station. As its popularity grew customers started to ask if they could get soap cases, shaving kits, makeup boxes etc. out of bamboo. Based on customer demand Yogesh and his team of artisans are adding more and more daily utility items to their portfolio of daily use products. Bamboo India’s model uniquely makes a foray into the FMCG segment where it pitches itself as an alternative to plastic for the environmentally conscious customer. Selling on eCommerce platforms and direct sales channels, Bamboo India’s, products are slowly reaching their economies of scale where their product prices are dropping to a level where even cost-conscious customers could eventually switch to bamboo products.

**Cluster based Approach**
Adopting a cluster-based approach to promote the use of bamboo and its export, the Hon’ble Union Minister for Agriculture inaugurated 22 bamboo clusters in nine states in 2020, as below:

<table>
<thead>
<tr>
<th>States</th>
<th>Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assam</td>
<td>1</td>
</tr>
<tr>
<td>Gujarat</td>
<td>1</td>
</tr>
<tr>
<td>Karnataka</td>
<td>1</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>2</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>6</td>
</tr>
<tr>
<td>Nagaland</td>
<td>2</td>
</tr>
<tr>
<td>Odisha</td>
<td>3</td>
</tr>
<tr>
<td>Tripura</td>
<td>5</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>1</td>
</tr>
</tbody>
</table>
The main items identified for development in these clusters are as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>Cluster</th>
<th>Focus Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assam</td>
<td>Ampri</td>
<td>Nursery, Plantations, Agarbatti making unit, Jewellery unit</td>
</tr>
<tr>
<td>Gujarat</td>
<td>Visdalia</td>
<td>Furniture unit, Craft Utility unit, Housing Construction Cluster</td>
</tr>
<tr>
<td>Karnataka</td>
<td>Medar</td>
<td>Market linkages for traditional Medar community</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>Bhopal</td>
<td>Charcoal / organic biochar unit, Bamboo chicks for curtains, false ceiling and yoga mats unit, Pre-fabricated bamboo structures for cottages/houses</td>
</tr>
<tr>
<td></td>
<td>Satna</td>
<td>Furniture, Home accessories, Lifestyle products units</td>
</tr>
<tr>
<td>Maharashta</td>
<td>Chandrapur</td>
<td>Handicraft unit, Treated/carbonized bamboo, Particle boards, Toothpick unit</td>
</tr>
<tr>
<td></td>
<td>Sindhudurg</td>
<td>Handicraft unit, Furniture unit, Construction purposes, Bamboo Component like nails/peg</td>
</tr>
<tr>
<td></td>
<td>Sakoli</td>
<td>Treated bamboo, Handicrafts, Furniture unit</td>
</tr>
<tr>
<td></td>
<td>Bhatgar-Sangavi</td>
<td>Treated bamboo, Handicrafts, Furniture, Agarbatti stick making</td>
</tr>
<tr>
<td></td>
<td>Walsa/Jimalgatta</td>
<td>Handicraft, Furniture unit, Agarbatti stick making</td>
</tr>
<tr>
<td></td>
<td>Pauni</td>
<td>Treated bamboo, Furniture making, Engineered bamboo, Charcoal making, Agarbatti stick making</td>
</tr>
<tr>
<td>Nagaland</td>
<td>Virzouma</td>
<td>Toothpick unit, Agarbatti Stick unit, Venetian Blinds unit, Bamboo board/tiles unit</td>
</tr>
<tr>
<td></td>
<td>NBRC Cluster, Dimapur</td>
<td>Furniture units, Handicraft units, Agarbatti Stick unit, Bamboo Treatment plant</td>
</tr>
<tr>
<td>Odisha</td>
<td>Baripada</td>
<td>Bamboo Treatment &amp; Seasoning Units, Fabric / Jewellery Making, Furniture Making Unit</td>
</tr>
<tr>
<td></td>
<td>Jeypore</td>
<td>Bamboo Treatment &amp; Seasoning Units, Furniture Making Unit, Management of Bamboo Waste</td>
</tr>
<tr>
<td></td>
<td>Sambalpur</td>
<td>Furniture Making Unit, Handicraft / Cottage Unit Incense Stick Making Unit</td>
</tr>
<tr>
<td>Tripura</td>
<td>Khash Chowmuhani</td>
<td>Bamboo bottles, Furniture, Basketry items</td>
</tr>
<tr>
<td></td>
<td>Charilam (South)</td>
<td>Basketry items, Jewellery box, Household items</td>
</tr>
<tr>
<td></td>
<td>Jogendranagar</td>
<td>Household items, packaging box, Turning product</td>
</tr>
<tr>
<td></td>
<td>Narsingarh</td>
<td>Office items, Table/ Yoga mats, Basketry items</td>
</tr>
<tr>
<td></td>
<td>Sarat Chowdhury Para</td>
<td>Furniture, Tools, Fishing rod</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>Doon Cluster</td>
<td>Furniture unit, Chopstick and skewer unit, Bamboo shoot unit, Toothbrush unit</td>
</tr>
</tbody>
</table>
References

11. https://www.thehindubusinessline.com/opinion/greening-india-by-planting-bamboo-ep/article2509098.ece#:~:text=Bamboo%20is%20grown%20in%2010%2C000%20at%2024.4%20billion
12. https://nbank.nic.in/
16. https://www.villagesquare.in/2017/12/18/konkan-farms-reap-bounty-bamboo-
25. https://www.investindia.gov.in/sector/construction#:~:text=The%20Construction%20industry%20in%20India%20is%20expected%20to%20grow%20at%20major%20ports%20(5.3%)
29. https://cgspace.cgiar.org/handle/10568/64360
31. https://www.thehindubusinessline.com/companies/covid-hit-paper-industry-on-consolidation-mode/article32356651.ece