HANDICRAFTS ASSOCIATION
OF BHUTAN

COMMUNITY-BASED SUSTAINABLE BAMBOO ENTERPRISE DEVELOPMENT (CBS-BED)

An innovative approach
to rural livelihood

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BAMBOO RESOURCE ASSESSMENT & PRODUCT DEVELOPMENT OPPORTUNITIES

Status I Diversity I Uses

LOWER KHENG
ZHEMGANG DZONGKHAG

PROJECT SNAPSHOT

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Contents

Acronyms

RGoB	Royal Government of Bhutan
HAB	Handicrafts Association of Bhutan
DoFPS	Department of Forest and Park Services
CBS-BED	Community-based Sustainable Bamboo Enterprise Development
C-BEG	Community-based Bamboo Enterprise Group
D-PEC	Dzongkhag Project Advisory Committee
INBAR	International Network for Bamboo and Rattan
NWFP	Non-Wood Forest Products
GEF	Global Environment Facility
SGP	Small Grants Programme
UNDP	United Nations Development Programme
NTFP	Non-Timber Forest Produce
CF	Community Forest
SFD	Social Forestry Division
SFED	Social Forestry and Extension Division
ToR	Terms of Reference
UWICER	Ugyen Wangchuk Institute for Conservation & Environmental Research
CSO	Civil Society Organisation
HH	House Hold

1. Executive Summary

Bhutan is home to 34 bamboo species, out of which 21 are recorded in Zhemgang Dzongkhag alone (RGoB, 1997). In order to ensure the sustainability of the CBS-BED project, an exhaustive bamboo resource assessment was carried out in the five gewogs of Ngangla, Phangkhar, Goshing, Bjoka, and Trong in Zhemgang. The survey covered 442 households which grow bamboo in homesteads, seven CFs, and five NWFP groups.

The study revealed that 16 species of bamboo are grown in the selected clusters. Of this, eight species are grown in homesteads: Bambusa nutans Wall. ex Munro, Bam-busa alamii Stapleton., Bambusa clavata Stapleton., Bambusa tulda Roxb., Dendrocalamus hamiltonii Munro var. hamiltonii, Dendrocalamus sikkimensis Oliver., Dendrocalamus strictus & Phylostachyum nigra; two species in community forests: Neomicrocalamus andropogonifolius (Griff.) Stapleton & D. hamiltonii; and six species in the NWFPs managed areas: D. hamiltonii, N. andropogonifolius, Psydostachyum ploymorphum Munro, Chimonobambu-sa callosa (Munro) Nakai., D. sikkimensis, & B. clavata. Bambusa alamii Stapleton. and Bambusa nu-tans Wall. ex Munro are common in lower Kheng while, in upper Kheng, the people have started plantations of Bambusa alamii Stapleton. Bamboo is harvested from the fifth year onwards.

There are around 817.71 truckloads of bamboo stocks, with ages ranging from one to four years, in the target gewogs. The estimated total excludes bamboo grown in the SRF land which is not possible to count within the scope of this project. However, the study indicates that it is feasible to establish a bamboo-based enterprise in Zhemgang with the diversity and quantity of the existing bamboo species.

According to a case study carried out by a Guwahati-based Indian Company ESES Bio-Wealth Pvt. Ltd, B. alamii, B. nutans, B. clavata, D. hamiltonii, & D. Sikkimensis can be used for the production of bamboo mats, toothpicks, furniture, and other household items. Likewise, Bambusa bambos (L.) Voss can be used to manufacture bamboo ply-board. However, the production of bamboo ply-board and corrugated sheets involves high-tech equipment with substantial investment.

Zhemgang Dzongkhag is traditionally known for cane and bamboo works and produces various handicrafts for household use. However, the communities have not explored opportunities to diversify the products and still use very old tools and equipment which reduce productivity and increase the price of the end product. The rural communities also lack access to market information and knowledge on product development. For instance, there is a huge demand for bamboo scaffolding and flagpoles within Bhutan but these items are currently imported from India. Bambusa nutans and Bambusa clavate are highly recommended for use in the construction industry and are widely available in the district.

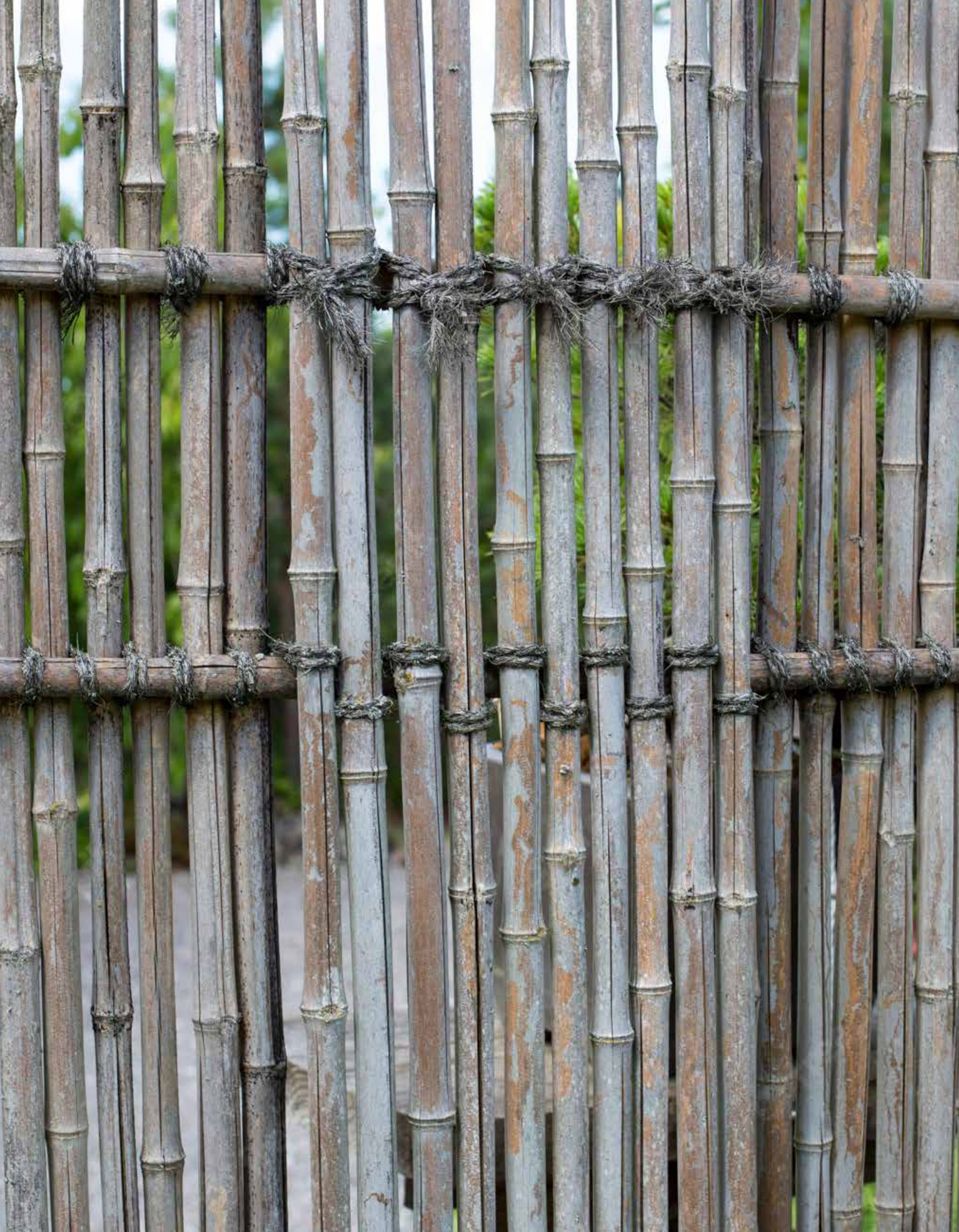
HAB has studied the current market trends within the country and in India, and recommended 14 product lines and machinery for the C-BEG and communities willing to take the initiative to establish bamboo enterprise.

2. Introduction

Bamboo is a non-wood forest product (NWFP) internationally acclaimed as the green gold of wilderness. The plant absorbs enormous amounts of greenhouse gases and, because of its rapid growth, is very useful for carbon sequestration. Bamboo is also referred to as a poor man's timber and is widely used as raw materials for handicrafts, textiles and construction, among others, providing economic security to the rural communities. Recognizing this immense potential to benefit rural communities, HAB has initiated the CBS-BED project in Zhemgang Dzongkhag with support from GEF-SGP, UNDP Bhutan.

The main purpose of the CBS-BED project is to address rural poverty and gender inequity by creating a high-value community-based bamboo enterprise in lower and middle Kheng. In order to get an in-depth knowledge about the potential economic opportunities, a comprehensive feasibility study was necessary to assess the existing resources, knowledge, skills, technology, and product development opportunities. The assessment was subsequently carried out in three gewogs of lower Zhemgang and one gewog in middle Kheng, covering 442 households, seven CFs, and 9 NWFP groups.

Zhemgang has a long history of bamboo utilization. However, the district still lacks market-oriented product diversification and appropriate technology to process the raw materials for the construction industry and handicraft manufacturing sectors. Therefore, to provide a potential solution to a sustainable, green, and community-based environment-friendly enterprise development, the HAB has conducted a detailed study on the existing technologies for bamboo processing, market research, and product diversification opportunities by benchmarking with bamboo product manufacturing industries in India.



3. Purpose of the study

The main intention behind carrying out the study was to get a true grasp of economic opportunities in the grassroots communities in terms of resources, knowledge and skills, appropriate technology, and market to establish a high-value bamboo-based enterprise in Zhemgang.

The specific objectives of the study are to:

1. Study bamboo species diversity in homestead, community forest (CF) and NWFPs managed areas along the Tingtibi-Panbang Highway;
2. Study the potential quantity of culms of different ages available for extraction in the project's target area;
3. Assess the potential volume of culms at different intervals available for harvest, consumption, and product processing.
4. Map potential products for diversification and development such as toothpicks, ply-board, bamboo cane furniture, etc.
5. Study current practices of bamboo utilization by species in the project area;
6. Benchmark product development process and appropriate technology for the CBS-BED project.

CBS-BED Project Area

4. Methodology of the Study

Prior to carrying out the bamboo resource inventory, a Dzongkhag Project Advisory Committee (D-PAC) - a multi-stakeholder project management committee chaired by the Dzongda of Zhemgang – was constituted. Based on the support and guidance from the D-PAC, bamboo resource assessment areas were identified and established by working in coordination with the extension office of Royal Manas National Park (EMNP), Jigme Dorji National Park (JDNP), and Zhemgang Forest Division. Together with the local communities, five clusters in three gewogs under Panbang Drungkhag, Zhemgang, and four clusters in middle Zhemgang were accordingly prioritized to carry out the resource assessment. The following criteria were used for the area selection:

1. Availability of naturally grown bamboo resources;
2. Availability of CFs and NWFP user groups;
3. Number of HHs growing bamboo in homesteads; and
4. Access to motor roads.

The specific communities and groups covered for the bamboo resource assessment are as follows:

1. Lower Kheng region - Thinleygang and Sonamthang from Ngangla gewog, Lamtang and Budhazhi from Goshing gewog, and Pantang from Phangkharg Gewog. These gewogs fall under Panbang Dungkhag and are commonly called Lower Kheng.
2. Middle Kheng region - Gomphu, Subrang, Zurphey, and Tshanglajong under Trong gewog.

In total, the bamboo resource assessment covered 442 households, seven CFs, nine NWFP groups as shown in table 1 below:

Literature review:

Several works of literature, government reports, and research works carried out by different individuals and institutions were referred to determine the kind of bamboo species available in the project area. Besides, to find out current utility practices in the project area and benchmark the best practices, extensive internet research on bamboo product development opportunities and suitability of bamboo species, and appropriate technologies use by bamboo industries in India were carried out.

Focused group discussion:

In order to ascertain livelihood benefits and knowledge on bamboo resource management, focused group discussions were held in each selected community represented by a minimum of 10 households in each sample cluster village who have good local knowledge of bamboo cultivation. It also provided a platform to map households with bamboo in their homesteads, issues and challenges in availing permits, product development, marketing, and transportation. The focused group members were also briefed on the purpose and objective of the study by bamboo expert from the Social Forestry Division, Department of Forest and Park Services (SFD/DoFPS). The questions asked for discussion are as follows:

- Do you have bamboo plantation on your private registered land/ CF?
- What species planted in it?
- How many clumps of different species?
- For what purpose do you use your bamboo?
- Where do you sell your bamboo culms?
- What is an annual income earned from sale of bamboo?
- What is your land holding size?
- How many acres of land are not suitable for agriculture work?
- Any other comments

The datasheet for recording bamboo resources was divided into two sections: one, a general information of the plot, and the other bamboo data. The table of bamboo data was designed to record

a detailed information of clump number, bamboo species, clump circumference, young stem (up to 1 year old), juveniles (1-2 years old), adults (2-4 years old), and old stems (5-6 years old). This design was meant to gather complete information on the ages of different bamboo species.

Data collection

To record the number of culms by age groups and species diversity, 56 enumerators were selected from the locality. The enumerators were thoroughly briefed on the data collection process and imparted practical knowledge, with demonstrations by a bamboo expert, on how to identify bamboo species and culms age. They assessed 14 bamboo clusters in the project area. The criteria used to identify bamboo culms age are as follows:

- Culms without branches and attached sheath were considered as less than one year old;
- Culms branched with prominent white rings above nodes and little waxes on the stem were considered as more than one year old;
- Culms with branches from the base with dark green and faded white rings above nodes were considered more than two years old;
- Culms with lichens growing on it were considered as more than three years old.

The datasheet for recording bamboo resources was divided into two sections: one, a general information of the plot, and the other, bamboo data. The table of bamboo data was designed to record a detailed information of clump number, species, clump circumference, young stem (up to 1 year old), juveniles (1-2 years old), adults (2-4 years old), and old stems (5-6 years old). This design was meant to gather complete information on the ages of different bamboo species.

5. Scope of study

The main purpose was to study the economic viability of starting a community-based sustainable bamboo enterprise (CBS-BED) focusing on the availability of resources, knowledge and skills, appropriate technology, and market. The five thematic purposes of the study are:

1. To assess the bamboo species diversity and quantity by age groups – one to four years in homestead, community forest (CF), and NWFP-managed areas within the CBS-BED project area;
2. Map community knowledge and skills in bamboo resource management and utilization practices in the project area;
3. Study suitability of bamboo species for manufacturing toothpicks, ply-board, and bamboo furniture;
4. Explore opportunities to diversify bamboo handicraft products and recommend ecologically and commercially viable products; and
5. Recommend appropriate technologies that are user-friendly and economically viable.

6. Out-put of study

6.1 Bamboo species diversity in Homestead

Apart from bamboo species which are abundantly grown in the state reserved forest (SRF) lands, CFs, and NWFP-managed plantations, the people in the target areas grow eight species of bamboo in their backyard, on the edges of farms, in marshy areas, and in places prone to soil erosion. The varieties of bamboo species found in the homestead are shown in table 2 below:

Table 2: Bamboo species diversity in Homestead

Sl.No	Bamboo Species	Local name	Cluster
01	*Bambusa nutans Wall. ex Munro*	Sai	Thinleygang, Sonamthang, Lamtang, Budhazhi, Pantang, Gomphu. Subrang, Zurphay, Tshanglajong.
02	*Bambusa alamii Stapleton.*	Jasai	Thinleygang, Sonamthang, Lamtang, Budhazhi, Pantang, Gomphu, Tsangla-jong.
03	*Bambusa clavata Staple-ton.*	Gook	Soobdrang
04	*Bambusa tulda Roxb.*	Shuzhing	Gomphu, Subrang
05	*Dendrocalamus hamiltonii Munro var. hamiltonii*	Soo	Thinleygang, Sonamthang, Lamtang, Budhazhi, Pantang, Subrang, Zurphay, Tsanglajong
06	*Dendrocalamus sikkimen-sis Oliver.*	Zang	Thinleygang,Gomphu,Subrang
07	*Dendrocalamus strictus*	Jasai	Tsanglajong
08	*Phylostachyum nigra*	Tsari Nyuma	Gomphu

Bambusa nutans Wall. ex Munro

Bambusa alamii Stapleton.

Bambusa clavata Stapleton.

Bambusa tulda Roxb.

Dendrocalamus hamiltonii Munro var. hamiltonii

Dendrocalamus sikkimensis Oliver.

Dendrocalamus strictus

Phylostachyum nigra

6.2 Bamboo species diversity in CF area

Seven CF groups were interviewed to identify the number of bamboo species being grown in their respective areas. Of this, the study found that the two CFs at Sangtshering and Gomphu currently do not grow any bamboo. However, Sangtshering CF has a vast area suitable for growing commercially viable species such as Bambusa nutans Wall. ex Munro, Bambusa alamii Stapleton. and Bambusa tulda Roxb. These species can be used as scaffolding, flagpole, and raw material for processed products such as lumber and plyboard. Currently, as shown in table 3 below, only three species of bamboo are found in the CF areas.

Table 3: Bamboo species diversity in CF area

Sl.No	Community Forest	Bamboo species	Remarks
01	Thinley gang CF	*Neomicrocalamus andropogonifolius (Griff). Stapleton*	
02	Norzinchholing CF	*Dendrocalamus hamiltonii Munro var. hamiltonii and Neomicrocalamus andropogonifolius (Griff). Stapleton*	
03	Budhazhi CF	*Dendrocalamus hamiltonii Munro var. hamiltonii*	
04	Sangtsering CF	No bamboo	Area suitable for plantation
05	Gomphu	No bamboo	-do-
06	Zurphey CF	*Dendrocalamus hamiltonii Munro var. hamiltonii*	
07	Tsanglajong CF	*Dendrocalamus hamiltonii Munro var. hamiltonii*	

6.3 Bamboo species diversity in NWFP managed area

The NWFP groups in the project area have been primarily formed to manage bamboo resources, and their coverage area is larger than the CFs. Out of the nine NWFP groups, five - Lamtang, Mamung, Panabi, Zangbi, and Salapong - manage only the Dendrocalamus hamiltonii Munro var. hamiltonii species. The diversity of bamboo species in the NWFP-managed areas is shown in table 4 below.

Table 4: Bamboo species diversity in NWFP managed area

Sl.No	Bamboo species	Local name	Name of community Forest
01	*Dendrocalamus hamiltonii Munro var. hamiltonii*	Soo	Lamtang, Mamung, Panabi, Zangbi, Salapong NWFP managed area
02	*Neomicrocalamus andropogonifolius (Griff). Stapleton*	Yula	Lamtang, Salapong, Gujong, Thinleygang
03	*Pseudostachyum ploymorphum Munro*	Dai	Lamtang, Budhazhi, Panabi
04	*Chimonobambusa callosa (Munro) Nakai.*	Rawa	Lamtang
05	*Dendrocalamus sikkimensis Oliver.*	Zang	Lamtang, Soobdrang
06	*Bambusa clavata Stapleton.*	Gook	Panabi

Neomicrocalamus andropogonifolius (Griff). Stapleton

Dendrocalamus hamiltonii Munro var. hamiltonii

Neomicrocalamus andropogonifolius (Griff). Stapleton

Chimonobambusa callosa (Munro) Nakai.

Dendrocalamus hamiltonii Munro var. hamiltonii

Pseudostachyum ploymorphum Munro

Bambusa clavata Stapleton.

7. Suitability of bamboo for target products

The Handicrafts Association of Bhutan (HAB) aims to initiate product diversifications like bamboo mat, plyboard, bamboo curtain, and bamboo corrugated sheet through the proposed project "Community Based Sustainable Bamboo Enterprise Development (CBS-BED)". However, the project exclusively needs to seek more support from development partners in order to meet requirements like equipment, skilled technicians, and human resources. The study reveals that the bamboo species available in the selected cluster areas are suitable for products such as toothpicks, bamboo furniture, bamboo mats, plyboard production, etc.

As per the case study done by ESES-Bio-wealth Private Ltd, based in Guwahati, Assam in India, the company uses bamboo species like *Bambusa bambos (L). Voss,* with a diameter of 12 to 15 inches for bamboo laminated boards. The species found in the lower and middle Kheng areas are also suitable for laminated bamboo boards that have a wider scope for Bhutan and our project in the near future. However, this might be possible only if the project is implemented on a larger scale with the goal to produce engineered bamboo products using high-tech machines.

Therefore, it is recommended that within this project, the production of only simple products like bamboo toothpicks, furniture, and other household utilitarian items be considered to trigger the interest of the youth to embrace bamboo-based enterprise. Development of such a product is feasible as the cost of tools and equipment is comparatively cheaper. While products like toothpicks and furniture can be easily sold in the available local market, bamboo mats can be supplied to the existing plyboard processing companies. However, artisans should be well trained in the treatment and curing process of bamboo culms.

The specific use of each bamboo species is shown in the following table 5:

Table 5: Specific use of each bamboo species

Sl. No	Bamboo species	Products
01	*Bambusa alamii Stapleton.*	Bamboo mat, Relax chair, stool, tooth pick
02	*Bambusa nutans Wall. ex Munro*	Bamboo furniture, tooth pick
03	*Bambusa clavata Stapleton.*	Bamboo bucket, tooth pick
04	*Dendrocalamus hamiltonii Munro var. hamiltonii*	Bamboo mat, furniture, tooth pick
05	*Dendrocalamus sikkimensis Oliver.*	Bamboo furniture, tooth pick

8. Knowledge and skills

Bamboo craft (Tsharzo) is one of the main sources of income for the people of Zhemgang, particularly in Bjoka gewog. They produce, among others, various traditional products such as Tserzim, Bangchung, hats, bags, purses, baskets, and decoration items. Although bamboo products like baskets and bags can potentially replace plastic usage, many do not opt for them as the prices are exorbitantly high and there is no innovation to suit the changing market demand. Everything is done manually by hand - from raw material processing to production - and productivity and price competitiveness remain a major challenge.

Some of the popular traditional bamboo handicraft products made in the Zhemgang are shown in the picture below.

9. Availability of bamboo stock harvest from the project area

8.1 Bamboo stock estimated in Homestead

In four villages of lower Kheng, *Bambusa alamii Stapleton.* and *Bambusa nutans Wall. ex Munro* were commonly found. The farmers prefer to plant these species since they can be of diverse use. A few households have also planted other species like *Dendrocalamus sikkimensis Oliver.* and *Dendrocalamus hamiltonii Munro var. hamiltonii* as well. Most of the farmers do not prefer *Dendrocalamus hamiltonii Munro var. hamiltonii* species as it occupies a large space and is easily dislodged by wind and storms.

In the middle Kheng areas, the plantation of *Bambusa alamii Stapleton.* started only in recent years. However, plantations of other species like *Bambusa clavata Stapleton*., and *Dendrocalamus sikkimensis Oliver.,* were seen in abundance.

Table 6: Projected no. of truckloads of different bamboo species in different year

Sl. No	Bamboo species	No. of Clumps	Projected no. of truckloads of different bamboo species in different year			
			1st year	*2nd year*	*3rd year*	*4th year*
01	*Bambusa alamii Stapleton.*	3117	18.96	37.92	28.44	58.00
02	*Bambusa nutans Wall. ex Munro*	3063	55.41	96.22	80.75	61.45
03	*Bambusa tulda Roxb.*	240	3.80	4.61	6.00	8.15
04	*Bambusa clavata Stapleton.*	7	3.15	2.10	1.35	1.40
	Total		**81.32**	**140.85**	**116.54**	**129.0**

Note: 300 poles of larger diameter and 900 poles of B. alamii are estimated to make one truck load.

8.2 Bamboo stock estimated in Community Forest

Table 7: Bamboo stock estimated in Community Forest (in truck load)

Community Forest	Gewog	No of clumps	Bamboo species	1st year	2nd year	3rd year	4th year
Tsanglajong CF	Trong	?	*Dendrocalamus hamiltonii Munro var. hamiltonii*	39	12	18	11
		16	*Bambusa nutans Wall. ex Munro*	3	1	1	1
Total (in Truck-loads)				**42**	**13**	**19**	**12**

8.3 Bamboo stock estimated in NWFP managed areas

Table 8: Bamboo stock estimated in NWFP managed areas (in truck load)

Name of the Group	Geowg	Area (Acres)	Bamboo Species	1st year	2nd year	3rd year
Mamung Group	Phangkhar	51.02	*Dendrocalamus hamiltonii Munro var. hamiltonii*	81	19	8
Zangbi Group	Phangkhar		*D. hamiltonii Munro var. hamiltonii*	28	11	9
Panabi/kulamti Group	Phangkhar	13	*D. hamiltonii Munro var. hamiltonii*	43	21	12
(A) Sub Total (In Truck Loads)				**152**	**51**	**29**
Panabi/kulamti	Phangkhar	5	*Bambusa nutans Wall. ex Munro*	8	8	9
		3	*Bambusa clavata Stapleton.*	2	2	4
(B) Sub Total (In Truck Loads)				**10**	**10**	**13**
Grand Total (A+B)				**162**	**61**	**42**

8.4 Summation of stock availability from Homestead, CF & NWFP managed areas

Table 9: Summation of stock availability from Homestead, CF & NWFP managed areas (in truck load)

Sl. No	Areas	Projected bamboo stock availability (in Truck Loads)			
		1st year	*2nd year*	*3rd year*	*4th year*
01	Homestead	**81.32**	**140.85**	**116.54**	**129.0**
02	CF	**42.00**	**13.00**	**19.00**	**12.00**
03	NWFP managed areas	**162.00**	**61.00**	**42.00**	-
	Total	**285.32**	**214.85**	**176.54**	**141.0**

Looking at the number of different bamboo species that could be harvested from the three areas (Homestead, CF, & NWFP) over a period of four years starting from the commencement of the Community Based Sustainable Bamboo Enterprise Development (CBS-BED) project, HAB should be comfortable with the availability of raw materials for the project implementation. Besides, sustainable management of the species could be pursued to ensure an uninterrupted supply of raw materials. Keeping in view the current practices, a few strategies for sustainable management of bamboo have been proposed in the following section.

Table 10: Total truckloads of *Bambusa alamii* poles of different ages available in the surveyed area

Sl.No	Village	No.of clumps	Bamboo poles production from clusters in different year (Truck load)			
			1st year	2nd year	3rd year	4th year
01	Thinleygang	80	0.53	1.07	0.8	1.6
02	Sonamthang	362	2.41	4.83	3.62	7.24
03	Lamtang	1864	12.43	24.85	18.64	37.28
04	Budhazhi	450	3	6	4.5	10.125
05	Pantang	88	0.59	1.17	0.88	1.76
06	Gomphu	273	0.8	0.8	1.87	2.13
	Total		**18.96**	**37.92**	**28.44**	**58**

Table 11: Quantity of *Bambusa nutans* available in surveyed areas

	No of clumps	1st year	2nd year	3rd year	4th year
Thinleygang	133	2.22	4.43	3.55	3.55
Sonamthang	735	12.25	24.5	19.6	2.45
Lamtang	1638	27.3	54.6	43.68	43.68
Budhazhi	240	6.4	6.4	8	4
Pantang	98	1.63	3.27	2.61	2.61
Gomphu	113	1.9	1	1	2.7
Zurphey	56	3.5	1.7	2.1	1.87
Tsanglajong	16	0.21	0.32	0.21	0.59
Total		**55.41**	**96.22**	**80.75**	**61.45**

Table 12: Number of truckloads of *Bambusa tulda* from surveyed area

Sl. No	Village	Total clump	1st year	2nd year	3rd year	4th year
	Gomphu	240	1.6	2.4	4	5.6

Table 13: Number of truckloads of *Bambusa clavata* in the surveyed area

Sl.No	Village	Total Clump	1st year	2nd year	3rd year	4th year
	Subrang	7	3.15	2.1	1.35	1.4

Table 14: Potential area for bamboo plantation in the cluster in future

Village	**Gewog**	**Collection area**	**Total Area (ac.)**	**Bamboo species**	**Distance from road head**
Thinleygang	Ngangla	Between Thinleygang village and Drangmen-chu	7acres	Barren area	10minutes
Budhazhi	Goshing	Chimati	25acres	*D.hameltonii*	One hour
		Lengman	50acres	*D.hameltonii*	One hour thirty minutes
		Jurang gang	10acres	*D.hameltonii*	
				D.sikkimensis	
Gomphu	Trong	Paibang Gelongmani	25acres	*D.hameltonii*	1 hour
		Praling	15acres	*D.hameltonii*	15minutes
		Sabang	15acres	*D.hameltonii*	15minutes
Total area			55acres		
Subrang		Zarwapong	25acres	*D.hameltonii*	On Subrang farm road sides

10. Practices in utilization and harvesting system

Current bamboo utilization practices

Traditionally, three bamboo species - Neomicrocalamus andropogonifolius (Griff). Stapleton (Yula) and Bambusa alamii Stapleton. (Jasai), and Bambusa nutans Wall. ex Munro (Sai - are commercially important for the people of Zhemgang. These species are heavily extracted from natural forests to make high-value traditional bamboo handicrafts and, therefore, experiencing a significant population decline.

In contrast, widely available species like Dendrocalamus hamiltonii Munro var. hamiltonii (Soo), Dendrocalamus sikkimensis Oliver. (Zang), and Bambusa clavata Stapleton. (Gook) lack utility. In countries like India and Vietnam, these species are widely used in the construction industry. In Bhutan, too, these species can be promoted for use as fencing pole, flagpole, and to replace the imported bamboo scaffolding, the latter after conducting a scientific test to ensure safety.

The utility of the bamboo species is shown in the picture below:

Zho-dop

Phrogpa

Zhom

Ara Palang

Soray

Tsirma

Sipang

Thrungchu Khapto Chen

.

9.1 Current bamboo harvesting method

The communities have little or no knowledge on how to harvest bamboo sustainably. The culms are cut, at about a meter high from the ground, from the outer edges towards the center. With this practice, the height of culm that needs to be cut not only increases every year but bushy branches throng the base of clumps, blocking light and competing for water and nutrients. Technically, bamboo culms must be harvested from the middle towards the edges, and culms must be cut above the first or second inter-node.

As the utility of bamboo increases in the country with the introduction of product development and new machinery, proper resource management needs to be put in place to convert this fast-growing grass into a durable raw material for construction purposes, handicrafts, and a wide range of semi-industrialized products.

The sustainable harvesting practices are shown in the picture below.

11. Eco-friendly Bamboo Products Manufacturing Opportunities.

Excessive consumption of plastic products has severe consequences for our ecosystem; thus, bamboo-based industries are thriving in neighbouring countries in recent years owing to its rapid growth and a high potential for mitigating climate change. Considering the abundant stock of bamboo resources in Zhemgang and environmental benefits, HAB with support from GEF-SGP, UNDP Bhutan has initiated an eco-friendly bamboo product manufacturing business in Marangdut, Panbang.

Although the culture of bamboo handicrafts existed in Zhemgang for generations, lacks the knowledge and skills to diversify products to suit the changing market demand. Therefore, this study intends to identify potential bamboo products and benchmark the product development process. Potential products recommended for C-BEG to manufacture to replace plastic usage and import substitution are as follows.

Bamboo Bottles

- Bamboo is cut and treated naturally by boiling, drying and then smoking.
- Various parts of bottle such as base, neck, bottle cap are carved using lathe or turning machine. Then these parts are smoothened via sanding-machine.
- OPTIONAL: Inner lining of plastic, steel, or glass filter as well as bottle cap of plastic, metal or bamboo finished with round or threaded finishing.
- Finishing of waterproof oil polish

Barbeque Skewers

- Bamboo is cut using cross cutting machine
- Bamboo splits are made using bamboo splitting machine
- Then put in a slicer machine to prepare sticks as per skewer size
- Sticks are boiled until yellowish then sun dried
- They are sharpened on one side using sharpening machine and further dried and polished

Bamboo Straws

- Bamboo of 1-3 years old and 6-8mm or less in diameter are required
- Bamboos are dried then cut using hand cutting tools
- Sanding is performed with sand paper or sanding machine as well as the ends
- Bamboo pieces are boiled in saltwater
- They are then dried, packed and ready

Mats, Baskets and other Office Supplies

- Bamboo of 1-2 years is required
- Branch removal can be done manually or with cross cutting machine
- Splitting of bambooculms to make strips and slivering to desired thickness and length can be done machine or using slivering machine
- Colouring of bamboo slivers and strips is done manually with hot water and dye in steel or aluminium container
- Weaving of mats and baskets by different interlacing and coiling techniques is done manually by the artisans

Bamboo Furniture

- The bamboo selected for making the furniture should be of at least 3 years maturity. Lesser hollow ones provide better results
- The bamboo is treated with preservatives to enhance its pest resistance and longevity. Preferred method is CCB Treatment(Boric-Borax)
- The bamboo is then straightened by application of heat. Usually, LPG Blow torch is used for the purpose. For bending the bamboo, straightening wooden column is used

- The components required for assembly of the bamboo furniture are made by knot removing, marking, filling end parts and groove making. The tools needed are measuring tape, saw, pencils, scraping knife, knot removal hand planer or angle grinder or knot removing machine
- The joineries are made with the help of marking jig, tape, markers, saw, chisel and hammer. The components are then assembled to make the final product using Long Clamps (F Type), C -Clamps, Hammer, Adhesive / Glue, Chisel, Hand / Electrical Drill

- Green bamboo of 1-2 years is ideal for making mats and baskets. Bamboo with large inter node lengths (i.e. *Bambusa Tulda/ Nutan*) provides better results.
- Removal of branches from the main culm and cross cutting of the Bamboo-culm to desired lengths, can be done manually or with a cross cutting machine
- Splitting of bamboo culms to form strips and slivers of desired thickness and length is done with a slivering machine in an industrial set up
- Colouring of bamboo slivers and strips is done manually with hot water and dye in steel / aluminium container.
- Weaving of mats and baskets by different interlacing and coiling techniques done manually by the artisans.

Bamboo Shoots

- Receipt of freshly harvested bamboo shoots
- Washing in Chlorinated Water
- Removal of Culm Sheath and Peeling
- Cutting to the desired size in the form of slices or dices
- Blanching in boiling water (5 - 6 times) with dose of fresh water for each wash
- Cooling by immersion in water at room temperature
- Dewatering using sieves > Weighment in 250 gms, 500 gms and 1kg
- Filling in 3 layer HDPE bags of 80 micron thickness
- Vacuum Sealing
- Packing in Corrugated Boxes.

Bamboo Toothbrush

- The bamboo should be of 1-3 years maturity and inner wall thickness should be more than 6-7mm. *B. balcooa, D. Hamiltonii* could be used and sourced from forest or homestead plantation.

- The bamboos are kept for drying at least 4 - 5days to reduce moisture. After drying, bamboo is cross cut and spliced into long pieces width 20 mm using cross cutting and splitting machine. Upper green layer and inner white layer with external and internal knot are removed using knot removing width sizing machine.
- Then long split is cut into 80 mm pieces for toothbrush handle. Now the 80mm x 20mm x 7mm rectangle bamboo pieces are shaped as required and polished using sanding machine.
- Core is made on the shaped bamboo handle for tufting bristle.
- Carbonization of handles is done to prevent microbial growth and make it water resistant. Tufting of the bristle is done.
- The bamboo toothbrush is now ready for laser etching. Brand name is etched on the lower flat part of the handle. The product is then packed and sold.

Agarbatti

- Sorting and Grading of bamboo according to wall thickness and outer diameter is essential for good quality round bamboo sticks
- At the time of harvest only mature bamboos of 3 years age and above should be selected so as to ensure quality of the round bamboo sticks
- The round bamboo and the finished round bamboo sticks should be stored in dry area away from dampness in order to avoid fungal infection and borar attack
- The profile cutters and the round saw should be sharpened at regular intervals in order to maintain the quality of round bamboo sticks

Bamboo Strip Board

- Sorting and grading of bamboo according to wall thickness and outer diameter is essential for good quality Bamboo Strip Board
- At the time of harvest only mature bamboos of 3 years age and above should be selected so as to ensure quality of the Bamboo Strip Board
- Bamboo Strip Board can be sanded and moulded similar to other hard-wood species such as teak. The natural grains on the surface have a unique attractive appearance.
- The Bamboo Strip Board should be protected from water and damp ar-eas to avoid swelling and shrinkage.

Table 15: Bamboo Products & Production Process

Bamboo product	**Suitable bamboo species in Bhutan**	**Machinery required as per Indian practices**	**Estimated break even period**	**Estimated cost of investment**
Bottles **(*Bambusa Balcooa*; may be combined with components of steel & plastic)**	Yes	Treatment tank, drying chamber, lathe machine, sanding machine and portable cross cutting machine.		High **2.5m INR** including around **0.5m INR** working capital.
Barbeque skewers **Toothpicks**	Yes	The machines and components needed are cross cutting machine, splitting machine, slicer machine, stick making machine, skewer- making machine, end sharpening machine polishing machine and boiling tub	39 months 21 months	High **5.5-6.0m INR** Along-with (**2.0-2.5m INR** working capital) **4.5-5.0m INR**
Straws requires Culms of *Melocana baccifera*, *Bambusa pallida* of 6-8mm or less diameter and 1-3 years of maturity.	Yes (alternatives are available: *Bambusa nutans* or *Bambusa tulda* could be alternative raw material as *M. baccifera* and *B. pallida* if unavailable.	Major equipment required are grinding and sanding blade, oven and straw cleaning brush.	7 months	Low **0.4-0.5m INR**
Bambusa Tulda; muda/ mula	Yes	Machete/Knife/Dao	43 months	Low **50,000 - 1.8m INR** depending on scale of enterprise
Paper bins, Files, Folders, Pen-stand and other school/ office supplies	Yes	Crosscut Machine, 1 HP Radial Splitter Machine 5HP, External knot removal Machine, HP,		Medium **0.65-0.85m INR**

Bamboo product	Suitable bamboo species in Bhutan	Machinery required as per Indian practices	Estimated break even period	Estimated cost of investment
Suitable species are *Bambusa nutans/ Bambusa tulda.*		Heavy Duty Sliver Machine, 1.5 HP Thin Sliver Machine 1 HP Heavy duty stitching Machine (JUKI) Spare & Maintenance kit		
Furniture: Solid bamboo species like ***Dendrocalamus Strictus*** and ***Dendrocalamus stocksii*** are most suitable for making furniture. ***Bambusa Tulda*** with ***Dendrocalamus giganteus*** and ***Bambusa pallida*** is often used in Assam. In Tripura, ***T.Oliveri*** is used.	Yes	Machines needed are pressure treatment plant, LPG blow torch with accessories, straightening wooden column, angle grinder or knot removing machine and portable cross cutting machine.	33 months	Medium-High **1.0-2.5m INR**
Basketry	Yes	Crosscut Machine, Radial Splitter Machine, External knot removal Machine, Heavy Duty Sliver Machine, Thin Sliver Machine, Spare & Maintenance kit		Medium **0.6-0.75m INR**
Bamboo Shoot	Yes	Double Chamber Vacuum Packaging Machine, Cutting and Dressing Tools, Stainless Steel Blanching Tank with cage and LPG Stove arrangement		Very High **11.8m INR**

Bamboo product	Suitable bamboo species in Bhutan	Machinery required as per Indian practices	Estimated break even period	Estimated cost of investment
Bamboo toothbrush; m. B.		Requires mainly semi-skilled workforce.	26 months	High
Balcooa, D. Hamiltonii		3 phase power supply, proper work shed, wide metaled road are minimum basic facilities required to establish the unit.		**2.5-3.0 m INR**
Bamboo Cutlery *Bamboosa Tulda, Bamboosa Nutans, Dendrocolums Strictus, Dendrocalamus hamiltonii, Bamboosa Balcooa*	Yes	ISO, FSSAI and SGS Certifications are required. Raw Bamboo Sawing machine, Bamboo Splitting Machine, Fixed Width Slicer, Bamboo Wool Slicer, Stick Cutting Machine, Bamboo Spoon Shape Milling Machine(Fork & Spoons), Further Shaping Forming Machine (Fork &Sp.), Spoon Backside Planning Machine (Fork &Sp.), Medium Type Blade Sharpening Machine 0.75 KW, Cordless Drill/Driver, Hand Grinder 650 W 8500 Rpm, Hand Tool Kit		High **3.5-4.0m INR**
Agarbatti	Yes	Crosscut Machine, Splitter (Manual or Chain Splitter) Slicer Machine Round Stick machine Stick Sizing Machine Polishing Machine, TC/ Saw Sharpening Machine		Very High **15.93m INR**

12. Important Machines for Bamboo Handicrafts

Bamboo producing machinery & their properties

The production capacity of each bamboo manufacturing machine does not have any specific unit attributed to it, i.e., there is no uniformity in describing the machines capability and capacity amongst different manufacturing companies.

Table 16: Machines, their Production Capacity & Working Principle

MACHINE	PROCESS/ PRODUCTION CAPACITY	WORKING PRINCIPLE OF THE MACHINES
Cross cutter Machine	3000-4000 kg/ 8 hours & Power: 1 HP-5 HP- Anil Ent. 250 poles in 8 hours (1 HP)- Prashant Ent.	Machine has round blades that cuts the length of the bamboo poles into cylindrical sections
Semi- Automatic Radial Splitter Machine	250-500 Piece/hour (2.5 kW)- AnilEnt.	Circular blades cut the bamboo radially
Automatic Radial Splitter Machine	Feasible for Bamboo Poles of up to 6 feet long; outer radius of up to 10 inches (7.5 HP)	Bamboo tube cutting knives/ blades with many spokes that correspond to various diameter bamboo tubes
Manual Splitter	150 Piece/hr	No mechanical/electrical components involved. Requires manual strength.
Round Stick Making Machine	130-400 kg sticks/ shift Power: 9 HP	The raw material after splitting the bar with a width of 10 - 15 mm and then passing through the slicing machine with the appropriate thickness and then put into the machine to create round or square billet with the optional size (replacement size change by knife)
Square Stick Making Machine	200 kg/ 8 hours Power: 1 HP	
External Knot Remover Machine	1 HP; 1440-2900 RPM	To remove the outside bamboo knot using a specially designed circular saw

Heavy Duty Sliver Machine	500 kg/ 8 hours (2 HP)	Bamboo into raw materials after splitting 10 - 15 mm wide pieces is put into this machine to split bamboo slices, with a thin thickness as you like (thickness adjustment). (Split 2 standard layers at a time and split revolving until the thickness of the material is split)
Thin Sliver Machine	100-500 Kg/hr The input material is up to 2.5 mm thick slivers and output could be 0.5-0.8 mm thin slivers The motor power is 0.5 HP -Anil Ent.	Thin Slicer machine or thin sliver machine is a very useful machine for handicrafts people/ Artisans in Bamboo Industry. The machine can produce up to .5 mm thick slivers good for weaving mats and making modern craft articles.
Semi-Automatic Bamboo Stick Polishing Machine	50-60 kg/ hour Power: 1-3 HP- Anil Ent.	
Drying Equipment		The device consists of combustion chamber, blower, chimney, and heat separation system, clean to provide material drying chamber and finished toothpick.

Table 12: Bamboo machines and price range

Name of Equipment	Price Range (INR)
Cross cutter Machine	20,000- 45,000
Automatic Radial Splitter Machine	1,92,000-2,50,000
Manual Splitter	18,000-40,000
Round Stick Making Machine	1,96,000-2,70,000
Square Stick Making Machine	55,000
Sanding Machine	22,500- 70,000
Lathe Machine	1,50,000
External Knot Remover Machine	38,000
Heavy Duty Sliver Machine	62,000-85,000
Thin Sliver Machine	38,000
Bamboo Stick Polishing Machine	72,000-90,000
Spare & Maintenance Kits	20,000
Carbonization System	5,00,000
Vacuum Packaging Machine(Bamboo Shoots)	8,00,000
Automatic Bamboo Stick Making Machine	14,00,000

Fully automatic bamboo outside knot removing machine

Cross cutter machine

Radial splitter machine

Bamboo slicing machine

Bamboo polishing machine

Bamboo round stick making machine

Automatic bamboo stick making machine

13. Bamboo treatment for construction

For bamboo to be suitable for construction, all depends on the structural properties of its stems, such as the weight to resistance ratio.

According to International Network for Bamboo and Rattan (INBAR), the ideal raw materials for mechanical processing are bamboos with the following physical properties.

- Lighter or less dense species or species with density less than 1g/cm3.
- Preferably straight with long inter-nodes.
- Medium culm wall thickness of 8-10mm.
- Large inner diameter, preferably above 25mm.

Bamboo construction

Bamboo scaffolding

Bamboo treatment

Bamboo greenhouse

Treatment for bamboos is done to improve its durability and to prevent it from infestation of insects and termites.
Bamboo Treatment Procedure:

- Harvesting of fresh bamboo
- Removal of branches
- Storage in area with shade
- Straightening of bamboo using heat treatment method
- Perforation of Internal partitions and knots for maximum of solution
- Heat Treatment of hallow bamboo
- Mixture of borax and boric acid with water for treating bamboo
- Every ten litres of water, add 25 grams of borax and boric acid mixture,OR
- For every hundred litres, add 2-2.5kg of the mixture
- Keep in solution for 8-10 days OR boil it in the solution for 2-3hours
- Pressure Treatment (only for large scale industry)
- Bamboo Poles are left to dry in the sun for a week approximately
- Bamboo is then bundled horizontally and ready

Immersion method in borax and boric acid is most recommended due to its cost efficiency and safety for environment. It is used in traditional as well as modern treatment of bamboo. Some experts say that immersion should be done to poles that have been dried for a week that are still green.

14. Limitation of study

The study is limited to only nine clusters and 442 households under Zhemgang Dzongkhag. Therefore, the bamboo species identified confines only to these selected clusters and do not represent species available in the entire Dzongkhag. The study too did not involve a scientific method of resource assessment, rather focus groups were formed and trained to conduct interviews with the community members and collect relevant data. Scientific methods were not used even for cluster selection and village identification. Clusters were selected and finalized based on the recommendation of D-PAC and villages were identified and selected according to the availability of the resources and accessibility to roads.

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Bamboo flagpole
Use Bamboo, save the Earth!

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