

Building a successful Bamboo based Community: A case study of Kerala State Bamboo Corporation Limited, Kerala, India

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ABSTRACT : As a country, India is extremely diverse in its bamboo varieties having around 140 species and being second in the world only after China. Bamboo products are appropriately considered eco-friendly due to their intrinsic characteristics of being biodegradable and being derived from a renewable natural resource base. The bamboo mat making initiative of Kerala State Bamboo Corporation Limited (KSBC) known for building a successful bamboo community based on *Ochlandra travancorica* (Bedd.) Gamble, the commonly found reed bamboo in Kerala, India is described. Among the various bamboo products, bamboo mat making is one of the oldest value-added product combining traditional wisdom and utility. The different stages involved in bamboo mat making, challenges faced and possible solutions are outlined. Other parallel aspects like making bamboo boards from bamboo mats and bamboo waste management have also been dealt with. The paper also highlights the potential of value-added products made from bamboo as a commercial green product with multiple applications that may have a significant impact enhancing local economy and upliftment of the indigenous tribal communities of the region.

Keywords: Kerala State Bamboo Corporation Limited (KSBC), *Ochlandra travancorica*, Bamboo mats, composite material, value addition, local communities.

INTRODUCTION

Bamboo plays an important role in climate change, environment and land restoration programmes as well as biodiversity conservation. Kerala has around 11 varieties of thin-walled bamboos under Genus *Ochlandra* (called reed bamboos) which are used mainly for weaving purposes by the traditional artisans (Koshy, 2011). In this study, we have explored the process of Bamboo Mat Making (BMM) using a commonly found reed bamboo, *Ochlandra travancorica* (Bedd.) Gamble as an initiative taken up by Kerala State Bamboo Corporation (KSBC) Ltd. by involving local people KSBC. Its main focus initially was on the utilization of Bamboo-Based Technologies to make value-added products like bamboo mats, bamboo boards, bamboo strip boards, etc. There by improving livelihood opportunities of significant number of people. The report by National Mission on Bamboo Technology has estimated revenue of 3,46,92,10,750.00\$ from bamboo and bamboo-based products in 2003. The nuances of Bamboo Mat making using a commonly occurring bamboo reed *O. travancorica* (Bedd.) Gamble in the Angamali region of Kerala by Kerala State Bamboo Corporation (KSBC) Ltd. involving local communities to produce value-added bamboo products that are economically beneficial has been explored in this study. The indigenous tribal communities who live amidst thick verdant tropical wet evergreen forests of Sholayar with flowing water bodies have also evolved traditional bamboo management practices that ensure the continuous supply of bamboo as well as contribute towards conservation and sustainable management of bamboo resources of the region (Gopakumar *et al.*, 2013). The fast flowing Chalakudy river has its

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origin in Sholyar located in the Western Ghats which is also where *O.travancoricais* found in abundance. At Idamalayar region in upstream areas of Sholayar they form dense canebrakes on either side of streams and water bodies (Muraleedharan *et al.*, 2006). This bio resource is found mostly at elevations of 1,500 MSL in moist deciduous and semi-evergreen forests typically in the Western Ghats region of India (Anon, 2014).

KERALA STATE BAMBOO CORPORATION - HISTORY AND BACKGROUND

The industrial sector in Kerala has been stagnant since 1970 and plagued by several malaises like weak inter-industry linkages, power shortage, a high unit of cost of production, restive labour force as well as high price of land. This was not conducive for investment by private entrepreneurs (John *et al.*, 2007). It was a struggle for artisans craftsman who thrive only on their traditional occupation to get the employment opportunity just to meet basic survival needs. State Bamboo Corporation (KSBC) Limited established by the Government of Kerala (Fig.1) has its headquarters at Angamali in Ernakulam district had a mandate to support and uplift the bamboo weaving and reed cutter communities as well as other traditional workers dependent on bamboo resources. KSBC Ltd. is recognized as a nodal agency to co-ordinate the bamboo sector and to cater to the needs of about a lakh of traditional workers in this sector with a capital base of about 12,48,615.00\$. Its main activity involves the collection of good quality reeds from reserve public forests and distributing these reeds to the registered mat weavers of the Corporation and other stakeholders on normal as well as credit basis. They procure woven mats from these weavers at pre-determined rates. Being lightweight, bamboo mats can be easily transported and has hence been utilized for building traditional bamboo houses and small huts in villages for centuries in India (Muraleedharan *et al.*, 2004). KSBC Ltd. has an expansive infrastructure to accommodate the demands of bamboo mat production with four Feeder /Primary processing Units being operated in Palakkad, Kadampuzha, Mananthavady, and Nadapuram in Kerala. Besides this there are fifteen mechanized Community Mat Weaving Centres (CMWC) distributed in Trivandrum and Ernakulam districts at various Panchayath /Municipality levels.

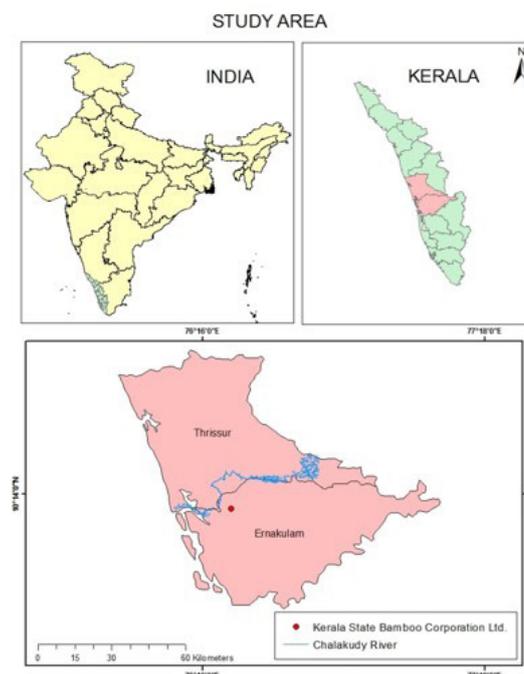


Figure 1: Location map of Kerala State Bamboo Cooperation (KSEB) Ltd. Angamali, Kerala

KSBC has traditionally focussed only on *O. travancorica* as its main bio-resource for mat making due to ease in availability and suitability. This is abundantly available in the Vazachal-Sholayar belt in Angamali, where in the Head Quarters of Kerala State Bamboo Corporation Ltd. is located. It is also commonly referred to as elephant grass and locally called 'eeta' in the region (Muraleedharan *et al.*, 2006). The traditional local community involved in mat weaving in KSBC are largely non-traditional and non-tribal communities whereas the indigenous tribal communities are engaged as bamboo/reed cutters. Some members of the traditional weaving community in Kerala even have considerable experience in making a different and traditional high quality of bamboo mat, known for perfect weaving pattern and polished surface well known as 'Kannadipanambu' (Mirror mats) which is a highly skilled craftsmanship. From basic mat weaving, KSBC has implemented modern technologies to come out with innovative engineered Bamboo products. KSBC also receives support from research institutions like IPIRTI Bangalore and IWSST Bangalore, who have been the backbone of R & D support for KSBC.

Value added Bamboo based products of KSBC

Besides bamboo Mats and Bamboo Mat Based product, KSBC has diversified into manufacture of Bamboo Mat Board (BMB), bamboo ply board and Bamboo Flooring Tiles (BFT) over the past few decades. BMB comprise of several layers of woven mats fused together is a panel consisting of an assembly of piles of bamboo mats/sheets bonded together in the direction of the plane in alternate piles at right angles. An adhesive consisting of phenolic resin is used for bonding of these sheets (Gonzalez *et al.*, 2001). Bamboo ply boards are extremely high in binding strength, modulus of rupture (MOR) and Modulus of Elasticity (MOE). It probably ranks as the highest among all of the structural boards and is considered even as good as solid wood of high-density commercial timbers. The end product has physical and mechanical properties at par with waterproof plywood (Malanit *et al.*, 2009, Li and Shen, 2011). Recently KSBC Ltd has ventured into making Bamboo Mat Veneer Composites (BMVC), Bamboo Mat High-Density Panel boards which are the future of the home interior markets and considered as lifestyle products by the new generation. Bamboo composite material such as Bamboo Fibre Boards and Bamboo ply: Composite material have excellent internal bond strength, resistance to fungal decay and insects and termite attack which are also are durable and exceptionally flexible building material making it an important component for utilization in flooring, walls, roofing, concrete reinforcement, and scaffolding.

Bamboo Mat Making (BMM) process at KSBC Ltd.

Bamboo mat Making is an intricate process involving multiple stages (Fig.2) including harvesting, cross-cutting and splitting, removal of knots from bamboos, treatment of mats, hot pressing and finally weaving of bamboo mats. The waste generated from the process needs to be discarded appropriately and needs special attention by itself. Being light in weight they can be easily transported. Over the years, bamboo mats have been regularly utilized for building mud houses and small huts in villages (Fig.3)

I. Harvesting bamboo: Experience plays an important role in the selection of suitable clumps for harvesting to make quality bamboo products. Typically, *O. travancorica* bamboo is harvested from upper riparian forests on either side of River Chalakkudy by bamboo dependent tribal communities having a special permit from the Forest Department (Muraleedharan *et al.*, 2006).

II. Splitting of bamboo: Using a splitting machine, the bamboo pole is fixed longitudinally in front of the set of splitting knives and a mechanical pushing device pushes the bamboo over the knives to produce splits of a uniform size. The size varies from 10 mm to 15 mm depending on the species diameter

and quality of bamboo. The strips are then air-dried either in a shaded area or in artificial ventilation. This process reduces the moisture content in strips to 30 percent

III. Knot removal: The outer green epidermal layer of the bamboo strips need to be removed. This is done either manually with a sharp knife or mechanically with a knot removal and width-sizing machine. Further, the strips are again taken for drying to reduce the moisture content to 15 percent. Post drying, bamboo slivers of desired thickness, length, and width (2cm-4cm). Now it is sliced to get bamboo slivers according to desired thickness

IV. Mat Weaving: The slivers are then used to weave mats. The three most common sizes of the mats produced by KSBC Ltd. are 250cm x 125cm, 180cm x 125cm, and 180cm x 150cm. There are two common weaving patterns followed viz. the herringbone pattern (45 degrees) and the rectangular pattern (90 degrees). The nodal portions are retained in species with short internodes, such as *Dendrocalamus strictus* (30cms) whereas in species with long internodes such as *O. travancorica* and *Melocanna baccifera* (50 to 100cms), the nodal portions are removed (Seethalakshmi *et al.*, 2008). Further, typically the slivers of long-internode species, such as *O. travancorica* are thicker than those of short-internode species such as *D. strictus*. Although both species are suitable for mat making, about 40 percent resin is required for bonding mats made of *D. strictus* and other similar short-internode species. The mats are dried either in the air or in a drier and stored undercover. The mats can be stored safely for 3 to 4 months in well-ventilated locations with low relative humidity or negligible changes in humidity. This is an essential step else chances of fungal or insect attack increases drastically as the relative humidity increases. Prophylactic treatments are for a longer storage period while spraying of one percent boric acid and borax mixture for a shorter storage period. Spraying is the simplest and most effective treatment for mats and can be done with a hand sprayer or a knapsack sprayer. Alternately, the mats can be soaked in the solution for about 10 minutes. Mats are re-sprayed once every three months and checked fortnightly for any signs of fungal growth and borer attack. To avoid with the ground and it is stored on wooden pallets of 12 to 18cm (4 to 6 inches) above ground level.

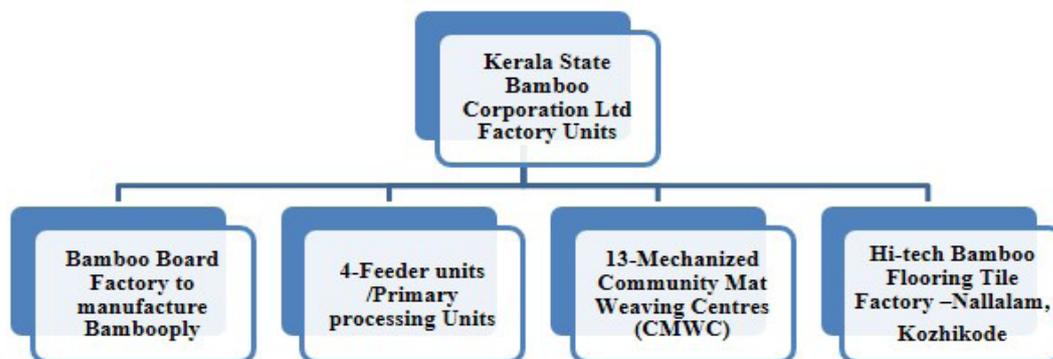


Figure 2: Different factory units of Kerala State Bamboo Corporation Ltd

V. Bamboo Mat Boards (BMB): Bamboo Mats are assembled in a multi-layered manner to the desired thickness and further sent to the gluing process (Li *et al.*, 2004). Hot pressing: This procedure helps in stronger binding by melting the resin in the mats thereby creating stronger bonds. The assembled mats are first loaded on the hot press. Parameters like pressure, temperature and time duration are set based on requirement and the mats are pressed. Subsequently, depending on storage period appropriate treatments are given.

VI. Cutting/Trimming: The next stage includes Trimming/ Dimensioning/ Cutting to size, sanding and surface coatings or lamination. Bamboo mat boards are then tested for conformity as per IS: 13958, 1994, specification for bamboo mat board for general purposes (Indian Standard) before it is transported out. Usually Bamboo boards available in different sizes like 6x4, 8x4, 6x5, also it can have variable thickness 4mm, 6mm, 9mm customized dimension products manufactured on- demand.

SOCIO-ECONOMIC IMPACTS OF BAMBOO MAT WEAVING

A brief survey on socio-economic factors and their prospects at KSBC Ltd. shows that source of Bamboo reeds from 70% forests and 30% from the riparian region. Wages paid for the harvesting of each reed costs about 0.21\$ per reed. When it's done in bulk charges will be less. Transportation charges vary from the point of raw-material collection to the destination (KSBC Ltd.) The mat weaving artisans are normally engaged based on the supply of raw material. All mat Weavers are provided with training and by practice the skill is made perfect.

KSBC pays 86\$ (35INR x100) for procuring Bamboo reed from collectors and then give it to the artisans/weavers. Around 3 to 10 mats can be done per person per day of various sizes. Approximately if they work in a regular shift for twenty days per month, they can potentially earn 84\$ to 277\$. This is equivalent to about 1000\$ to 3,334\$ per annum per person (for weaving 270 to 3600 mats per year). This shows the potential in income generation which contributes to achieving better per capita income without spending much more fees on qualification certificates and avoiding exposure to hazardous environment involved in actual collection process of raw material.

However, since the material is supplied at a subsidized rate to weavers by KSBC, it is estimated that 11,874,500\$ loss is occurred (1970 to 2019). KSBC sells 100 reeds to the KSBC weavers just for 4.86\$ whereas raw material procurement itself costs about 29.17\$. Kerala state government is nurturing KSBC at all events of fund crisis as of now since it has a very distinct social and employment generation linkage The manufacturing cost of a 4mm thickness bamboo mat board 6x4 size is 20.84\$, which is sold at the loss of 13.89\$. It is estimated that considerable losses in the manufacturing process can be offset by using the cashew resin as a natural adhesive (an easily available local resource) the manufacturing cost can be reduced for the similar dimension bamboo fibre board by 9.73\$.

KSBC provides equal employment opportunities for all types of categories of the society like (i) Scheduled Castes (ii) Scheduled Tribes (iii) Backward (iv) Religion Minorities etc. Administration and managerial posts were directly filled through standard recruitment procedures of Kerala state government. There are numerous skilled factory workers/unskilled factory workers required working selected and many bamboo cultural events like exhibitions and fairs since decades, thus spreading indigenous art and skills across the nation.



A: Harvested bamboo culms brought to KSBC



B: Storing of bundles of *O.travancorica*



C: Weaving of bamboo mats by bamboo slivers



D: Woven mats kept for drying under shade



E: Adhesive application to treated and dried mats to make bamboo boards



F: Ready to use bamboo boards loaded to trucks for transportation

Figure 3: Bamboo Mat and Board Making process at KSBC Ltd., Angamali



Figure 4: Waste generated during the bamboo cutting and splitting

Future areas of operation

There is vast economic potential in bamboo mat making, but its contribution to the rural livelihood opportunities of women is often under estimated (Lynser *et al.*, 2014) Bamboo Fiber board making is a recent venture by extracting bamboo fibre using a crushing machine and using cashew resin as binding agent in specific proportion and moulding it into the desired dimension. It is observed that lifestyle products like Bamboo Furniture and innovative Bamboo Handicrafts are premium products in demand by the newer very innovative design are already available in market and online outlets. Recently KSBC has embarked on an ambitious project to make Bamboo logs/bamboo timber in round/split/composite form to help build flood-resistant infrastructure in an innovative Bamboo Based Housing System (BBHS). This is considered as a good replacement for wood infrastructure (Rogerson *et al.*, 2016).

Evolving clean solutions from Bamboo Waste

Lots of bamboo biomass is available as green and dry waste generates at various stages in processing from raw material till it becomes an end product. Disposal mechanism differs according to the type of waste generated. The amount of waste generated from the process ranges from 500 to 1700 kg per day in the bamboo mat process of KSBC everyday and needs to be disposed of appropriately. Waste is generated from the leaf litter (Fig. 4A), twigs shavings (Fig. 4B) and bamboo sawdust (Fig. 4C). This waste need not necessarily be disposed in an unscientific hazardous way and instead can be utilized in several innovative ways like in making Bamboo-Polymer Composite (Bamboo Plastic Composite). Another alternative is the use of certain wastes for Biogas production (Arisutha *et al.*, 2016). At KSBC Ltd. currently, the waste generated is incinerated within factory premises based on a standard protocol. Bamboo waste can also be used in Bioethanol production (Littlewood *et al.*, 2013) cleanenergy production (Truong *et al.*, 2015) Eco-friendly recycling possibilities like these mentioned are being explored.

CHALLENGES FACED BY KSBC

KSBC Ltd. is one of the few communities based non-profitable bamboo organization committed to empowering people using traditional knowledge in the country. The initiative by itself is an extremely tedious effort with many challenges. Some of the critical challenges which have been identified include;

- **Man -Wildlife conflict:** While selecting and harvesting the raw material from forest region, the local tribal communities are often exposed to wild pachyderm attacks. There are also challenges by way of close encounters with venomous reptiles like Malabar pit vipers found abundantly in bamboo forest and also having to deal with blood sucking leeches. Proper training to workers about animal behaviour along with adequate safety gear and precautions may enable them to address these issues.
- **Transportation issues:** The harvested bamboo reeds must be transported to KSBC facility without any physical damage in this steep hilly terrain. This is especially difficult as damages can occur at various stages either during harvesting, collection, transportation and final destination. Adequate care should be taken to ensure the least damage during various stages to fetch premium prices.
- **Bamboo product Preservation:** Bamboo mats are susceptible to fungal attacks in the initial stages due to high moisture content and unfavorable climatic conditions. It is essential to take extra care during this stage of bamboo mat making. Subsequently, mats need to be treated and stored under dry conditions with adequate air circulation to avoid fungal infestations at later stages too which entails lot of expenditure and time.
- **Frequent occurrence of natural disasters:** Floods and landslides which hit Kerala during 2018 and 2019 has resulted in a lot of human casualties and changes in land use patterns have become apparent (Vishnu *et al.*, 2019). Balancing the continuous supply and demand ratio appears to be a high-risk issue due to frequent disasters in ecologically fragile zones of Western Ghats where the bio-resource is currently being sourced, especially in upper Sholayar region of Western Ghats.
- **Social and cultural issues:** In the digital revolution new generation age, the quality of life of the work force engaged in this activity has become a sensitive issue (Arumae *et al.*, 2017). The biggest challenge in the bamboo sector is to assess the quality of life of the workforce and to retain them in this traditional sector giving ample opportunities for quality enhancement of lifestyle of artisans and stakeholders. Expectations for a better learning platform and securing best rewards for the role they perform is being increasingly articulated.

CONCLUSIONS

Uninterrupted supply of raw material without depletion of the natural resource base remains a major challenge for KSBC. Rising labor costs and limitations in sourcing the raw material and seasonality of the products are additional challenges. There is also no denying the fact that current production levels are much below the capacity of KSBC Ltd. primarily due to a scarcity of raw material. This is primarily because despite having a favourable agro-ecological region in the vicinity, apart from natural occurrence in wet evergreen forests, *O. travancorica* is still not grown at a plantation level (Sijimol *et al.*, 2016). There is also a need for a mechanism to identify a suitable market for promoting the sale of value added bamboo products both at the domestic and the international level. Utilization of strategic human and material resources, anticipating the mobility of the workforce with focus on providing job security, remains a major challenge at management level in KSBC.

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