Case Study on Bamboo Farming

2023

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 About the Publication

This research study was conducted by National Institute of Agricultural Extension Management (MANAGE), Hyderabad. The results and findings discussed in the report are based on the study undertaken in two districts of Maharashtra namely Sindhudurg and Latur. The report will be helpful for the stakeholders to understand the importance of bamboo farming and its benefits.

Authors

Dr. Tahera Arjumand
MANAGE Intern
National Institute of Agricultural Extension Management (MANAGE)
Rajendranagar, Hyderabad, Telangana, India e-mail:
arjumandtahera@gmail.com

Dr. B. Renuka Rani
Deputy Director
Natural Resource Management
National Institute of Agricultural Extension Management (MANAGE)
Rajendranagar, Hyderabad, Telangana, India e-mail:
brenuka@manage.gov.in

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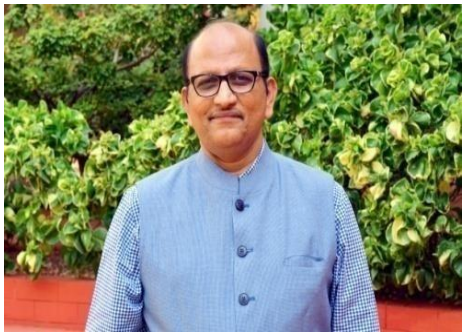
FOREWORD



I congratulate Ms.Tahera Arjumand, MANAGE intern and completed Ph.D from Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar Jammu and Kashmir, for selecting the topic "The case study on Bamboo Farming" and collected good data from the field. In detail, the paper analyses the impact, institutional linkages, socio-economic benefits among bamboo farmers, as well as the other bamboo stakeholders in Sindhudurg and Latur districts of Maharashtra.

Bamboo farming provides multiple benefits to the related stakeholders. The primary difficulties preventing farmers from planting bamboo includes a lack of information, as well as market and legislative disincentives. Although bamboo plays many roles in the life of rural people and support the life of locals, very little is known about the cost and benefit of bamboo farming.The study highlights the factors influencing bamboo cultivation, economic potentials from bamboo farming, capacity building strategies to develop competencies and skill of the entrepreneurs and beneficiaries.

The study revealed the factors responsible for motivating bamboo farming and it provides huge income to farmers in addition to ecological benefits. Other stakeholders such as artisans and labours are also benefitted by provision of job opportunities in bamboo based industries. Bamboo is different from wood. The artisans and labours have to be trained before making the bamboo products. KONBAC in Sindhudurg and Phoenix in Latur is providing training and building the capacity of rural and less educated people to earn their living. KONBAC has trained a number of farmers, labours, and artisans in order to build their capacity. It has in place mechanisms to link poor bamboo producers to larger lucrative markets and has already emerged as a model that is being emulated elsewhere in India and overseas. Phoenix foundation at Latur is still at initial period of convincing farmers but their efforts are commendable.

The study will generate baseline information regarding economic feasibility of establishing Bamboo farms and factors responsible for bamboo cultivation. The research will help in promoting skill development, capacity building, and awareness generation for development of bamboo sector from production to market demand. The research findings will be of great importance for scientists, planners, policy makers, and extension workers for planning, formulation, and implementation of Bamboo projects for local people security and livelihood generation under the regime of National Bamboo Mission.

25.01.2023

(Dr. P Chandra Shekara)
Director General, MANAGE

PREFACE

India is one of the richest countries in terms of bamboo resources but still imports bamboo at large scale. The government identifies bamboo as a potential livelihood generator and climate mitigation candidate. The restructured National Bamboo Mission (2018-19) provided a policy structure to the bamboo sector. However, in reality the objectives of the bamboo mission have not been achieved. The information about the benefits of bamboo farming has not yet percolated to the farmers and other stakeholders.

Hence, the need for understanding the factors responsible for adoption of bamboo farming by the farmers is very important. Although the government is backing the farming activities but the reasons for slow results is not understood clearly. There was a consistent emphasis on the need for promoting bamboo farming from the speech of Hon'ble Prime Minister of India Shri. Narendra Modi Ji during National Investors Summit- Assam 2018. Recently the government has launched a logo for National Bamboo Mission.

In view of this, a quick case study on Bamboo Farming was conducted by MANAGE with the objectives to provide an insight into the status of Bamboo cultivation , programmes and policies, opinions of stakeholders such as farmers, artisans, labours, entrepreneurs and government officials about factors that triggered the adoption of bamboo farming. The report provides a comprehensive overview of the global bamboo resources and their market scenario, different institutional mechanisms working for promoting bamboo and state policies in India. Further, the study is supported with documentation of successful cases. The recommendations suggested in the report based on the study may help for the expanding the Bamboo Farming further.

Dr. B. Renuka Rani
Deputy Director (NRM)

Date: 25.01.2023 MANAGE, Hyderabad

ACKNOWLEDGMENT

Bamboo farming has a potential to generate livelihood, boost rural economy and mitigate climate change. In order to strengthen the rural people, Government of India is promoting Bamboo farming. In view of this MANAGE conducted “The case study on Bamboo farming". I express my heartfelt gratitude to MANAGE for selecting me to conduct this important study.

I immensely thank Dr. P. Chandra Shekara, Director General, MANAGE for his leadership and support during the study. Also, I extend my sincere thanks to Dr. B. Renuka Rani, Deputy Director (NRM) for guiding and facilitating to conduct field survey. It was all her conscientious supervision, valuable suggestions, kindness, untiring assistance, judicious technical support. I will always be proud of having had the chance to work under her mentorship.

Completion of this quick case study could not have been possible without the efforts of Shree Pasha Patel, founder of Phoenix foundation and Shree Sanjeev Karpe, Director of KONBAC.

It is my great privilege to thank all the officials of the KONBAC and Phoenix and also Department of Agriculture and Forestry, Bank officials, Entrepreneurs, representatives of NGOs from Sindhudurg and Latur districts of Maharashtra for extending necessary cooperation and facilitating in meeting the farmers, conducting discussion and collecting data.

My heartfelt gratitude to all the practicing bamboo farmers, artisans and labours and the related officers of all two districts who spared their precious time and provided valuable information related to the study.

I would like to mention and express my special thanks to my friends and colleague Ms Basira Mehraj, Ms Khuban Buch, Ms Shaista khan, Ms Tabassum Qureshi, Mr S Sharath, Mr Sharath MP, Dr. S. K. Jamanal, and Ms Pragati Shukla.

I am greatly indebted to my parents for their consistent encouragement, blessing, moral support, and unconditional love. I cannot deny the contribution of my brother Adil who supported and motivated me whole heartedly in this long journey. I would like to dedicate this work to my parents and family for their continuous effort, support, and prayers.

Not all those who care for me may have got a mention, but none shall ever be forgotten.

Tahera Arjumand
MANAGE Intern

Date: 25.01.2023

LIST OF ABBREVIATIONS

ARS	Action Research Sites
CFC	Common Facility Centre
CIBART	Centre for Indian Bamboo Resource and Technology
FDCM	Forest Development Corporation Of Maharashtra
GABAR	Global Assessment of Bamboo and Rattan for green development
INBAR	The International Network for Bamboo and Rattan
ISFR	Indian State of Forest Report
KONBAC	Konkan Bamboo and Cane Development Centre
MTDC	Maharashtra Tourism Development Corporation
NBM	National Bamboo Mission
NGO	Non-Government Organisation
NTFP	Non-Timber Forest Product
SDG	Sustainable Development Goals
SFD	Social Forestry Directorate
UN	United Nations

CONTENT

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Bamboo, a woody grass, constitutes a very important and versatile resource worldwide. Almost half the world population are estimated to use bamboo in one form or other. Moreover, bamboo plants are capable of providing ecological, economic and livelihood security to the people. Bamboo can absorb nearly 400 tonnes of carbon per hectare. The green canopy of bamboo lowers light intensity, protect from ultraviolet rays, and purify atmosphere as well as soil. Hence, bamboo reduces pollution and mitigates climate. Economically, bamboo is popular as an excellent substitute for wood in paper industries, domestic commodities, cottage industries, board, and charcoal. Bamboo provides livelihood to over 2.5 billion people globally. The National Bamboo Mission, an initiative by Indian government to develop bamboo sector, reflects the acknowledgement of bamboo as a potential industry.

However, despite the credentials of bamboo, the sector has not yet received the real acknowledgement due to lack of information at ground level. The primary difficulties preventing farmers from planting bamboo includes a lack of information, as well as market and legislative disincentives. Although India has the highest area under bamboo, yet India is a net importer of bamboo. Many states have not yet drafted their bamboo policy. The states, which had already drafted have not yet revised their policy after bamboo moved into grass category. There is a huge difference between the written policy and the actual ground work that is going on. Almost twelve states have a good existing bamboo resource but still no action plan is present to conserve those resources. The restructured National Bamboo Mission (NBM) has also been launched in 2018-19 to focus on the development of complete value chain of bamboo sector and link growers with markets. With an aim to support the objectives of National Bamboo Mission and promote the bamboo cultivation, "**the case study on bamboo farming**" was undertaken in Sindhudurg and Latur district of Maharashtra. Sindhudurg is a selected bamboo action research site (ARS) by INBAR for the Konkan region. The Konkan Bamboo and Cane Development Centre (KONBAC) in Sindhudurg is dedicated to bamboo and cane development in the Konkan region. The organisation has readily linked poor bamboo producers to larger lucrative markets and has emerged as a model that is being emulated elsewhere in India and overseas. It has established several facilities/areas of expertise (both infrastructure based and human resource) within the organization. The study was also extended to Latur to study about the research and technological development through Phoenix foundation. Phoenix foundation is a non-profit organisation

working towards the rural development and bamboo promotion. Phoenix with collaboration of KONBAC, is in the process of developing huge stock of planting material through tissue culture. Therefore, the study was contemplated with the following objectives such as to find out the economic potential of bamboo cultivation, to determine the factors influencing its cultivation, to understand the importance of capacity building in order to develop competencies and skill of the Entrepreneurs and beneficiaries. Also, to propose suggestions for promoting bamboo cultivation in India.

The study is based on survey done through purposive sampling of the sites and the questions asked from the target groups. For the purpose of the present study, a semi structured interview schedule was prepared and also observation method was used to collect the information. The schedule consists of both closed- and open-ended questions relating to socio-economy, income, education, skills, products, tools used, trainings provided, problems associated, and insurance were asked. The schedule has been pre-tested. The final schedule was used for data collection.

Data was collected from randomly selected target group from Sindhudurg and Latur districts of Maharashtra. It was collected by conducting survey and face to face interviews with 30 farmers, 5 artisans, and 21 labours. Also, a few officers from Lead Bank and Agriculture and Forest departments were interviewed to gain their views.

The study in Sindhudurg revealed that the mean age of the bamboo farmer was 59 years. Most of the farmers had large families with more than five members in their family. The mean education score reflects high literacy with the average number of bamboo farmers had completed intermediate.

In our study, respondents expressed that out of the their total land (172.6 hectares), 120.4 ha were used for cultivation of other crops like, mango, cashew, coconut, nutmeg, areca palm, banana, rice, etc., and in 52.2 ha were under bamboo farming. The farmers planted bamboo either on boundaries or in a block. Out of the total bamboo farmers surveyed, 60% planted bamboo in block whereas 40% of them planted on the boundaries. A total of 950 farmers were cultivating bamboo in their field. Present study respondents reveals that the source of income from agriculture contributes maximum (55%) to a household income followed by business (21%), bamboo plantation (20%), services (3%), and livestock rearing (1%). Hence, bamboo plantation was the third major source of household income for the bamboo planters.

While interacting with farmers, it was observed that they never regretted after planting bamboo in their field. Although it was a traditional culture for planting bamboo in boundaries for the protection of field crop, later they have motivated by the KONBAC initiatives. Hence, respondents

took interest on bamboo cultivation to a next level by block plantation, boundary plantation and where ever they found barren land.

The economic analysis of bamboo plantation revealed that an initial expenditure for three years of around Rs 77200/- may be incurred per hectare for block plantation and Rs 14520/- for boundary plantation. Potential revenue of Rs. 240000 for block plantation and Rs 48000 for boundary plantation, in the fourth year can be expected from 400 culms and 80 culms respectively after accounting 10% mortality of the clumps per hectare of block and boundary plantation. Hence, a net benefit of Rs 162800/- with BC ratio of 2.1 (for block plantation) and Rs 33480/- with BC ratio of 2.3 (for boundary plantation) can be achieved from fourth year onwards. When the bamboo crops are ready to be harvested, farmers contact the contractors for harvesting.

Latur is completely different from Sindhudurg in term of geography, economy, and environment. There are only 45-50 farmers in Latur who have undertaken bamboo plantation. In our study, we could reach only 11 farmers who were growing bamboo on their field. Out of 11 farmers, 8 had a block plantation of bamboo whereas 3 had boundary plantation. The mean age of the farmer was 58 years. Almost all the farmers have large families with more than five members. The farmers were mostly educated up to with middle school. The mean annual income of farmers was around Rs 299181/-. The mean distance of house to bamboo field was 3.45 kilometres where the mean size of a farm turned out to be 10 hectares.

The study reveals that agriculture was the main occupation of people and hence agriculture contributed the highest into their income. However, bamboo based income of farmers could not be recorded because most of the farmers had newly planted the bamboo in their field. Only a few who had large lands undertook bamboo plantation due to the efforts and consistent motivation of Phoenix foundation. Mr Pasha Patel (founder of Phoenix) and Mr Sanjeev Karpe (Director of KONBAC) are working effortlessly to promote the bamboo farming in the area. Many farmers acknowledged the sincere efforts of the duo. Recently, a project on bamboo based ethanol refinery has been approved and will be set up soon in Latur. Since bamboo will be the raw material for the refinery, the aim is to plant bamboo plantation on 5000 acres of land. For this Almaq biotech is preparing to produce 5000 samplings per hour. This will definitely boost the rural economy and income of farmers.

Most of the artisans were provided training before employing them into the company. The monthly salary varied from Rs 12000/- to Rs 15000/-. All the artisans were male with age upto 30 yrs. Designing the bamboo products, teamwork, machine knowledge and training the new labour or staff was the main skills involved for artisans. They had to work with Laser machines, computer,

designing software, bamboo cutting machines and sanding machines in the factory. They worked for eight hours in a day for any order based production.

In KONBAC, Kudal there were 80 labours working at the factory and more than 300 labours works from home. They were mostly women working from home. The representation of female labours was more than men. At Phoenix, Latur there were 25 labours out of which 20 were females and 5 were male. All the labours were trained prior to work. The labours had to work with Sickle, hammer, driller, bamboo cutter, handsaw, chisel, sand paper, and sanding machine. The labours were satisfied with their work and preferred to work at the factory. KONBAC has also worked towards upliftment of Mahar community who were on the verge of giving up their bamboo based craft making occupation.

The study concludes that bamboo provides social, economic, as well as ecologic benefits. On the basis of our conclusion, it is recommended that government system may support bamboo cultivation by creating mass awareness among the community through different media and use bamboo products manufactured by the artisans and **may replace plastic with bamboo**. The location specific bamboo products may be promoted and KONBAC type of institutions at district may be established across the country. Research and development in order to increase the quality of bamboo and decrease the fear of bamboo flowering may be promoted.

I. INTRODUCTION

Bamboo, a woody grass from the family Poaceae or Gramineae, sub family *Bambusoideae*, is a versatile resource worldwide. The fastest growing plant can attain 40 m height and 30 cm diameter in four months (Troya and Xu, 2014). Bamboo is an important livelihood crop and material for rural people living in Asia, Latin America, and Africa. Almost half the world population use bamboo in one form or other (Rao and Sastry, 1996). Bamboo and its parts are utilised by various cultures to deliver the products and services essential to their way of life.

Ecologically, bamboo reduces carbon dioxide up to 35 per cent and delivers more oxygen. Bamboo roots make water barrier, hence control erosion, and also, devours high amounts of nitrogen decreasing water pollution. The green canopy of bamboo lowers light intensity, protect from ultraviolet rays, and purify atmosphere as well as soil. If well-managed, bamboo plantations can conserve soil and water, and improve soil fertility and local climate as well. Bamboo plants are capable of providing ecological, economic and livelihood security to the people.

Economically, bamboo provides multiple benefits. It is an excellent substitute for wood in paper industries, domestic commodities, cottage industries, board, and charcoal (Lobovikov *et al*., 2007). Owing to its quality and strength, bamboo reduces the use of timber consumption in construction (Atanda, 2015). The people of Asia, Africa, and South America use bamboo poles for house construction and agricultural implement. Bamboo shoots are eaten as vegetable in South-East and East Asian countries (Troya and Xu, 2014).

Bamboo provides livelihood to over 2.5 billion people globally (INBAR, 2014). In 2012, the domestic market for bamboo and rattan products in major bamboo producing countries was estimated at US$ 34.2 billion, with and additional US$ 2.5 billion of international trade in bamboo and rattan products (INBAR, 2015). Global export of bamboo and rattan products reached its record high of US $2,557 million in 2008 but slumped sharply by about 25% in 2009 due to the financial crisis. In 2012, the world export of bamboo and rattan commodities was about US$ 1,881 million, of which 29% was industrialized bamboo products and 25% was bamboo woven products (INBAR, 2014; INBAR, 2015). The size of bamboo use in Agarbatti industries itself in India has been estimated at Rs. 135 crore and bamboo utilized in ice-cream industries, kites, crackers, lathies and fishing rods has been estimated to the tune of 10 lakh tonnes annually (Mehra & Mehra, 2007). Its ability to rejuvenate itself from its below-ground rhizome stock means that it does not require replanting, needs little tending, and generally has little need for capital, labour or chemical inputs

to provide adequate levels of fibre. Bamboo can be harvested and replenished without destroying the natural forest (Anon., 2015). As such, it is highly suited to a diversified agricultural system, constituting one of several livelihood resources for farmers (INBAR, 2004). The National Bamboo Mission, an initiative by Indian government to develop bamboo sector, reflects the acknowledgement of bamboo as a potential industry.

However, despite the above facts and credentials, bamboo sector has not yet received the prominence due to lack of information at ground level. The primary difficulties preventing farmers from planting bamboo includes a lack of information, as well as market and legislative disincentives. Although bamboo plays many roles in the life of rural people and support the life of locals, very little is known about the cost and benefit of bamboo to farmers. Private bamboo farms established by large farmers provide the households with huge income and sustenance. A better understanding of the bamboo farming, its contribution to rural household economy, and the factors associated with the farm income levels is essential. Amidst these opportunities, benefits and issues, there is a need to understand the factors responsible for farmer's decision on cultivating bamboo at farm level and its economic feasibility. Keeping in view, a case study entitled "**Bamboo farming**" was contemplated with the following objectives:- 1. To find out the economic potential of bamboo cultivation

2. To determine the factors influencing bamboo cultivation
3. To understand the importance of capacity building in order to develop competencies and skill of the Entrepreneurs and beneficiaries.
4. To propose suggestions for promoting bamboo cultivation in India.

1.1. Scope

a. The study will generate baseline information regarding economic feasibility of establishing Bamboo farms and factors responsible for bamboo cultivation.
b. The research will help in promoting skill development, capacity building, and awareness generation for development of bamboo sector from production to market demand.
c. The research findings will be useful in formulation of appropriate extension and communication strategies for effective dissemination of scientific information about establishment of bamboo farming through efficient utilization and mobilization of existing land resources

d. The research findings will be of great importance for scientists, planners, policy makers, and extension workers for planning, formulation, and implementation of Bamboo projects for local people security and livelihood generation under the regime of National Bamboo Mission

II. LITERATURE REVIEW

Bamboo has been receiving increased attention as a renewable resource owing to its fast growth, economic value, large availability, and physical properties comparable to that of wood (Engler *et al*. 2012; Mahdavi *et al*. 2010). In the view of importance of bamboo as bio resources, the present chapter discusses the bamboo types, flowering, distribution, and existing scenarios of bamboo farming in different bamboo producing countries and the strategies adopted by countries to promote bamboo farming.

2.1 A brief introduction about bamboo and its type

Bamboos can be differentiated on the basis of their growth. The growth of a bamboo is governed by its rhizome. The bamboo rhizome is the underground part of a bamboo stem (culm). However, rhizomes are not roots, roots grow under the rhizome, and culms erect on top of the rhizome. Axillary buds on the rhizome can produce new rhizomes, or bamboo shoots, which grow into culms. Just like the culm, rhizomes have nodes and internodes. Bamboo is divided into three categories based on their rhizomes:

I. ***Monopodial bamboo or running bamboos***: These bamboos have thin rhizomes, which extend horizontally underground for long distances. Degenerated leaves and roots grow on the nodes of the rhizome, and there is one bud on every node. Some of the buds grow into new underground rhizomes; some grow into shoots and develop into stems. Bamboo stems of monopodial species grow in scattered state, and can spread over a large distance. (Fig 2.2.1)

II. ***Sympodial bamboo or Clumping Bamboo*:** They have axillary buds on the stem base, which develop directly into shoots and then grow into new stems. In the next year axillary buds on the stem base of new stems develop into new shoots and grow into new bamboo stems again, thus the propagation cycle is repeated and an underground rhizome system of mother bamboo and new stems is formed. Such underground rhizome system cannot extend for a long distance. The length of stem petioles (the stalk by which a leaf is attached to a stem) with sympodial bamboos is different. Some of them are short (sympodial-tufted) and grow new stems from these petioles closely. Others like the sympodial-scattered bamboos almost resemble monopodial growth habits. Sympodial-scattered bamboos, or open clumpers have longer petioles, which form false rhizomes. These can easily extend

into distances of 50 - 100 cm. That's why new culms from these bamboo species grow in a scattered pattern. *Guadua angustifolia* is a perfect example of an open clumper. (Fig 2.2.1)

III. ***Amphipodial bamboo****:* Finally, to make it even more complicated there is the mixpodial rhizome type. These bamboos have axillary bud on the stem base of the mother bamboo, which develop into rhizomes and extends horizontally underground. The axillary buds on rhizome nodes develop into new stems in scattered state. Meanwhile axillary buds on these new stem bases develop into shoots and form a dense bamboo brush. Such underground rhizomes incorporating the features of both monopodial and sympodial types are called mixpodial, or mixed brush.

Running Bamboo Clumping Bamboo

Running and Clumping bamboo
Source: https://lewisbamboo.com/pages/clumping-vs-running-bamboo

2.2. Species of Bamboo

Bamboos have a wide range of species distributed around the world through natural or biological

Bambusa nutans

Bamboosa bambos

Bambusa tulda

invasions. India has 125 indegenous and 11 exotic species from 23 genera (FAO, 2007). NBM identified 18 commercially important species. Biological invasions involve the human-mediated introduction of species beyond its native region. These invasions are influenced by their direct value to humans. The main economic value of bamboo lies in the utility of the hardened culm, which serves many of the same functions as timber (Chung and Yu 2002; Scurlock *et al.* 2000). The versatile nature of bamboo makes it an interesting group beyond timber. For instance, leaves are used as fodder, shoots as food source, culms for biomass, construction, textiles, musical instruments and many bamboos are used in horticulture (Hunter, 2003). Moreover, bamboo cultivation is promoted largely due to various commercial aspects of the plant. Due to its worldwide distribution, bamboo plays a very important role in bio-diversity conservation, carbon sequestration and soil moisture conservation. Bamboos have many uses due to their characteristics, such as light weight but still strong, hard, flexible, straight, fast growth, and their available in a various size. Hence, they have many uses such as in making normal and fine quality paper, fishing poles, furniture, flooring, handicrafts, walking sticks, etc. Young bamboo shoots are used as vegetables in some state's cuisines. (Table 2.1)

Bambusa vulgaris

Dendrocalamus brandissi

Dendrocalamus giganteus

Dendrocalamus hemiltonii

Dendrocalamus asper

Different species of bamboo

Table 2.1. Commercially important species of bamboo

Sr no	**Species**	**Local names**	**Description**	**Uses**
1.	***Bambusa balcooa Synonym- Dendrocalamus balcooa***	Female Bamboo, Balcooa Bamboo	It is a native from the Indian subcontinent to Indo-China. Bambusa balcooa grows up to an altitude of 700 m in tropical monsoon climates with an annual rainfall of 2,500 - 3,000 mm. It grows on any type of soil but prefers heavy textured soils with good drainage and a low pH of about 5.5.	Construction, scaffolding, basketry, woven Mats, fishing implements, paper pulp, edible shoots, fodder

2.	***Bamboosa bambos***		It is the giant thorny bamboo, Indian thorny bamboo, spiny bamboo, or thorny bamboo is native to southern Asia.	They are extensively used in many applications, mainly for making bridges and for ladders. Leaves are used for thatching.
3.	***Bambusa nutans***		It is an evergreen tropical plant found in Southeast-Asia.	Used in paper industry and can be grown as ornamentals.
4.	***Bambusa pallida or Arundarbor pallida (Munro) Kuntze***	Mokal bah	The plant is perennial and caespitose. Found in Laos, Malaya, Myanmar, Thailand, Bangladesh, China South-Central and Vietnam. In India it grows in sub-Himalayan tracts from Yamuna eastwards to Arunachal Pradesh, Assam, Bengal, Sikkim, Dehradun, North West India, Odisha.	Young rhizomes are eaten as vegetable after processing.
5.	***Bambusa tulda***	Indian timber bamboo	It is native to the Indian subcontinent, Indochina, Tibet, and Yunnan, and naturalized in Iraq, Puerto Rico, and parts of South America. It is a tall, dull green colored bamboo species with greyish green when mature. It is composed of few closely growing culms. It reaches a height of 6–23 m.	Extensively used by the paper pulp industry in India
6.	***Bambusa vulgaris or Bambusa striata***	Vittata or Painted Bamboo, Common bamboo	It is native to Indo-china and to the province of Yunnan in southern China, but it has been widely cultivated in many other places and has become naturalized in several regions. Among bamboo species, it	The stems are used as fuel and the leaves used as fodder. Also used as ornamental plants, fencing and
			is one of the largest and most easily recognized	soil erosion control.

7.	***Dendrocalamus brandissi (Munro) Kurz., Synonym Bambusa Brandisii Munro***	Velvet Leaf Bamboo, Teddy bear bamboo, or Sweet dragon bamboo, Burma bamboo	A large size, straight growth habit, and thorn-less nature bamboo. It is one of the largest tropical clumping bamboos in the world.	Culms are used for building construction, boat masts, furniture, farm implements, water pots, basketry, handicrafts, paper making, ladders. Shoots are edible and consumed as a vegetable. This species is currently used widely as fencing poles for ginger cultivation in upland paddy fields
8.	***Dendrocalamus giganteus***	Giant bamboo	It is a giant tropical and subtropical, dense-clumping species native to Southeast Asia. It is one of the largest bamboo species in the world. The plant is native to India, Myanmar, Thailand, and China's Yunnan province. Its habitat is in forests and on river banks, from sea level to 2,000 metres (6,600 ft) altitude.	Used in construction and weaving. The shoots are edible
9.	***Dendrocalamus hemiltonii***	Hamilton's bamboo	It is a tall, dull green-colored bamboo species with drooping tops, which grows in thickets consisting of a few closely growing culms. It has 12–15 cm diameter and grow up to 15–18 m in height. Found in South Asian countries such as, India, Sri Lanka, Bhutan, Nepal, Pakistan, and far eastern China.	Young shoots are widely consumed as a vegetable. A sour pickle, known as 'hiyup', is made from the shoots in India. Grown as windbreaks on tea plantations.

10.	***Dendrocalamus asper***	Dragon bamboo, Rough bamboo	It is a giant, tropical, clumping species of bamboo native to Southeast Asia. Has been considered as non-invasive species by most gardeners. It has a natural growth habit as a sympodial, colony-forming plant. This bamboo grows 15–20 m tall, and 8–12 cm in diameter. It is found commonly in India, Sri Lanka, Southwest China	Used for constructions purpose and the shoots used as a source of food in Asia.
			and Southeast Asia and more recently in Latin America and warmer regions in the United States.	
11.	***Bambusa polymorpha***	Burmese bamboo	It is a tall, greyish green colored bamboo species, which grows in thickets consisting of a large, number of heavily, and branched, closely growing culms. It reaches a height of 10–30 m. It is a native to Bangladesh, Laos, Myanmar, Thailand, Sri Lanka, Java, Cuba, Puerto Rico, and Ecuador.	Construction, furniture, basketry, weaving, handicrafts, paper pulp, food, laminated boards, landscaping. In India, it is used for walls, partitions, troughs, and mats. In Myanmar, it is used for making house frames, wattle-and-daub walls, partitions, concrete reinforcement, and ceilings.
12.	***Dendrocalamus strictus***	Male bamboo, Solid bamboo, and Calcutta bamboo.	It is a tall, dull long green-colored bamboo species, which grows in thickets consisting of a large, number of heavily, and branched, closely growing culms. It reaches a height of 6–18 m. It is widely found across South and Southeast Asia, particularly India, Nepal, Bangladesh, Myanmar, and Thailand. It is also found in Cuba	They are used for making house frames, rafters, tent poles, concrete reinforcement, walls, scaffolding, and fences. The leaves are used for thatching. Used by the British army in India for making lance shafts.

13.	***Dendrocalamus stocksii Previously known as Oxytenanthera stocksii***	Chivari or Mes in Maharastra. Konda, Oorshema and Marihal bamboo in Karnataka and Manga in Goa. Also known as African lowland bamboo, savannah bamboo or Bindura bamboo.	It is a graceful mid-sized non-thorny bamboo species with loosely spaced solid erect culms ranging from 30-50 mm diameter, which provides flexibility in harvesting, easy management, and steady income to farmers. This species is naturally distributed Central Western Ghats from Kasargod in Kerala to Ratnagiri in Maharashtra.	Traditional uses of *Oxytenanthera abyssinica* include weaving for basketry, as a building material for local construction, houses, and furniture, and in the Southern Highlands of Tanzania in Iringa, Mbeya and Ruvuma Region. It

				is tapped for its juice, and fermented for the production of a local alcoholic beverage.
14.	***Melocanna bambusoides Synonyms- Bambusa baccifera, Melocanna baccifera,***	Muli Bamboo, Pear Bamboo, Berry bamboo, Terai bamboo.	It is tall, small-culmed bamboo with greenish young culms and strawcolored old culms. It grows in clumps composed of many wellspaced culms. It has a dense appearance due to its branching habit. It an evergreen bamboo, grows up to 10–25 m tall. It is native to Bangladesh, Myanmar, India, and Thailand.	Young shoots are cooked. The shoots are also sliced and dried in the sun for preservation. The remarkable large fruits are fleshy and edible. They are used as a famine food. The leaves may be used in brewing liquor. **Tabashir** is a siliceous concretion found in the culms of the bamboo stem, can be collected from the culms. It is used as a tonic in treating respiratory diseases.

15.	***Ochlanda travancorica***	Reed bamboo	The bamboo is endemic to the Western Ghats, India. It is naturalized in the West Indies.	Used for making mats, baskets, handicrafts etc. The plant is sometimes cultivated as a soil binder and source of materials.
16.	***Schizostachium dulloaa*** *SynonymNeohouzeaua dullooa (Gamble) A.Camus Teinostachyum dullooa Gamble*	Dulloo/ Dolobanh	Thin-walled, clump-forming species distributed in the moist semi evergreen forests of N-E India (Assam, Sikkim, Meghalaya, Tripura, Mizoram, Nagaland, Manipur), Bangladesh, and Myanmar. It is among the 38 bamboo species listed by the International Network for Bamboo and Rattan (INBAR), Beijing, China and the International Plant Genetic Resources Institute (IPGRI) as the priority species. Among the 78 species of bamboos distributed in NE India.	
17.	***Thyrostachys oliverii***		It is an evergreen, perennial, clumping bamboo with short rhizomes. The erect culms can be 15 - 25 meters long; 50 - 70mm in diameter; with internodes 40 - 60cm long. The culms are valued as a local source of material for construction. The seed is also eaten locally. In Thailand, the young shoots are harvested commercially for the production of steamed bamboo shoots, which are canned and exported. The plant is sometimes grown in villages and is also introduced in some parts of India.	Young shoots are edible.

18.	***Phyllostachys bambusoides***	Madake, Giant timber bamboo, or Japanese timber bamboo	It is a monopodial type evergreen bamboo, which can reach a height of roughly 20 m (66 ft) and a diameter of 10 cm (3.9 in). The culms are dark green, with a thin wall that thickens with maturity, and very straight, with long internodes and two distinctive rings at the node. The species is thinskinned, easily split lengthwise, has long fibres, and is strong and highly flexible, even when split finely.	Weaving and ornamental purpose

2.3. Propagation of Bamboo

Bamboos can be propagated either by reproductive method or vegetative method. Reproductive method involves the production of new bamboo plants through seeds while the vegetative method makes use of vegetative parts such as rhizomes, culms, and branches.

1. Seed Propagation
2. Vegetative Propagation

2.3.1. Seed propagation

This method is very seldom used because of the rare and irregular flowering of most bamboos observed locally which produced infertile seeds or seldom develop seeds. Moreover, most bamboos generally die soon or a year after flowering. If seeds are available, this is the best method of bamboo propagation since clump age would be known at the initial stage of its life cycle. Seeds can be used for seedling production only for short duration of maximum six months.

2.3.2. Vegetative Propagation

Vegetative propagation of bamboo involves using part of the parent plant to produce a new plant. There are several ways of accomplishing vegetative propagation including culm cutting, branch node cutting, whole culm burial, rhizomes or offsets, layering, macro proliferation and tissue culture. The following is a brief account on the different methods of vegetative propagation for bamboos.

i. ***Rhizome (offset) based propagation***: it is an age old traditional method but suitable for

cultivating few clumps only, particularly in small and accessible regions. Offsets or rhizomes are conventionally used for propagating sympodial bamboos. An offset is the basal portion of a single culm to which the rhizome axis and roots are attached. The propagating material in this method is whole rhizomes or portions, each with single culm having three to five basal nodes (called offsets). Preferably, 1- to 2-yearold culms from the peripheral portion of a clump are selected for offset planting, and cut at 1.0 - 1.5 m height. The culms are cut in a slanting manner with two to three nodes left at the base, or right above the node without damaging the basal portion of the branches. The rhizome attaching the culm is dug and cut 30 to 45 cm from the ground. The rhizome and roots attached must not be damaged when collecting the off-sets, and the buds must also remain intact. The underground parts of the offset should be wrapped with moist substratum like banana stem, coir or gunny bag to avoid drying, in case of delayed planting due to transportation. These offsets can be planted in pits in the field, or alternatively potted in medium-sized gunny bags. The culm top should be covered with polythene bag and cavity filled with water to prevent drying in field. Alternatively, covering the cut end using soil - cow dung mix is also practiced

ii. ***Cutting-based propagation:*** Vegetative propagation using 'cuttings' is advantageous over rhizomes/offsets (Ntirugulirwa *et al*. 2012) as cuttings are easily available for largescale propagation. This could be achieved by either 'culm cuttings' or 'branch cuttings'**.**

a. ***Culm cuttings:*** The culm segments with 2-3 nodes are removed from mother plant and treated with root inducing chemicals. The method has been successfully tested for most of the economically important bamboos. Plants raised from cuttings develop faster to culms as compared to seedlings. Though it is applicable for both thick- and thin walled bamboos, the success rate for thin-walled bamboos is quite low. This method enables the large-scale multiplication of superior varieties with rooting in 90 days. Culm/branch cuttings are more suitable for propagation because of easy handling and abundant availability, and they can be collected from the stock material without affecting the rhizome system. Culm cuttings are 40–80% more successful than the offset method.

b. ***Branch cuttings***: It is a simple and easy method of propagation, but the success of rooting is not as high as in culm cuttings. The primary branches are easily separated from the hollow main stem of an upright shoot and reduced to 2-3-node cuttings, which are buried in growth medium. Though abundant availability and ease of handling are advantages of this method, it is restricted to thick-walled bamboo species with stout branches only, like Bambusa spp. or Dendrocalamus spp. This method is

timeconsuming, as branch cuttings require 6–12 months for rooting and 12–30 months for rhizome development.

iii. **Layering-** For layering, a whole culm, or a branch bearing part of the culm is brought in contact with a rooting medium when it is still attached to the mother plant. The branch is bent down to the ground so that the nodes are pegged into the soil. Roots develop from the nodal regions, which are then separated and planted in polybags for hardening.

a. ***Ground or Simple layering***: Less than two year old culms are selected and the top parts are cut off to stimulate bud growth, and the side branches are trimmed. The culm is bent down into a shallow trench, pegged down and covered with soil or rooting medium. Rooting and sprouting occurs in the nodes, and after rhizome formation the nodes are separated by cutting at the internodal regions

b. ***Air layering or Marcotting****:* This involves application of root-promoting medium around nodes of the culm, which may be wrapped with coconut fibre and/or water hyacinth roots. Marcotting is performed by bending the culm to a slanting position, supported by a prop. After pruning off the branches, the nodes are covered with suitable rooting medium and held in position by tying. Rainy season is best for marcotting, since the medium should always be kept moist.

c. ***Stump layering*****:** This method is not common. The culm is cut leaving 2-3 basal nodes and the stump is covered using rooting medium. Use of Indole Butyric acid is found to enhance sprouting and rooting. The use of this method is limited by low success rate. Only 10% survival has been reported in B. vulgaris and D. giganteus through stump layering.

d. ***Seedling layering***: Polybags with seedlings are placed in horizontal positions allowing the nodes to touch the ground. The nodes are covered with rooting media with the branches standing above. Rooted nodes are then separated and transplanted to poly bags. This process can be used repeatedly to produce more planting stock from limited number of seedlings.

iv. **Macro-Proliferation:** In order to increase number of plantlets from rooted cutting and to reduce cost of production, macro-proliferation of 6 months old rooted cuttings with 2-3 tillers and miniature rhizomes may be done. To avoid the chances of shoot wilting and root drying it is

performed under shade, especially during morning or evening. The polythene cover and the potting mixture are removed without damaging roots and rhizome. Then, 1-2 tillers with roots and rhizome are separated using secature, and around 2 to 3, plants can be made from one six month old rooted cutting. Macro-proliferated plants must be kept in shade/ shade house for 2-3 weeks or till new root and leaf development takes place, after which, plants can be kept in open nursery. After 3 months, to boost growth of the plants, NPK solution, or slow release of nutrients can be provided at regular one-month intervals. To get further plants, the process is repeated after six months, and about 5-6 folds multiplication can be achieved in one year from 6 months old single rooted cuttings using this method. This cycle can be repeated every year for planting stock production to raise large scale plantations. Depending on the species, each plant can be multiplied three to seven times using this method. Though seed dependency is a major drawback, a large number of planting stock can be produced from limited seeds, and the planting stock can be maintained in the nursery, without going for repeated nursery establishment every year.

2.4. Soil and Climate

The soil for bamboo plantations should be well drained. They grow well in sandy loam or loamy clay soils. Bamboos have also been reported to grow in swampy soils. The soil with slightly acidic nature or with pH around 4.5 to 6 is good for bamboo cultivation. The soil with high water table is favourable for the growth of bamboo. The warm temperate and tropical climates are the best climates for bamboo cultivation. It is believed that the under these conditions, it grows 3 inches a day. Rainfall should be not less than 1200 mm a year for bamboo cultivation. Humidity of the area should be in between 75-85% and the wind velocity above 80 km/hr can cause problems during the development stage**.**

2.5. Land preparation

The site selected for bamboo plantation should be cleared of bushes, grasses and other unwanted materials or plants. The cultivation area should be cleaned so as to facilitate intercropping. A proper layout is designed and pits are dug for planting. The size of the pit depends on the type of planting material being used. Generally, the pits are made large and deep so that the newly planted bamboo gets established easily. The dimensions of the pit are 60 x 60 cm in heavy rainfall areas. Small pits of size 30 x 30 cm are dug for well rooted seedlings. Where the rainfall is scanty, pits of size up to 1 m are created to improve micro-catchment. The spacing between the seedlings should be 5 x 5m, so that 1 hectare of land can approximately accommodate 400 plants. The offset

should be placed 10-20 cm below the ground and should be covered with soil. It is necessary to slightly press the soil around the seedling**.**

2.6. Manure and fertilizer

Top soil mixed with 2 kg of phosphoric fertilizer is filled in each pit up to 10 cm and planting should be done just before the rainy season. Bamboo is a plant, which needs excess nutrients. One clump of mature bamboo needs 5 pounds of NPK fertilizer in a year. The plants need a constant supply of nitrogen and potassium. The green colour of the bamboo and the growth of new shoots depend on the content of nitrogen in the soil. The development of strong, healthy root mass depends on the amount of potassium in the soil. Macronutrient silica is also required by the plants for extreme growth of the bamboo clump. People in the rural areas also use cow dung as a fertiliser for bamboo.

2.7. Irrigation requirement

The production of healthy bamboo depends heavily on irrigation. A drip irrigation system or a sprinkler arrangement can be an effective solution for supplying water regularly to the plants. During the first few months, watering should be done on a regular basis because the bamboo plants take time to establish in the soil. Once the plants get rooted firmly, then the interval of water supply can be increased.

2.8. Intercultural operations

Weeds in the soil can prevent the growth of bamboo by absorbing the nutrients from the soil. So, regular and systematic weeding should be done. The weeds removed from the farm should be disposed properly. An area of 60 cm around the bamboo plants should be always free from weeds.

Mulching helps in proper bamboo growth. The areas having less rainfall or have dry weather conditions, mulching helps to prevent soil water from evaporation. Dry organic matter or dry leaves are spread around the base of bamboo plants as mulch material to preserve soil moisture and also to control weeds. Mulch also protects the young bamboo shoots from direct sunlight and facilitates in producing good quality shoots.

Managing the clump is highly essential as this improves the productivity of the farm. The unwanted culms should be removed as a part of maintenance activity so as to decongest the clump old and rotten culms should be removed to promote the growth of healthy shoots.

Intercropping is done during the early years (3 years) of planting bamboo. Most plants, which are intercropped with bamboo, are ginger, turmeric, chillies, and other shade loving plants.

2.9. Pest and disease control

The first important step in disease management is to monitor the plants regularly. Most of the diseases can be controlled by the cutting and removal of infected parts of the plant. The debris, thus collected should be burnt. The cultural operations should be carried out before the monsoon. Application of prophylactic fungicides can also help control the spread of diseases. (Table 2.2)
Table 2.2. Common diseases in bamboo plants are:

Sr No	**Disease**	**Causal Organism**
1	Bamboo blight	*Fusarium semitectum*
2	Branch necrosis and tip die-back	*Fusarium sp.*
3	Witches' broom	*Aciculosporium take*
4.	Little leaf	Mycoplasma-like organism
5.	Thread blight	*Botryobasidium salmonicolor*
6.	Leaf rust	*Dasturella divina*
6	Leaf spot	*Exserohilum holmii and E. rostratum*
8	Foliage blight	*Bipolaris maydis and Bipolaris sp*
9	Rhizome and root rot	*Rhizostilbella hibisc*

Pests that attack the bamboo plants are:

1. Aphids
2. Scales
3. Mealy bugs
4. Termites
5. Beetles

Non-chemical insecticidal soap is the best way to prevent the insects from infesting the plants.

Aphids

Mealy bug

Termites

Beetles

Pests that attack bamboo

2.10. Bamboo Flowering

Bamboos flower only once and die afterwards. The reasons for it still not clearly understood. There are two different kinds of flowering pattern in bamboo. They are:

1. Sporadic
2. Gregarious

a. Sporadic flowering

The flowering pattern, which is usually not wide-spread but can happen to either singular plants or all of the same species within a localized area, is known as sporadic flowering. It is brought on by environmental factors (such as drought or cold) rather than genetics. Sporadic flowering rarely results in the production of viable seeds but on the upside, the plants very rarely die after the event.

b. Gregarious flowering

There are some bamboo species, which flower at the same time over an entire continent, some even say all over the globe. This is called gregarious flowering, i.e., simultaneous flowering of all the bamboos of a single clone spread over a large geographical area. Gregarious flowering

generally progresses in waves for a period of two to three years from one end of a forest to the other. This is a strategy of nature to prevent the entire bamboo forest area from dying after the bamboos have flowered. Gregarious flowering often happens in different stages because mature stems start to produce seeds first. When the seed ripen and eventually fall off, the bamboo plant loses all its leaves, and the culm starts to dry up from top to bottom until it finally dies. Gregarious flowering is easily observable when it happens because of all the dried bamboo stems (straw like color) and the thousands of spikes in their branches. These spikes bare the seeds, which are usually very similar in appearance to rice, wheat or barley.

Scientists believe that there must be some kind of genetic alarm that signals the diversion of all energy to flower production and the cessation of vegetative growth. This mechanism, as well as the evolutionary cause behind it, is still largely a **mystery**. Apparently, once a particular species reaches its life expectancy, it will start to flower, which is then followed by the development of seeds.

2.10.1. Bamboo dies after flowering

The two most probable explanations for why bamboo dies after flowering is that seed production requires an enormous amount of energy which stresses the bamboo plant to such an extent that it will actually die. A second explanation could be that the mother plant is creating an optimal environment for its seedlings to survive. In other words when the mother plant dies, the bamboo seedlings will have full access to water, nutrients and sunlight that would otherwise be used by the mother plant.

2.10.2. Consequences of gregarious flowering

The mass flowering of bamboos and consequential seed setting also have economic and ecological consequences. The huge amount of seeds in forests attract large populations of rats and other rodents which may consume all available food crops and may cause severe spread of diseases in surrounding villages. Furthermore, when bamboo stems die, local people lose access to a vital building material for their homes and agricultural activities. Various methods have been tested to revive flowering bamboo but only a few have been effective in some cases, many have not.

Table 2. 3. Flowering cycle in different Bamboo species

Species	**Number of Years**
Bambusa balcooa	35-45
Bambusa bambos	45
Bambusa tulda	30-60
Dendrocalamus giganteus	40
Dendrocalamus hamiltonii	30-40
Dendrocalamus longispathus	30-32
Dendrocalamus strictus	25-45
M. baccifera	40-45
Ochlandra ebracteata	7
Phyllostachys bambusoides	120
Sinarundinaria wightiana	01
Thyrsostachys oliveri	48-50

Gregarious flowering

Sporadic flowering

2.11. Global scenario

The geographical distribution of bamboo depends on climate. It adapts easily to a range of climatic and soil conditions, and is therefore widely distributed in the tropical and subtropical zones between approximately 46°N and 47°S latitude, reaching elevation as high as 4000 m in the Himalayas and parts of China. Normally, bamboo thrives at temperature range of 8.8 to 36°C, but some species can grow in cold climate with temperature of about -20 °C (Troya and Xu, 2014). Rainfall plays a dominating role in the distribution and growth of different species. Bamboo prefers region of high rainfall ranging from about 1270 mm to about 6350 mm or more (Ha, 2010; Ram *et al*., 2010; Song *et al*., 2011).

Geographically bamboo is distributed in three main regions; namely, the Asian- Pacific Region, the American Region, and the African Region (Troya and Xu, 2014). About 80% of bamboo forest lands and species in the world are distributed in Asia and Pacific regions. Within its tropical and

temperate climates, Asia has many advantages for bamboo growth accounting for more than 900 species in 40-50 genera. Many Asian countries such as China, India, Myanmar, Indonesia, Thailand, and Vietnam are very rich in bamboo resources.

There are different opinions of scientists on the distribution of bamboo species. According to Sharma (1980), Soderstrom & Ellis (1987) and Upreti & Sundriyal (2002) bamboos are 1250 species under 75 genera spread in all over the world whereas Ohrnberger and Georrings (1985) mentioned approximately 110 genera and 1010 to 1400 species. Londoño (2002) affirms that in Latin America have 20 genus and 429 species. According to Chen *et al*. (2009) China has 500 bamboo species belonging to 48 genera, Brazil has 256 species of which 176 are endemic (Greco *et al.*, 2015). India has 148 species and 29 genera (Sharma and Nirmala, 2015) and Japan has 84 species (Bystriakova *et al*. 2003).

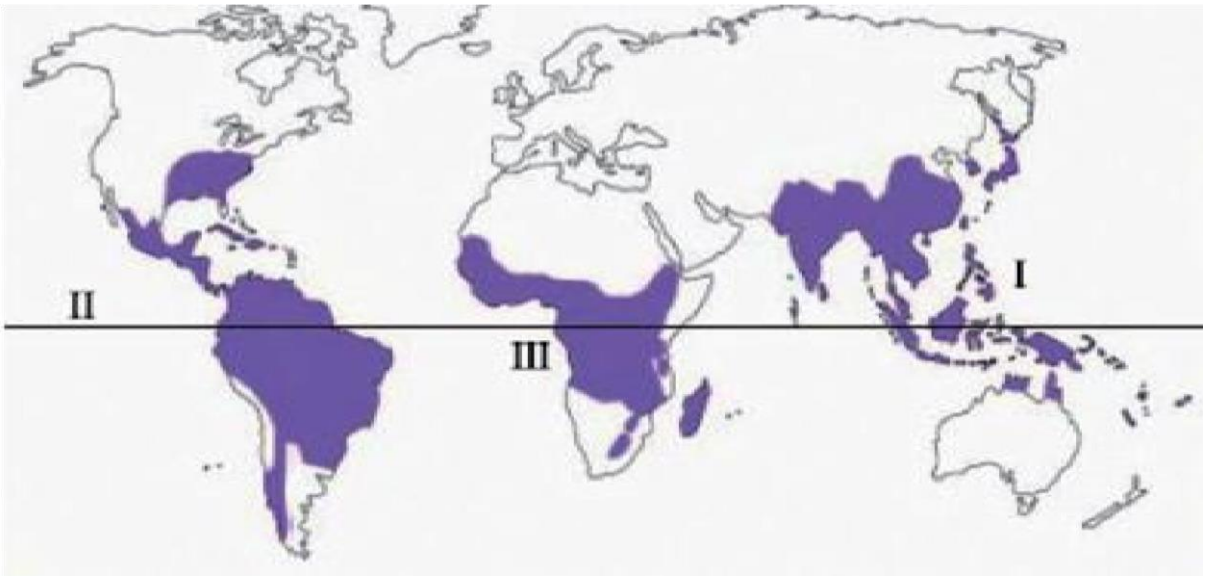


Figure: A sketch map of World Bamboo Distribution. The Asian-Pacific Region (I); The America's Region (II); The African Region (III)

2.12. World bamboo market

According to Global Industry Report, the global bamboo market at USD 72.10 billion in 2019 which is expected to reach over USD 98.75 billion by 2026, growing annually at around 5.5% during the period from 2020 to 2026. Although India has 30% of the world's bamboo resources with the world's largest growing area of more than 15.69 million hectares, the country taps only one-tenth of its bamboo potential contributing to only 4% share of the global market for bamboo products.

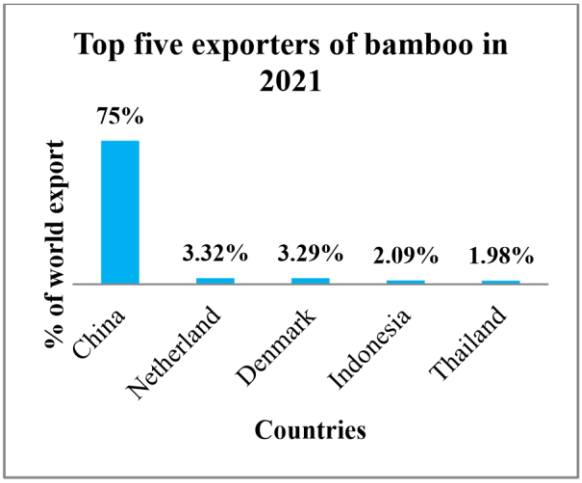


Fig 2.1. Top five exporters of bamboo

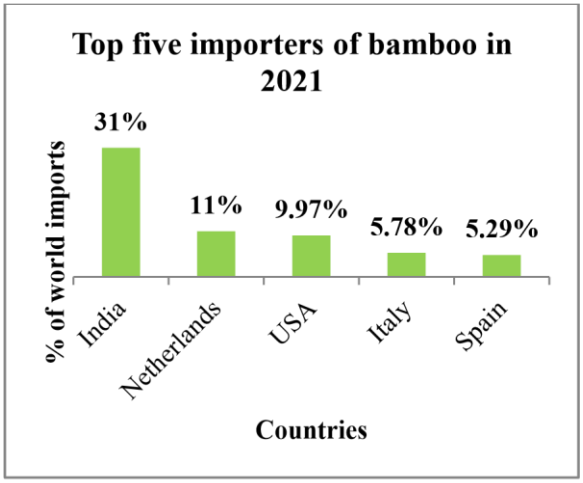


Fig 2.2 Top five importers of Bamboo

Fig source: https://trendeconomy.com/data/commodity_h2/140110

The market for bamboo products is large in high income countries, while global supply is dominated by China. According to a study, the top five global exporters of bamboo in 2021 were China, Netherland, Denmark, Indonesia, and Thailand (Fig 2.1). However, the top five leading importers were India, Netherland, USA, Italy, and Spain (Fig Fig 2.2). Three countries, namely, China, India, and Myanmar account for 80 per cent of the total bamboo area in the world. The industrialization of bamboo is at 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.

Why China is a leader?

China is one of the most important countries for bamboo production and processing. Its bamboo resources, area, growing stock and trade volume all rank first in the world, and are reputed as Kingdom of Bamboo. China has made a breakthrough in the development and scientific cultivation of bamboo. At present, China ranks first in bamboo research worldwide, because of numerous research units and strong technical force. Some of the main reasons are mentioned below:

- **Political will:** China is the earliest country to develop and utilize bamboo resources after realising the presence of abundant bamboo resources and the largest bamboo forest reserve. The Chinese government attaches great importance to developing the bamboo industry.

China’s forestry development has four sunrise industries- the bamboo industry, flower industry, forest tourism and forest food industry. Being a good friend of the poor, bamboo is a precious renewable resource and a new material of green economy. Chinese are using bamboo resource to achieve the goals of poverty eradication, environmental protection, and green development.

- **Strategic planning:** the Chinese government is working towards the promotion of bamboo industry in a strategic manner. They have categorised industrial bamboo plants to be used at national and provincial level. The country has well defined laws and concrete framework of regulations related to bamboo industry. After identification of resource, they have progressively worked towards the increment of the same. According they have a short term and long term economic goals for each year to be achieved.
- **Team work:** they have different groups such as expert group, CEO group, farmer group, artist, or craft man’s group, administrator group to work towards the same goal. And each group is working towards their own goal.

Picture depicting the quality of straight bamboo poles produced in china

2.13. National scenario

India has largest area under bamboo in the world, which is estimated around 15.0 million hectare, with 136 species and 23 genera (ISFR, 2021). However, India stands second largest in terms of annual cultivation of bamboo. According to the Union Ministry of Agriculture and Farmer Welfare, India's annual bamboo production is estimated at 3.23 million tonnes. However, despite all this, the country's share in the global bamboo trade and commerce is only 4 per cent.

2.13.1. National Bamboo Resource

According to the India State forest report 2021, Madhya Pradesh has maximum area (1.84 million ha) under bamboo followed by Arunachal Pradesh (1.57 million ha), Maharashtra (1.35 million ha) and Odisha (1.12 million ha) (Table 2.4) (Fig 2.3). The North- eastern States and West Bengal account for more than 50% of the bamboo resources of the country. Other bamboo rich areas of the country are the Andaman & Nicobar Islands, Chhattisgarh, Madhya Pradesh, and the Western Ghats. Although, bamboo is found in almost every state of the country, its distribution, and concentration varies primarily due to the climatic and edaphic conditions. As compared to the estimates of ISFR 2019, the total bamboo bearing area in the country has decreased by 1.06 million ha. If we compare the state wise area, the bamboo bearing area in Mizoram has increased by 1,085 sq km followed by Arunachal Pradesh (758 sq km). Similarly, Madhya Pradesh has shown highest decrease of 2,473 sq km in the bamboo bearing area followed by Maharashtra (1,882 sq km).

Table 2.4: Distribution of bamboo resource in different states of India

Sr No	State/UTs	Bamboo bearing area (Sq.km)	Sr No	States/UTs	Bamboo bearing area (Sq.km)
1	Andhra Pradesh	6104	16	Meghalaya	5007
2	Arunachal Pradesh	15739	17	Mizoram	4561
3	Assam	10659	18	Nagaland	3947
4	Bihar	1103	19	Odisha	11199
5	Chhattisgarh	10467	20	Punjab	280
6	Goa	288	21	Rajasthan	1555
7	Gujarat	3547	22	Sikkim	994
8	Haryana	39	23	Tamil Nadu	4001
9	Himachal Pradesh	1027	24	Telangana	4535
10	Jharkhand	3717	25	Tripura	4201

11	Karnataka	8624	26	Uttar Pradesh	1832
12	Kerala	2404	27	Uttarakhand	1201
13	Madhya Pradesh	18394	28	West Bengal	702
14	Maharashtra	13526	29	Andaman and Nicobar Island	1413
15	Manipur	8377			
	Total	**149443 Sq Kms**			

Source: ISFR-2021

The major bamboo genera found in India are Arundinaria, Bambusa, Chimonobambusa, Dendrocalamus, Dinochola, Gigantochloa etc. Bambusa and Dendrocalamus are tropical species, whereas Arundinario and its associates occur in the temperate region and are common at high altitudes in the Western and Eastern Himalayas. Phyllostachys is a genus of temperate to warm temperate regions. *Dendrocalamus strictus* is a predominant species of the dry deciduous forests, while *Bambusa bambos* thrives in the moist deciduous forests. *Gigantochloa rostrata* is the most important bamboo species in the semi evergreen forests of Andaman Islands. The commercially important bamboo species of the Eastern & the north-eastern India are *Bambusa tulda, Dendrocalamus hamiltonii* and *Melocanna bacciferra.*

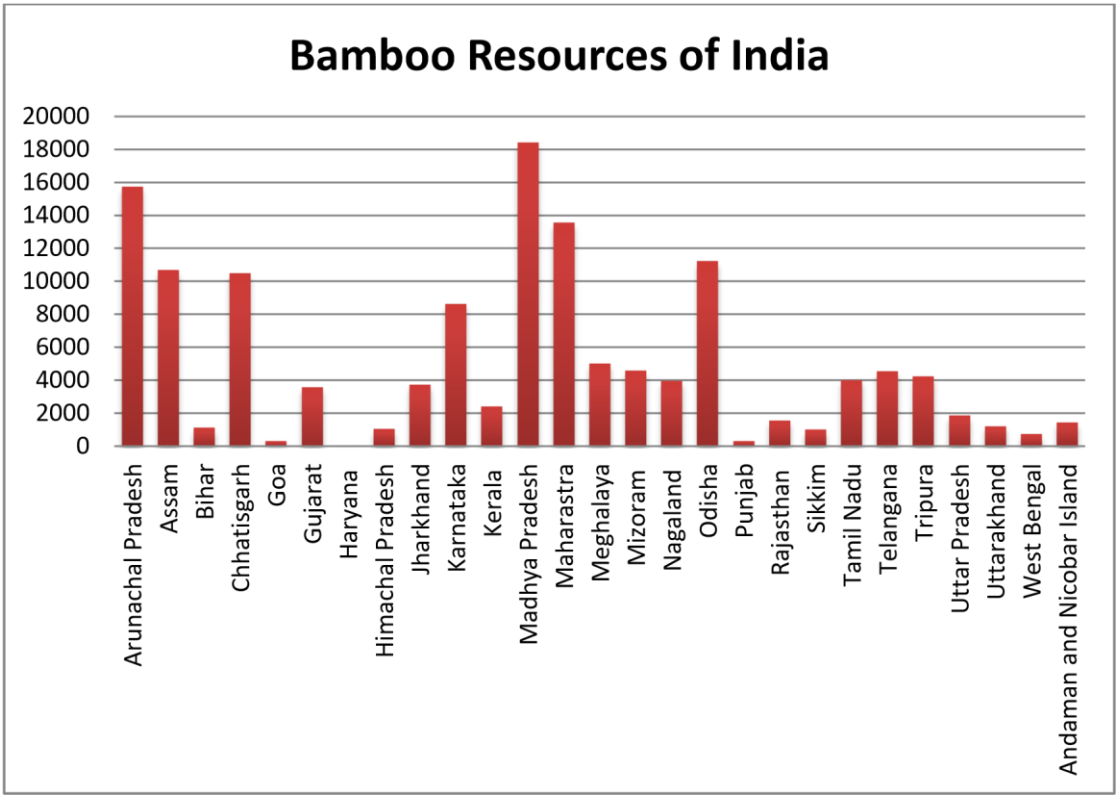


Fig 2.3 Bamboo resources of India

Bamboo is one of the fastest-growing species in the world and takes a much shorter period from plantation to processing, just 3 to 5 years, which is very less compared to most trees with 30 to 50 years of rotation 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. Bamboos grow not only in forests but also widely raised in homesteads and farms. Shade loving crops such as colocasia, ginger, and turmeric can be intercropped in bamboo-based agroforestry systems. Its leaves may be used as green fodder throughout the year for the ruminants in the fodder deficit areas.

Bamboo has long been recognized as an essential commodity globally for its diverse applications ranging from household construction to utensils to food and medicines. Owing to its ecofriendliness and large biomass production bamboo is being considered as an easy substitute for timber. Moreover, the bamboo also helps in the maintenance of soil health and checking erosion. Therefore, due to the manifold advantages of bamboo resources are often designated as Green Gold, Poor man's timber, friend of the people and cradle to coffin timber.

2.14. Organisations Working For Bamboo

2.14.1. The International Network for Bamboo and Rattan (INBAR)

The International Network for Bamboo and Rattan (INBAR) was created in 1997, is an intergovernmental development organization that promotes environmentally sustainable development using bamboo and rattan. It has 49 member States. In addition to its Secretariat headquarters in China, INBAR has Regional Offices in Cameroon, Ecuador, Ethiopia, Ghana and India. (Source: https://www.inbar.int/about-inbar/)

Its unique setup makes INBAR an important representative for Member States. With over 40 of its Member States from the Global South, INBAR has played an especially strong role in promoting South-South cooperation for the last 20 years. Since its founding in 1997, it has been making a real difference to the lives of millions of people and environments around the world, with achievements in areas such as: raising standards; promoting safe, resilient bamboo construction; restoring degraded land; capacity-building; and informing green policy and Sustainable Development Goal objectives.

INBAR's work is wide-ranging, but has several core focus areas such as:

- *Capacity building and training:*
- *Climate change:*
- *Energy*
- *Construction and design*
- *Ecosystem support*
- *Livelihoods*
- *International trade*

Guided by its 2015-2030 strategy, INBAR's priority is to work with countries to focus the use of bamboo and rattan as strategic resources that support sustainable development and their green economy action plans. Its strategy and performance contribute directly to at least six Sustainable Development Goals (SDGs), including:

SDG 1: End poverty in all its forms
SDG 7: Provide affordable, sustainable and reliable modern energy services for all

SDG 11: Access to adequate and affordable housing

SDG 12: Efficient use of natural resources

SDG 13: Address climate change

SDG 15: Protect and restore terrestrial ecosystems

INBAR is a permanent observer to the UN Convention for Biological Diversity, the UN Framework Convention on Climate Change and the UN Convention to Combat Desertification. In 2016, INBAR started the Global Assessment of Bamboo and Rattan for green development (GABAR), a major initiative to provide policy-relevant information and suggestions about the potential of these plants. The mission of INBAR is to enhance the well-being of the producers and users of bamboo and rattan within the context of a sustainable bamboo and rattan resource base. INBAR will continue to promote and support sustainable and green growth.

2.14.2. Centre for Indian Bamboo Resource and Technology (CIBART)

It is a non-governmental organisation (NGO) registered as a not for profit public company limited by shares under Section 25 of Companies Act and Section 8 under Indian Company Act, 2013. Set up in 2002, as an apex technical and policy organisation on bamboo in India, CIBART is devoted to rural, economic and environment development. CIBART has developed and mentored the largest group of subsidiary NGOs and social enterprise. The CIBART employs 1024 people on a

full time basis, mainly bamboo artisans, and can address any need/opportunity for natural resource utilization and value added products thereon.

The main objectives of CIBART to be pursued by the company on its incorporation are:

- To identify, plan, undertake, coordinate and support strategic development activities on bamboo & cane and related industries/ sector.
- To help and coordinate activities of organizations, agencies and other bodies and institutions on the development and utilization of bamboo & cane based products.
- To facilitate the linking of scientific, technical, management and financial expertise with local partners with relation to Bamboo, Cane and related products.
- To provide expert resources that bridge scientific knowledge with local needs in strategic areas of research, technology transfer, policy formulation and information services for bamboo & cane and related products / industries.
- To promote bamboo & cane based products and related technologies.
- To provide consultancy, assistance and research support to bamboo related technology with regard to the setting up and structuring of bamboo-based industries, cultivation and development of bamboo made products

2.14.3. Konkan Bamboo and Cane Development Centre (KONBAC)

In 2003, Sindhudurg was selected as one of the bamboo Action Research sites (ARS) by INBAR. Later in 2004, Centre for Indian Bamboo Resource and Technology (CIBART) who is INBAR's partner in India, established a non-profit NGO, the Konkan Bamboo and Cane Development Centre (KONBAC) dedicated to bamboo and cane development in the Konkan region. KONBAC was established as a not-for-profit Section 25 company. The role of KONBAC is to take forward the ARS programme in the Konkan division and utilize the available bamboo resources to help bamboo working communities derive greater economic returns from bamboo, expand its use by others by trying to overcome the caste and social prejudices, and generate employment and income through the setting up of bamboo-based enterprises. KONBAC has developed into a selfsustaining institutional ecosystem and has a fully developed facility for designing, prototyping and producing premium bamboo products for Indian and international markets. It has in place mechanisms to link poor bamboo producers to larger lucrative markets and has already emerged as a model that is being emulated elsewhere in India and overseas. It has established several facilities/areas of expertise (both infrastructure based and human resource) within the organization.

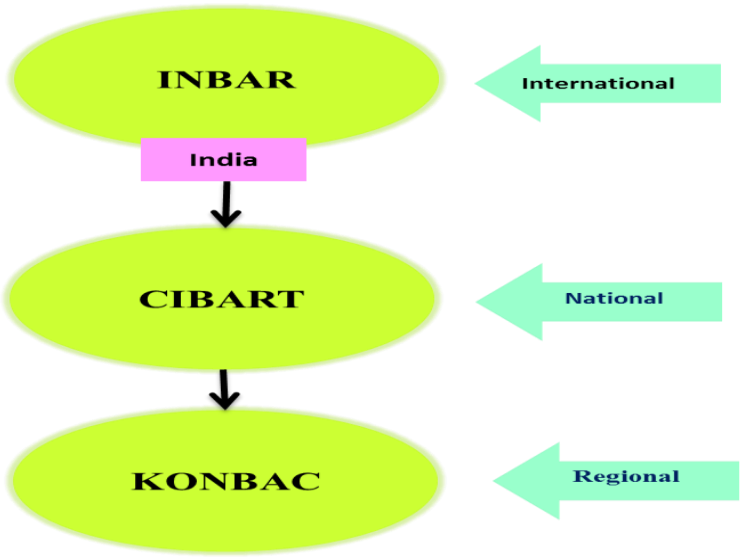


Fig 2.4: Organisation structure

2.15. Bamboo Policies of India

2.15.1. National Bamboo Mission of India

The National Bamboo Mission initially launched by GoI in 2006, with the following objectives such as:

- To increase the area under bamboo plantation
- To improve post-harvest management
- To promote product development
- To rejuvenate the under developed bamboo industry in India
- To promote skill development, capacity building, awareness generation

Later, to re-align efforts so as to reduce dependency on import of bamboo, the restructured National Bamboo Mission (NBM) has been launched in 2018-19 to focus on the development of complete value chain of bamboo sector and link growers with markets. In the same context, the Government of India promulgated the Indian Forest (Amendment) Ordinance, 2017 to exempt bamboo grown in non-forest areas from definition of tree, by amending the Section 2 (7) of the Indian Forest Act, 1927 and thereby doing away with the requirement of felling/transit permit for its transport and economic use. The major objective of the amendment is to promote cultivation of bamboo in non-forest areas to achieve the twin objectives of increasing the income of farmers and

also increasing green cover of the country under the purview of National Bamboo Mission. Major objectives of the Mission are:

- To increase the area under bamboo plantation in non- forest Government and private lands to supplement farm income and contribute towards resilience to climate change as well as availability of quality raw material for industries.
- To improve post-harvest management through establishment of innovative primary processing units near the source of production, primary treatment and seasoning plants, preservation technologies and market infrastructure.
- To promote product development keeping in view market demand, by assisting R&D, entrepreneurship & business models at micro, small and medium levels and feed bigger industry.
- To rejuvenate the under developed bamboo industry in India.
- To promote skill development, capacity building, awareness generation for development of bamboo sector from production to market demand.
- To re-align efforts so as to reduce dependency on import of bamboo and bamboo products by way of improved productivity and suitability of domestic raw material for industry, so as to enhance income of the primary producers.

Considering the need and demand from bamboo based stakeholders and to provide cheaper bamboo products to the consumers, the Government has reduced GST on bamboo furniture & bamboo flooring to 12%. The Mission also envisages establishment of primary processing units close to the production area to reduce transportation costs and complete utilization of bamboo to move towards zero wastage so as to improve economies of entrepreneurs and lower costs to consumers. For popularizing use of bamboo & bamboo based products, seminars, conferences, awareness campaign etc. at national, state & district levels are regularly conducted under the restructured NBM. Awareness is also created through print and electronic media and participation of NBM in fairs national & international fairs. (Source: PIB).

2.15.2. State Bamboo Policies

2.15.2.1 Assam bamboo and cane policy

The Assam bamboo and cane policy formulated in 2019, aims at sustainable development and utilization of bamboo and Cane resources in the state through scientific management and stakeholder's participation. The main action plan for upliftment of the sector involves:

Conservation of the resource: to conserve the superior species, introduction of high yielding verities for commercial cultivation and maintain a bambusetum to enable local artisans, bamboo growers and farmers to get first-hand information about morphological features, aesthetic properties and growth characteristics of these plants.

Plant propagation: to maintain plant material for large scale cultivation setting up of different nurseries. The Table (2.5) provides the tentative details of establishing nursey.

Table 2.5. Nursery establishments as per National Bamboo Mission

Tentative Activities		Maximum Incentives (Rs in Lakhs)	Pattern of Assistance
Bamboo Nursery both in public and private sectors including Strengthening (project based)	Hi-tech (2ha)	50	100% of cost to Govt. sector and 50% of cost to private sector as credit linked back ended subsidy
	Big (1 ha)	16	
	Small (0.5ha)	10	

1. *Plantation:* Raising of plantations either in Government/Panchayat/ community land including wastelands or in Farmers field either as block plantations or in their homestead gardens (Table 2.6). As per the plantation, maintenance funds in subsequent two years shall be linked to survival percentage - minimum 80% after 1st year and 100% after 2nd year, with replacement saplings of the same age as that of the remaining surviving ones.

Table 2. 6: Financial assistance for bamboo as per Assam bamboo policy

Sl	Tentative Activities	Maximum Incentives (in Lakh)	Pattern of assistance	Minimum area to be planted (as suggested by State Bamboo Development Agency)

1	High density Bamboo plantation on Govt./ Panchayat/ Community land including waste lands	Rs 1.00 lakh per ha over a period of 3 years	100% of cost to Govt. sector and 50% of the cost upto 2 ha (~ <3000 plants), 30% of the cost for 2 - 4 ha (up to 10000 plants) over 3 years (50:30:20). For plantation above 4 ha no subsidy will be provided. Maintenance funds will be linked to performance (survival %)	0.5 ha
2	Block Plantation/ Boundary plantation on farmer's field	Rs.1.00 lakh per ha (equivalent to Rs 240 per plant)	100% of cost to Govt. and 50% of the cost of Private Sector over 3 years (50:30:20). Maintenance funds will be linked to performance (survival %)	0.14 Ha (1 Bigha)

2. *Transfer of Technology*: Under this programme, skill development / training of farmers, field level workers, and Entrepreneurs will be taken up. Training to bamboo farmers on scientific harvesting of bamboos and bamboo shoots will also be encouraged.
3. *Post-harvest storage and treatment facilities*: Use of Integrated pest management and Preharvest and post-harvest treatments are effective in reducing damage by fungi and insects. Finding a suitable and cost-effective treatment for protection against biodegradation and fire needs further research.
4. *Inventory, data collection, and Research*: Detailed inventory of bamboo resource inside forests and outside forest areas is essential. It will be collected by engaging some Government Agency and/or through private Agencies or contractual functionaries. Research for the identification of genetically superior varieties/ Species, establishment of Tissue culture lab, demonstration plot establishment, and Bamboo Market Research will also be promoted.
5. *Encouragement of Bamboo entrepreneurs:* promotion of Small and medium scale industries, through entrepreneurship development; revival of old plywood industries as bamboo processing area, standardization of bamboo species and focus on activities to promote bamboo products as well as its market
6. *Development of Infrastructure/Bamboo Cluster*: setting up of bamboo cluster with basic facilities like provision of shed, power, water supply, effluent treatment plant etc. Development of effective value chain from the sourcing of raw material to finished product marketing. Based on PPP model, financial support upto 50% of the project cost may be

provided to the Bamboo/Cane based Manufacturing/ Processing units for promoting the Bamboo/Cane plantation and arranging for the buyback of the same.

7. *Marketing:* promotion of bamboo and cane products through advertisement on and off e platforms, Zone & State Level Exhibitions, and encouragement of tie-ups in order to boost bamboo market. Further, for marketing of bamboo products, the Government of Assam would encourage Government agencies to utilize bamboo for door frames, doors, window frames, windows, indoor and outdoor furniture, flooring, wall cladding and outdoor decking in all Government Projects and also in Private Projects.

2.15.2.2. Nagaland Bamboo Policy

Nagaland has rich bamboo resource therefore the policy aims to develop the bamboo resource and transform the bamboo as an enterprise. The main features of bamboo policy action plan include:

1. Development of Natural Bamboo Forest: identification of natural bamboo area, and their management according to the approved plan.
2. Bamboo Plantation Development: Promotion of bamboo cultivation by individuals and communities on private and community lands, introduction of superior varieties of seedlings, development of bamboo nursey, streamlining of finance and credit facilities for bamboo plantation management and harvesting, and Development of mechanism for technology transfer, extension and awareness education.
3. Regulation of bamboo harvest: to make the production and transportation of bamboo cumbersome and hassle free.
4. Protection from forest fire: adequate financial measures required to control the economic loss from fire.
5. Bamboo flowering and strategy to utilize surplus bamboo: often there is damage to bamboos while harvesting therefore, construction of extraction road/path network to reduce extraction cost. use of improved products from bamboo for infrastructure development works like construction, road laying, retaining walls, jhum terracing, water harvesting structures and gabions
6. Bamboo trade: With increased bamboo harvesting before the flowering and establishment to bamboo industries and with support incentive framework, trade in bamboo and bamboo

products within and outside the State shall grow. It shall be the endeavor of the State to promote trade in bamboo and bamboo products among the people. A study to organize the marketing structure of the Bamboo Industry that may evolve in the State is a priority need.

7. Infrastructure for development of bamboo trade and commerce: A very good network of extraction roads is required which need to be tie-up with schemes such as agri-link roads and rural connectivity programmes under PMGSY. It shall endeavor to initiate special infrastructure programmes for Bamboo roads and strengthening the Rural Power programmes to provide special infrastructure for the development of bamboo as an industry in Nagaland.
8. Development of bamboo as an enterprise: Development of ''Bamboo as enterprise'' shall evolve policies and action plans that will focus on the following aspects:

   A. *Promote bamboo based industries:*

   i. Food Products ii. Medicinal, Chemical Products and Alcohol Beverages iii. Craft, handicraft and Art Products iv. Value added products and wood substitutes such as ply, flooring tiles, shuttering, etc.

   B. *Create awareness of the uses and value of bamboo by imparting training, seminar, workshop, etc.*

   C. *Promote and develop traditional usage of bamboo*

9. Human resource and entrepreneurial development: Adequate pool of trained labor to be created for the purpose. The activities that help in strengthening the market and associated group shall be promoted.
10. Research and development: Appropriate technology and technology transfer would be facilitated through establishment of technology part to facilitate effective lab to land transfer.
11. Institutional arrangement: the bamboo agency shall be assisted in its function by two Task forces one, for development of bamboo as resource and enterprise and the other e for Development of Bamboo as an enterprise.
12. Funding of the bamboo policy: The Bamboo Agency will maintain a Bamboo fund to achieve the goals as set out in the Nagaland Bamboo Policy. This shall consist of the funds received from the National Bamboo Mission, allocations from the State Plan and any other sources as the Agency may so obtain.

13. Sharing of benefits: The State Government will levy the royalty Sale tax excise and any other taxes as enforced from time to time on the bamboo harvest and the Bamboo Products produced in the State.

2.15.2.3. Tripura Bamboo Policy

Tripura lies in the highest climate, vegetation, precipitation zone of the country. State is endowed with rich and diverse bamboo resources. Hence the policy envisages to develop bamboo sector in the state through a market-led community-based utilization, development and conservation of the resource in forest and farm areas. The approach of the policy in achieving the above mentioned objectives would be based on the following:

- Community and private sector participation in bamboo development
- Support to activities focussed on conservation of bamboo resource
- Plant propagation
- Enhancement of the production base
- Management Information System (MIS), inventory and database development
- Promotion of handicrafts
- Industrial utilisation and entrepreneurship development
- Bamboo utilisation in building material and low cost housing
- Development of marketing and trading plan and systems

The strategy involves:

1. Community participation
2. Conservation of the resource
3. Plant propagation
4. Development of the resource
5. Inventory and data collection
6. Handicrafts
7. Industrial Use
8. Building Material
9. Marketing
10. Funding and institutional strengthening
11. Monitoring and regulation

2.15.2.4. Manipur bamboo policy

The Manipur Government has recently come out with Draft on Manipur Bamboo policy. With the intent of harnessing the huge economic and environmental potential of Bamboo, the Manipur Bamboo Policy envisages:

1. Sustainable development and utilization of bamboo resources through scientific management and research.
2. Revitalization and promotion of local traditional bamboo craft and art with improved technology, design, and market linked trade for value added items for export through industrialized mode of production.
3. Promotion of bamboo based industries at cottage level, small scale, medium scale and large scale for utilizing the resources at a sustainable level for generating assured income to farmers and entrepreneurs. The policy will provide a road map for developing bamboo based enterprises. Developing bamboo based industries and advocating a strong link between the producer (farmer) and industry.
4. Promotion of bamboo sector development as an essential component of rural development strategy linked with forestry and agri-business sector in the State promoting rural employment.
5. Promotion of bamboo as an essential wood substitute by increasing bamboo production and bamboo based enterprise to reduce pressure on forests. To ensure the ecological and environmental benefits of bamboo are harnessed to its potential for the State.
6. Developing bamboo sector through market-led and community-based resourcing leading to augmentation of the rural economy.
7. Promotion of private bamboo plantation (individual and community owned) as a key thrust area for future economy of the State.
8. Promotion of awareness and understanding of bamboo as “green gold” among farmers, traders, industry, and people of the State to harness its full potential and spur rural and industrial economy of the State.
9. Effective exploitation of existing bamboo before the impending gregarious flowering. To design effective mitigation and management strategies.

2.15.2.5. Madhya Pradesh bamboo mission

The main objective of the state bamboo missions are:

1. To increase the area under bamboo plantation in non- forest Government and private lands to supplement farm income and contribute towards resilience to climate change as well as availability of quality raw material requirement of industries. The bamboo plantations will be promoted predominantly in farmers' fields, homesteads, community lands, arable wastelands, and along irrigation canals, water bodies etc.
2. To improve post-harvest management through establishment of innovative primary processing units near the source of production, primary treatment and seasoning plants, preservation technologies and market infrastructure.
3. To promote product development keeping in view market demand, by assisting R&D, entrepreneurship & business models at cooperative, micro, small and medium levels and feed bigger industry.
4. To rejuvenate the under developed bamboo industry in India.
5. To promote skill development, capacity building, awareness generation for development of bamboo sector from production to market demand.
6. To realign efforts so as to reduce dependency on import of bamboo and bamboo products by way of improved productivity and suitability of domestic raw material for industry, so as to enhance income of the primary producers.

2.15.2.6. Maharashtra bamboo policy

Although the state does not have a concrete policy for bamboo but the government has recommended few strategies to promote bamboo, these include:

1. Redefine the role and responsibilities of the Secretariat
2. Creating bamboo cells within Social Forestry Directorate (SFD) and FDCM
3. Improved communication for bamboo sector
4. Multiple Stake Holder Agency for developing bamboo sector in Maharashtra
5. Bamboo for Artisans
6. Increase in bamboo specie biodiversity in Maharashtra forests
7. Proper segregation and treatment of bamboo in bamboo depots
8. Installing treatment plants within or near big bamboo depots
9. Developing bamboo resources within forests
10. Commitments regarding availability of bamboo
11. Promotion of farm bamboo
12. Promoting intense bamboo farm clusters

13. Removal of restriction on farm bamboo movement by withdrawal of Transit pass system
14. Human Resources for the Bamboo Sector

Although India has the highest area under bamboo, yet India is a net importer of bamboo. Many states have not yet drafted their bamboo policy. The states, which had already drafted have not yet revised their policy after bamboo moved into grass category. There is a huge difference between the written policy and the actual ground work that is going on. Almost twelve states have a good existing bamboo resource but still no action plan is present to conserve those resources.

The restructured National Bamboo Mission (NBM) has also been launched in 2018-19 to focus on the development of complete value chain of bamboo sector and link growers with markets. With an aim to support the objectives of National Bamboo Mission and promote the bamboo cultivation, "**the case study on bamboo farming**" was undertaken in Sindhudurg and Latur district of Maharashtra. The study highlights the actions, which are currently being taken by the farmers and other stakeholders to promote bamboo farming in both the areas.

III. METHODOLOGY

The study was conducted in Sindhudurg and Latur districts of Maharashtra. Maharashtra is a state in the western peninsular region of India occupying a substantial portion of the Deccan plateau. According to ISFR 2021, the total geographical area of the state is 307,713 sq km. the total population is 112.37 million out of which 45.22 per cent is urban population and 54.78 per cent is rural population. There are a total of 35 districts in the state.

Bamboo is a fast growing, wide spread, renewable, versatile, low cost natural resource. Bamboo helps in climate change mitigation by sequestering carbon. It can absorb nearly 400 tonnes of carbon per hectare. According to Forest survey of India, 2021 the total bamboo bearing area of the country is estimated to be 15.0 million hectare. Out of the total area, Maharashtra has 1.35 million hectare of area under bamboo. However, as compared to ISFR 2019, Maharashtra has shown the decline of 1882 sq km in bamboo bearing area.

Sindhudurg is a home to *Dendrocalamus stocksii* or Manga bamboo. Manga bamboo has been the preferred choice among farmers for its multipurpose uses. It is solid without thorns and grows straight, achieving a height of 15 m. It is used as stakes in horticulture, for making implements, for scaffolding and for making furniture and handicrafts. It starts yielding after five years, yielding eight to 12 sticks every year. The Konkan Bamboo and Cane Development Centre (KONBAC) dedicated to bamboo and cane development in the Konkan region is working actively to promote bamboo cultivation and related enterprise. It has in place mechanisms to link poor bamboo producers to larger lucrative markets and has already emerged as a model that is being emulated elsewhere in India and overseas.

Latur district falls in the Marthawad, the worst drought-affected region in Maharashtra. The farmers are looking for crop options which can fetch them good income but require less irrigation and management. Recently they are being educated about the benefits of bamboo farming by phoenix foundation. Phoenix foundation is a non-government organisation working towards the farmer's education and rural development in Latur.

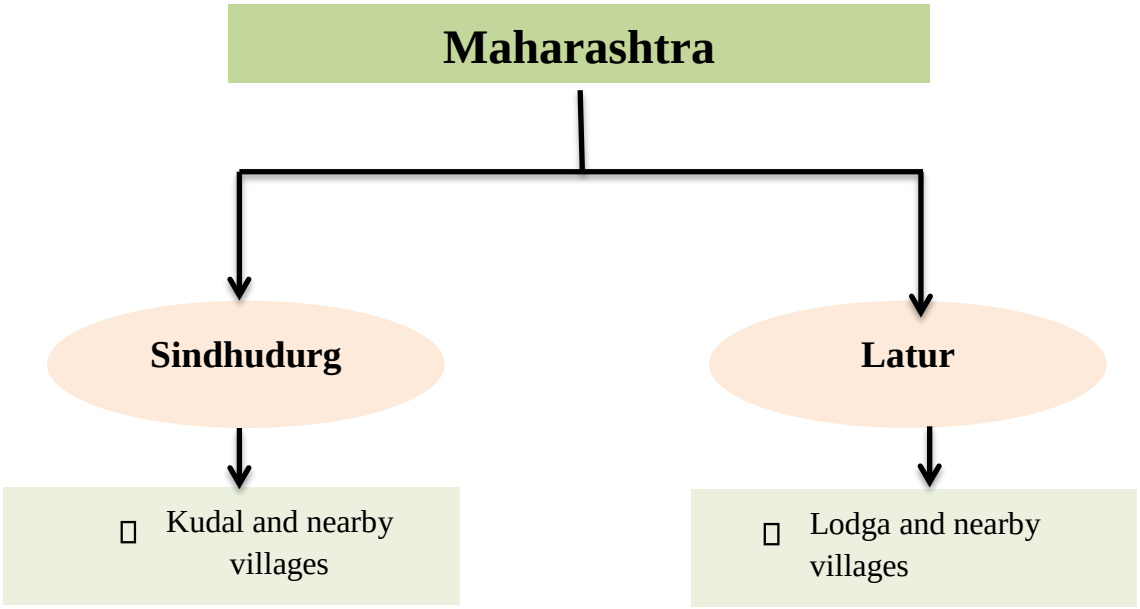
Sindhudurg has achieved a little success towards development of bamboo sector due to the presence of KONBAC; however, Latur is still at its initial stage.

a. Sampling

A non-probability sampling method, purposive sampling was used in this research. In purposive sampling, units are selected because they have characteristics that we need in our sample. For the

purpose of this research, bamboo based farmers, artisans and entrepreneurs were targeted. Farmers and artisans were purposively selected with expert advice from KONBAC. The advice was based on their working relationships with bamboo farmers, artisans and labours. A few officers from lead bank and agriculture and Forest departments were also interviewed to gain the idea about their perception. A total of 30 farmers, 5 artisans, and 21 labours were interviewed (Table 3.1) Table 3.1 Number of interviews conducted

Categories	**Number of interviews conducted**		
	Sindhudurg	**Latur**	**Total**
Farmers	20	10	30
Artisans	3	2	5
Labours	10	11	21



b. Designing Interview Schedule

Three different interview schedules were designed for bamboo farmers, bamboo based artisans and for labourers. For the purpose of the present study, a semi structured interview schedule was prepared and also observation method was used to collect the information. The schedule consists of both closed- and open-ended questions relating to socio-economy, income, education, skills, products, tools used, trainings provided, problems associated with and about insurance were asked. The schedule has been pre-tested. The final schedule was used for data collection.

c. **Data collection**

The current study used both qualitative and quantitative methodologies to attain the research goals. Both original field surveys and secondary sources were used to gather the data.

Secondary data collection: It was collected after reviewing the annual reports, research papers, online publications, books, magazines etc. and also different case studies regarding bamboo cultivation in the selected districts of Maharashtra to achieve the objectives of the study. It helped to explore the impact of good extension practices, bamboo farming, and value chain system.

Primary data collection: Data was collected from the target group from Sindhudurg and Latur districts of Maharashtra. It was collected by conducting survey and face to face interviews with 30 farmers, 5 artisans, and 21 labours. Also, a few officers from lead bank and agriculture and Forest departments were interviewed to gain their views.

d. Data Analysis

The data collected from field was further scrutinized to validate the data. Quantitative techniques were employed for analysis of the primary data collected from the respondents during the field survey. A database management system in MS excel version was developed for easy data entry of the information from the field survey formats. In order to maximize accuracy, most of the variables were pre-coded as most of the questions in the schedule were open-ended. This enabled to analyse the data for consistency checks, sorting of open ended questions cross checking as well as validating the data entry. The collected data was statistically analyzed by using suitable simple descriptive statistics (averages, percentages); pivot tables and the analyzed data was presented in tabulation and graphic form for better interpretation.

IV. RESULT AND DISCUSSION

4.1. The Case study of Sindhudurg

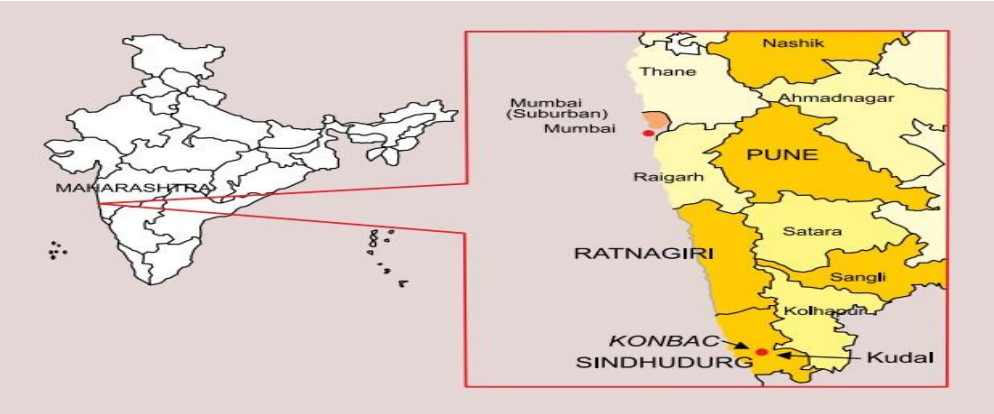
The total geographical area of Sindhudurg is 5,04,000 hectares, which is differentiated as nonagricultural use (4.07%), barren and un-cultivable land (19.80%), permanent pastures/ other grazing land (0.40%), cultivable waste land (13.12%), forest (6.57%) and net area sown (27.88%) (Table 4.1).

Table 4.1: Land use classification of Sindhudurg

District/State	**Sindhudurg**
Total area	4.07%
Forests	19.80%

Area under Non Agricultural Uses	13.12%
Barren and Un-culturable Land	2.86%
Permanent Pasture and other Grazing Land	20.28%
Land under Misc. Tree Crops and Groves Not included in Net Area Sown	6.57%
Culturable waste Land	5.04%
Fallow Lands other than current Fallow	27.88%
Current Fallow	0.40%

In Sindhudurg district, Kudal is a lovely small town with a population of 16,015 (Census, 2011). The town is situated on the banks of Karli river. Kudal region was selected because of presence of Konkan Bamboo and Cane Development Centre (KONBAC). KONBAC is a non-profit organisation dedicated to bamboo and cane development in the Konkan region. As the study purposively required the bamboo farmers, labours and artisans attached to bamboo based industry, therefore this place was the most appropriate. The bamboo farmers were targeted with the help of experts' advice of KONBAC.



Map of Sindhudurg and Kudal

4.1.1. The natures' gift in kudal- *Dendrocalamus stocksii bamboo species*

Sindhudurg region has fairly dense patches of *Dendrocalamus stocksii*, *Bamboosa balcooa*, (Katang or thorny bamboo), *Dendrocalamus strictus* (Manvel), and *Munrochloa ritchiei* (Chivari). However, *Dendrocalamus* stocksii popularly known as managa/ mes/ chiwari munro/or konda bamboo was the major bamboo species found in our study. The reason is Managa bamboo is grown in Kudal since years together and the quality, elasticity, strength, etc., was very good. Managa is the preferred choice among farmers for its multipurpose uses. It is solid without thorns and grows straight, achieving a height of 15 m. This is suitable for craft products and for scaffolding purpose. The second most abundant bamboo is *Bambusa bambos*, which mostly occurs in forests. It is

sometimes grown as a protective fencing due to its thorny branches. *Bambusa bambos* is a large bamboo, up to 12 cm in diameter and up to 20 m tall – but the culm is hard and often crooked. It is therefore not suitable for craft products. Other bamboos are *Oxytenanthera monostigma* and *Dendrocalamus strictus*; the latter is also small in diameter but less preferred in the region than *Dendrocalamus* stocksii.

According to a survey report by INBAR, 2009 farmers accepted that bamboo gave higher economic returns than mango (an export item), coconut, or rice. The other attraction of bamboo to farmers was that it was a "plant-once-and-forget" resource, which did not need constant attention to produce poles annually. Farmers did not even have to cut the bamboo since interested parties, mainly traders, would cut and transport the bamboo themselves. The indigenous farmers of the area planted bamboo on the field or on the boundaries of their agricultural land. Majority of the large farmers are going for bamboo cultivation. Whereas small and marginal farmers are willing to go for cashew cultivation due to high returns (annual harvest is auctioned). Owing to lack of awareness about bamboo and concept such as; bamboo is mostly thorny, when they flower a drought prevails, are few wrong information that prevent farmers from planting the bamboo. This needs policy intervention if the poor are to benefit from income from growing bamboo.

Observation: During the interaction, the reason for existence of *Dendrocalamus* stocksii in such a large number was enquired. Farmers revealed that the species exhibits a special feature. They are very fast growing and are extremely flexible. Moreover, the same bamboos growing in the Kudal region are especially more in demand because of high elasticity and flexibility. Probably the climate and the soil of Kudal were extremely favourable for D. *stocksii.* However the same species when grown in nearby districts like Ratnagiri, did not exhibit the same healthy characters, reasons need to study by research department

4.1.2. Advantages and Disadvantages of *Dendrocalamus* stocksii expressed by respondents:

Advantages

- This species are highly adaptable and comes up well in tropical humid, sub humid and semiarid conditions.
- Non thorny by nature
- Loosely spaced culms permits easy harvesting of culms and management of clumps.
- Non predominant nodes, hence may be used as substitute for cane in furniture making

- Solid culms, offer more strength and less end splitting or cracking like other hollow bamboo species.
- Self-pruning of lower branches permits easiness in harvesting and processing
- Only sporadic flowering noticed, hence less chance of entire growing stock getting depleted.
- In commercial cultivation, because of its specific culm characteristics (erect nature, less number of side branches and solid and narrow culm diameter) this species can be grown at higher density.

Disadvantages

- No seed formation, hence narrow genetic base of endemic population
- The culm height is slightly less compared to other mid-sized bamboo species
- Vegetative propagation is difficult since only two or three nodal culm cuttings can be used.

  Transportation of material for propagation becomes difficult due to solid nature of culms
- They are susceptible to scale insect, rust disease during growth phase and borers to a lesser extent during post-harvest and utilization phase.
- Being very rigid, it has to be steamed to make it flexible for furniture making.

4.1.3. The Mahar Community of Sindhudurg

In Konkan region, the traditional artisans, mainly the Mahar community (Burud in other regions) who are in Sindhudurg and surrounding districts are well versed in primary processing of bamboo poles and producing interlaced or woven articles. They constitute an estimated 15,000 bamboo artisan families in Konkan region. The Mahars are the traditional bamboo working community and bamboo based activities used to be their main occupation. But, the scenario changed with the advent of plastics. Plastics are cheaper, colourful, and durable. Gradually, the mahars were forced to take up new occupations alongside their traditional occupation. Since working with bamboo is also an indicator of low caste, many mahar artisans have given up this profession altogether to be rid of the stigma attached to it. KONBAC, to some extent has strategically targeted the bambooworking castes and incrementally changed their declining interest in bamboo.

4.1.4. Socio-Economic Attributes of Bamboo Farmers

A total of 20 farmers, who grew bamboo on the farms were interviewed. The socio-economic attributes of the farmers are given below (Table-4.2)

Table 4.2. Socio-economic attributes of bamboo farmers

Attributes	**Mean**	**Max**	**Min**
Age of the farmers	59	85	35
Family composition	More than 5 members	More than 5 members	Less than 5 members
Education	Intermediate	Graduate and above	High school
Annual income (Rs)	706250	1200000	425000
Distance from bamboo field (Kms)	3.75	6	2
Farm size (ha)	8.63	17.8	4

The mean age of the farmer was 59 years. We observed the dominance of middle aged group (*i.e.* 31 to 50 years). The speculation behind this may be because the establishment, planting, harvesting, and selling activities of bamboo are labour-intensive operations in the initial stages and harvesting stage that are typically carried out by a supportive middle-aged group. The fact that middle-aged person tends to be energetic, creative, and hardworking with more experience, vigour, fervour, aptitude, and take up challenges. Most of the farmers had large families with more than five members in their family. Although the number of respondents is a few but it is a fact that large farm families provides more labour force. The household size influences household decision making to establish and manage farm operations (Hingi, 2018). The mean education score of reflects high literacy with the average number of bamboo farmers had completed intermediate. It is pertinent that educated farmers take up the risk of bamboo plantation and are able to understand the importance of bamboo plantation. The mean annual income of farmers was around seven lakh with an average farm size of 8.63 hectares. This means that the monthly income of bamboo farmers were near around Rs 50,000/- per family through bamboo in addition to other farm incomes. This reveals that only farmers with large land holdings planted bamboo.

4.1.5. Occupation

Agriculture is the main occupation in the region. In our study, respondents expressed that out of the their total land (172.6 hectares), 120.4 ha were used for cultivation of other crops like, mango, cashew, coconut, nutmeg, areca palm, banana, rice, etc., and in 52.2 ha were under bamboo farming (Fig 4.1). A total of 950 farmers were cultivating bamboo in their field. The data is showing the area under agriculture and bamboo cultivation for 20 farmers were interviewed.

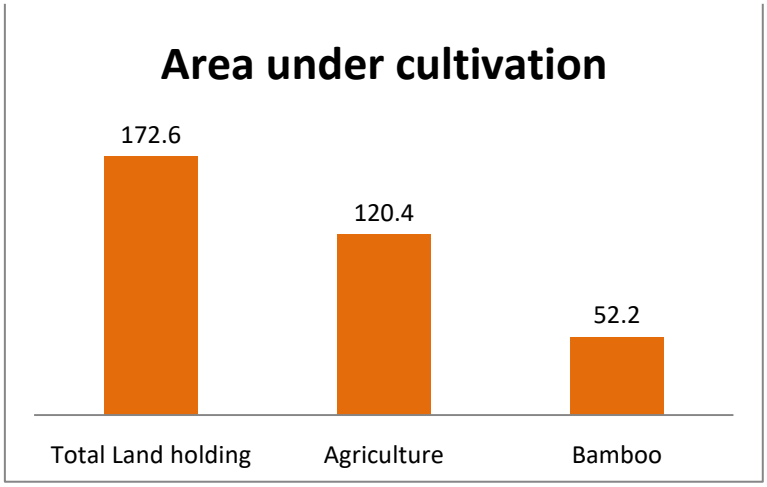


Fig 4.1 Area under cultivation

4.1.6. Source of income for the respondents

Present study respondents reveals that the source of income from agriculture contributes maximum (55%) to a household income followed by business (21%), bamboo plantation (20%), services (3%), and livestock rearing (1%). Hence, bamboo plantation was the third major source of household income for the bamboo planters (Fig 4.2)

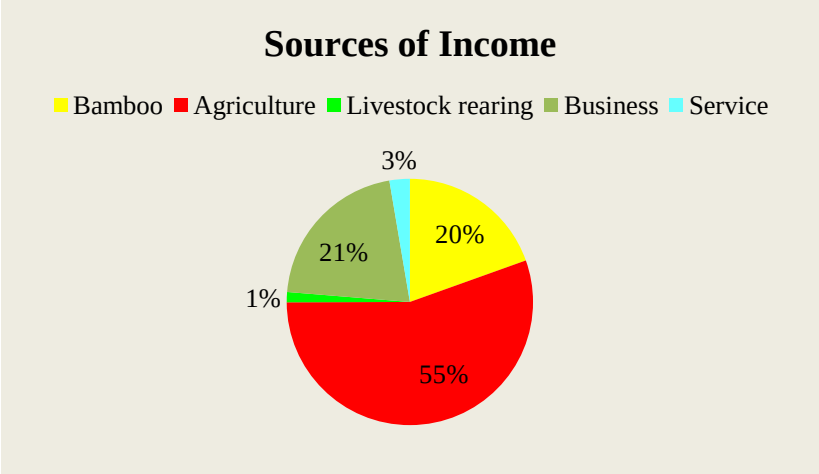


Fig 4.2 Income sources of Sindhudurg bamboo Farmers

Observation: While interacting with farmers, it was observed that they never regretted after planting bamboo in their field. Although it was a traditional culture for planting bamboo in boundaries for the protection of field crop, later they have motivated by the KONBAC initiatives. Hence, respondents took interest on bamboo cultivation to a next level by block plantation, boundary plantation and where ever they found barren land. A middle aged farmer namely Mr.

Sunil Sawant happily shared that planting bamboo is an investment, which never fails (*Success story of Sunil Sawant*)

Bamboo brings wealth-A success story of farmer Sunil Sawant

Sunil Sawant is a successful farmer of Kudal. He loved farming since childhood and always yearned for innovative ideas. When nothing worked for him, he planted managa bamboo on his land. Nobody could believe that bamboo can bring wealth. After five years of plantation without any expenses, he received an income of Rs 15 lakhs from 20 acres of land. 'Bamboo cultivation has made me rich and famous without any investment,' says Sawant. People from and around the country often visit his bamboo farm and seek his advice on farming. He keeps on experimenting his agricultural land. He has also introduced some new species of bamboo and eagerly waiting to see the results. 'Bamboo requires no especial treatment but only patience and belief',

says Sawant while flaunting his 24 acres of beautiful bamboo farm. He is now an inspiration for many farmers in Kudal.

4.1.7. Planting pattern of Bamboo

The farmers planted bamboo either on boundaries or in a block. Out of the total bamboo farmers surveyed, 60% planted bamboo in block whereas 40% of them planted on the boundaries (Fig 4.3).

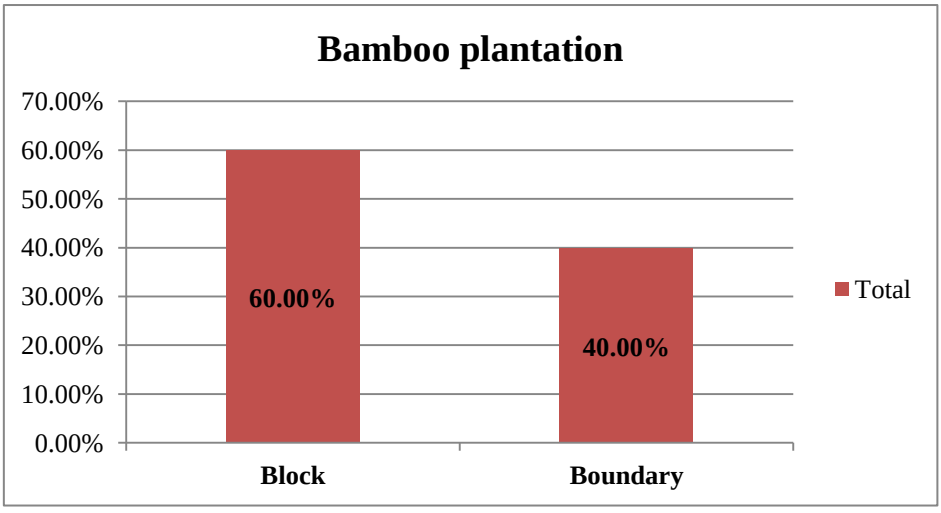


Fig: 4.3 Pattern of plantation

Observation: Farmers knew very well about the benefits of bamboo planation. Most of the farmers were planting bamboos in their field as a part of their tradition. Some continued the tradition of planting bamboos on the boundaries of their field but some farmers adopted block plantation. Generally, for new plantations, the farmers use rhizome from the existing mature bamboos in their own field. The cost of rhizome varied from Rs 200-250. However, for new farmers, it was difficult to buy rhizomes therefore; they planted bamboo saplings from nursery. Hence, farmers wanted tissue culture production of bamboo so they can get good quality bamboo planting materials at low cost. Moreover, the role of KONBAC is appreciating in promoting the awareness about bamboo plantation in the region.

Bamboo plantation in a Block
Species- *Dendrocalamus stocksii*

Boundary plantation of bamboo in the field
Species- *Bambusa balcooa*

4.1.8. Crop Management Harvesting

Bamboo species can be commercially cultivated by farmers and has a high demand in the furniture industry. Commercial plantations of this species may be highly viable if it can be raised with appropriate scientific management practices. Spacing of 5 x 5m (400 plants/ha) for block plantation and 80 plants with plant distance of 5 mts on boundary, is considered appropriate for this mid-sized bamboo species. The culms grow straight; have a diameter of around 40 mm and very less branching. This spacing provides sufficient space for bamboo clump to grow in subsequent years. The total cost on bamboo plantation is accounted for

a) Planting material
b) Pit digging
c) Weeding and fertiliser
d) Labour charges
e) Irrigation
f) Fencing and watching

4.1.9. Economics of raising bamboo plantation

From first year to third year, cost may be incurred in ground preparation, irrigation, watch, and ward. The analysis revealed that an initial expenditure for three years of around Rs 77200/- may be incurred per hectare for block plantation and Rs 14520/- for boundary plantation. The major expenditure is incurred during the first year while minor cost are spread over subsequent two years. Returns can be expected from the fourth year onwards through selective harvesting of mature culms by maturity marking.

Potential revenue of Rs. 240000 for block plantation and Rs 48000 for boundary plantation, in the fourth year can be expected from 400 culms and 80 culms respectively after accounting 10% mortality of the clumps per hectare of block and boundary plantation. Each culm produces 10 bamboo poles approximately for harvesting per year. Minimum cost of each pole is Rs. 60/- approximately. Hence, a net benefit of Rs 162800/- with BC ratio of 2.1 (for block plantation) and Rs 33480/- with BC ratio of 2.3 (for boundary plantation) can be achieved from fourth year onwards (Table 4.3 & Table- 4.5)

Table 4.3. Economics of Bamboo plantation (Block)

Economics of Bamboo plantation (Block)						
	Activities	**Year wise expenditure in Rs**				**Plants=400**
		1	**2**	**3**	**4**	**Rate**
1	Planting material	17600	0	0	0	Rs 40 for 440 plants
2	Pit digging	6000				Rs 15 per pit, for 400 pits
3	Planting with good soil	2200	0	0	0	Rs 5.50/pit
4	Planting out bamboo in the field	2400	0	0	0	Rs 6/plant
5	weeding and fertiliser	8000	6000	4000		Rs 20/pit

6	Irrigation	10000	6000	4000	0	Rs 25/plants; 15/plant; 10/plant in respective years for 5 months
7	Fencing and guarding	9000	0	2000	0	Rs 1000/month
	Total cost	55200	12000	10000		**77200**
Revenue obtained per Hectare						
1	Bamboo felling	0	0	0	**240000**	Rs 60/bamboo; 10 bamboo per culm

Total benefit = 162800; B:C ratio= 2.1

Table 4.4 Economics of Bamboo plantation (Boundary)

	Economics of Bamboo plantation (Boundary)					
	Activities	**Year wise expenditure in Rs**				**Plants=80**
		1	**2**	**3**	**4**	**Rate**
1	Planting material	4000	0	0	0	Rs 40 for 120 plants
2	Pit digging	1200				Rs 15 per pit, for 400 pits
3	Planting with good soil	440	0	0	0	Rs 5.50/pit
4	Planting out bamboo in the field	480	0	0	0	Rs 6/plant
5	weeding and Fertiliser	1600	1200	800		Rs 20/plant
6	Irrigation	2000	1200	800	0	Rs 25/plants; 15/plant; 10/plant in respective years for 5 months
7	Fencing	0	0	0	0	
	Total cost	10520	2400	1600		**14520**

Revenue obtained per Hectare

1	Bamboo felling	0	0	0	**48000**	Rs 60/bamboo; 10 bamboo per culm

Total benefit= 33480; B: C ratio= 2.3

4.1.10. Marketing of Bamboo

In Sindhudurg, the bamboo is sold through contractors or village traders mainly. Some of the available market for bamboo is mentioned below

1. Maharashtra itself the biggest market for bamboo through furniture is high-end resorts, hotels and government tourism departments, such as the Maharashtra Tourism Development Corporation (MTDC). The strategic location of Sindhudurg close to Goa, which is an international tourist destination, has contributed significantly to expanding the market for bamboo furniture. Smart pricing policies adopted ensure that the artisans get the best remuneration possible for their work. Buyers accept the high prices because of the high quality and good finishing of the products.
2. **KONBAC facility centre**: The demand for bamboo by KONBAC is high. The average total number of bamboo poles purchased by KONBAC is 9235 annually from the local bamboo farmers.
3. **Farmers**: Farmers use bamboo as stakes in agriculture commodities like tomato, support/prop for banana and grape cultivation. Hence, farmers are themselves buyers of bamboo at a large scale.
4. **Supply to other states**: the traders and contractors supply the harvested bamboo to other nearby states like Karnataka, Andhra Pradesh, Tamil Nadu, Gujarat, etc. Transportation of bamboo from Maharashtra is cheaper as compared to other north-eastern states.

4.1.11. Bamboo Supply Chain

Through interviews, it was revealed that when the bamboo crops are ready to be harvested, farmers contact the contractors for harvesting. The contractors and the village traders were important to whom the maximum number of growers marketed their crops. Farmers sold their bamboo directly to contractors and village traders without any marketing cost. Hence, farmers received better prices for their produce. Out of the total production of managa bamboo 12.67 per cent was retained for domestic purpose like household use, for new plantations and the remaining 87.33% of bamboo was sold to the traders, contractors, or agents. Similar type of supply chain has been reported by Bhuwad *et al* (2021) and Sakhrie and sharma (2017) the overall average production of managa bamboo per farm is 1363.46 poles (Bhuwad *et al*, 2021).

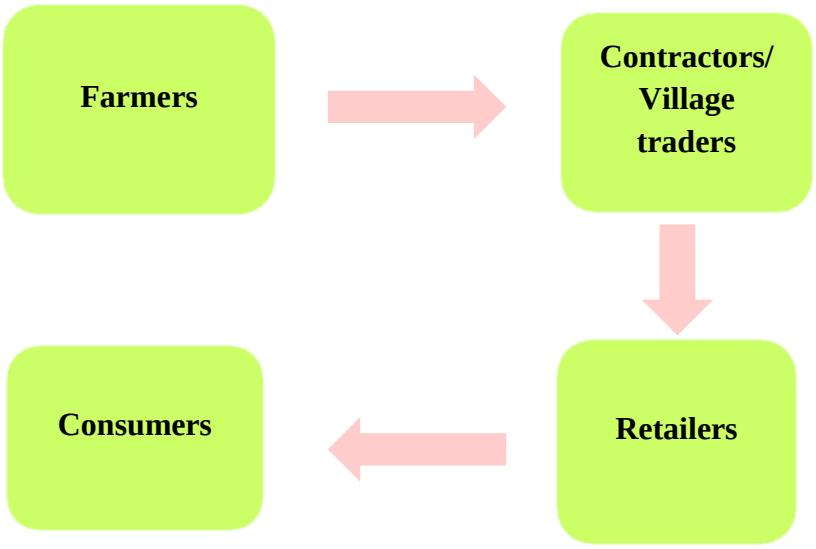


Fig 4.4. Bamboo supply chain

4.1.12. Observed initiatives by KONBAC:

KONBAC has developed into a self-sustaining institutional ecosystem and has a fully developed facility for designing, prototyping and producing premium bamboo products for Indian and international markets. There are three different units in KONBAC, they are:

A. Treatment unit
B. Workshop and training unit
C. Display unit

A. Treatment unit

The bamboo treatment unit is equipped with high-pressure treatment and bamboo pre-processing facilities. The raw materials are mechanically processed and made to market specifications, ensuring quality in handicrafts.

Stages of treatment

1. Root cutting
2. Drilling of holes for treatment
3. Chemical treatment
4. Straightening
5. Sanding
6. Washing

7. Polishing and drying

Konkan produces over 15 lakh tons of bamboo and more than 15,000 artisans work in the bamboo sector. KONBAC provides rural communities with training in cultivation, production processing and design, enterprise development, and marketing. KONBAC works from a Common Facility Centre (CFC) in Kudal, Maharashtra, equipped with high-pressure treatment and bamboo preprocessing facilities. KONBAC produces round pole bamboo furniture, and is actively involved in constructing bamboo eco-resorts resorts in India and Maldives. KONBAC has a dedicated facility in its CFC to mechanically process raw materials made to market specifications, ensuring quality in handicrafts. Artisans save time and are able to produce larger quantities of handcrafted goods. These activities have mainly benefited women; many are first-time earners.

Root cutting

Drilling of holes for treatment

Chemical treatment

Straightening

Sanding

Washing

Polishing

Drying

The stages of treatment

B. Workshop and training unit

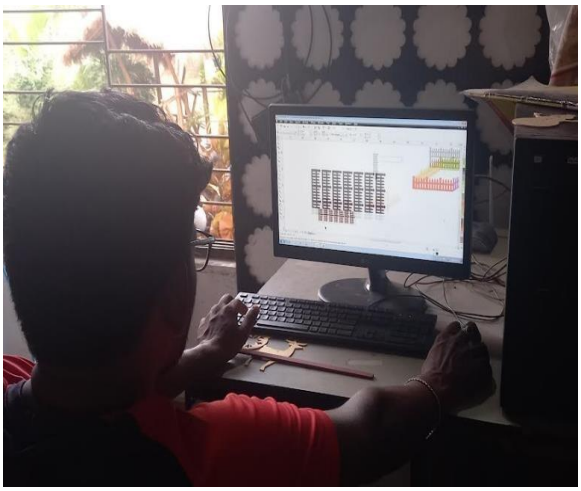
KONBAC provides rural communities with training in cultivation, production processing and design, enterprise development, and marketing.

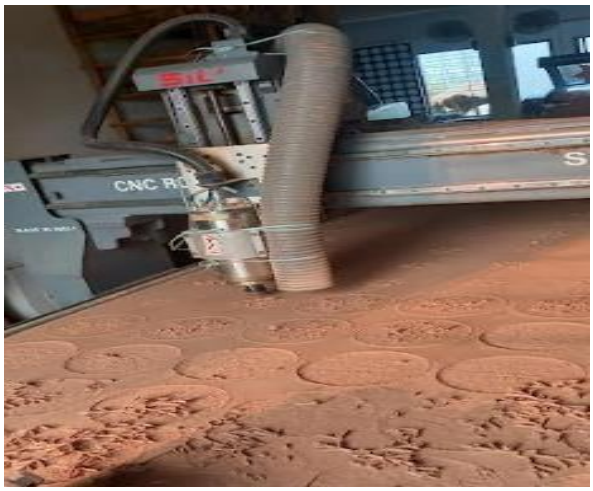
- KONBAC has trained farmers to read the age from the condition of the culm. This has resulted in only mature bamboo culms, which fetch a higher price, being harvested.
- Farmers have been trained to produce large numbers of vegetative propagated planting material from culm cuttings, so that farmers could get adequate planting material locally Advice on planting material procurement and propagation of different species.
- Carpenters are trained to work with treated bamboos
- Labours are trained to make different parts of furniture

4.1.12.1. Capacity building strategy by KONBAC

- **Designing of products:** The products are designed by the experts on the basis of order placed. The designs of product mainly depend on the preference of buyers. Based on the project, training are imparted to the artisans.

- **Finalising the layout:** KONBAC is associated with many innovative wood designers, innovative entrepreneurs, and technical staffs who keep on experimenting with new designs. They collaborate together to work and design the product. Firstly, they prepare product model and if everyone agrees then the design is finalised**.** Sometimes, the buyer themselves come with the design and KONBAC manufactures the product accordingly.
- **Printing the design**: Computer based software is available where the final designing is done. The designed products are carved on wood through laser machines.
- **Training to the artisans and labour:** The NGO hires the artisans and labour to complete the order**.** They are trained and provided with stipend Rs.250/- per day. And, if their performance is good, KONBAC provides them with job opportunity. During the visit, most of the labours and artisans were recruited in the same manner.
- **Order based manufacturing of products:** The order based products are manufactured within the specified time period and handed over to the buyer.
- **Uploading the products online:** All the bamboo products are available on the online platform of KONBAC, www.woodygrass.com. The products and their details are mentioned on the website along with their prices. People can buy all the products online.
- **Supply of products:** Once the product is ready, it is delivered to the buyer within the specified period.





A designer working on computer to prepa Product designing through laser machines designs of product

Labours being trained

Product being prepared by labour Order based product manufaturing

The capacity building and training workshop of KONBAC

C. Display unit

KONBAC has a very beautiful display showroom with display of different articles prepared in its own workshop. The showroom has a collection of wide varieties of bamboo products like lamps, shades, table, chair, desk, cupboard, and other furniture.

Armchair

Lawn chair

Bamboo idols

Lamp

Basket

Tea- trey

Idol of Radha-Krishna

Face of Mahatma Gandhi

Wall hangings

Furniture

A beautiful hut

Articles produced at KONBAC

Candle shades

Candle shades

Bamboo frames

Bamboo Place mats

Mat

Wall decor

Retro speaker

Basket

Laundry Basket

Flower Basket

Bamboo hanging lamps

Polo lamp

Bamboo

Bamboo tongue

Bamboo

Bamboo soap

Table Lamp

Table

Bench

Bench with backrest

Hanging planters

Two-tier hanging planters

Bamboo planter basket

Bamboo pot stand (three-tier)

Bamboo table planter

Bamboo foldable chair

Bamboo Reclining chair

Bamboo folding low chair

Bamboo round dining table and chair

Bamboo Round table

Bamboo Hunchback two-seater sofa

Bamboo stools

Bamboo Hunchback footrest

Bamboo Arm chair

Bamboo Arm chair

Bamboo cushion chair

4.1.13. Role played by KONBAC in the life of bamboo farmers

- *Capacity building*: Training programmes with different reach and depth are developed for imparting and upgrading basic skills, and raising awareness. Significantly, with changing perceptions, the number of participants on training courses has risen significantly over 2005, with increasing representation from across the caste system. Training and awareness programmes have also been undertaken on bamboo propagation, management, and its use.

- *Resource enhancement:* KONBAC established a linkage with local nursery in Kohlapur district to produce more than 150,000 plants per year. The technical knowledge needed to produce bamboo plants was provided to the nursery. A total of 217,500 plants were produced between 2005 and 2008. KONBAC has also developed a bamboo supply chain, ensuring that bamboo farmers are able to supply raw materials to nearby areas at fair prices.

- *Institutional linkage:* KONBAC is a recognized technical advisor on sourcing planting material in the region for government institutions such as Social Forestry Department and Agricultural Department, Government of Maharashtra, Forest Department, Government of Goa, private nurseries, and other agencies. They rely on KONBAC for technical support on plantation development, and advice on planting material procurement and propagation of different species

- *Income generation and Livelihood:* KONBAC provides stipend of around Rs 250-300 per day along with the food to the trainees and later provides employment according to their experience. The NGO has immense income generation potential for youth. The average monthly income of artisans were INR Rs.15000/- and for labours it is INR Rs.7500/-

- *Development of Institutional ecosystem*: The KONBAC has set up linkages with different government and public enterprises. They supply the trained workers to other bamboo based construction and furniture institutions.

- *Market development*: KONBAC is itself a buyer of local bamboo. The average total number of bamboo poles purchased by KONBAC is 9235 annually from the local bamboo farmers.

- Value addition of bamboo products: KONBAC buys raw bamboo from the farmers and after transforming them into beautiful products, they sell it at favourable prices.

- Increasing interest in youth: KONBAC has trained many young local bamboo artisans who never thought that they can do anything with bamboo. At the beginning it was difficult to motivate young artisans but gradually they have trained and provided employment to many.

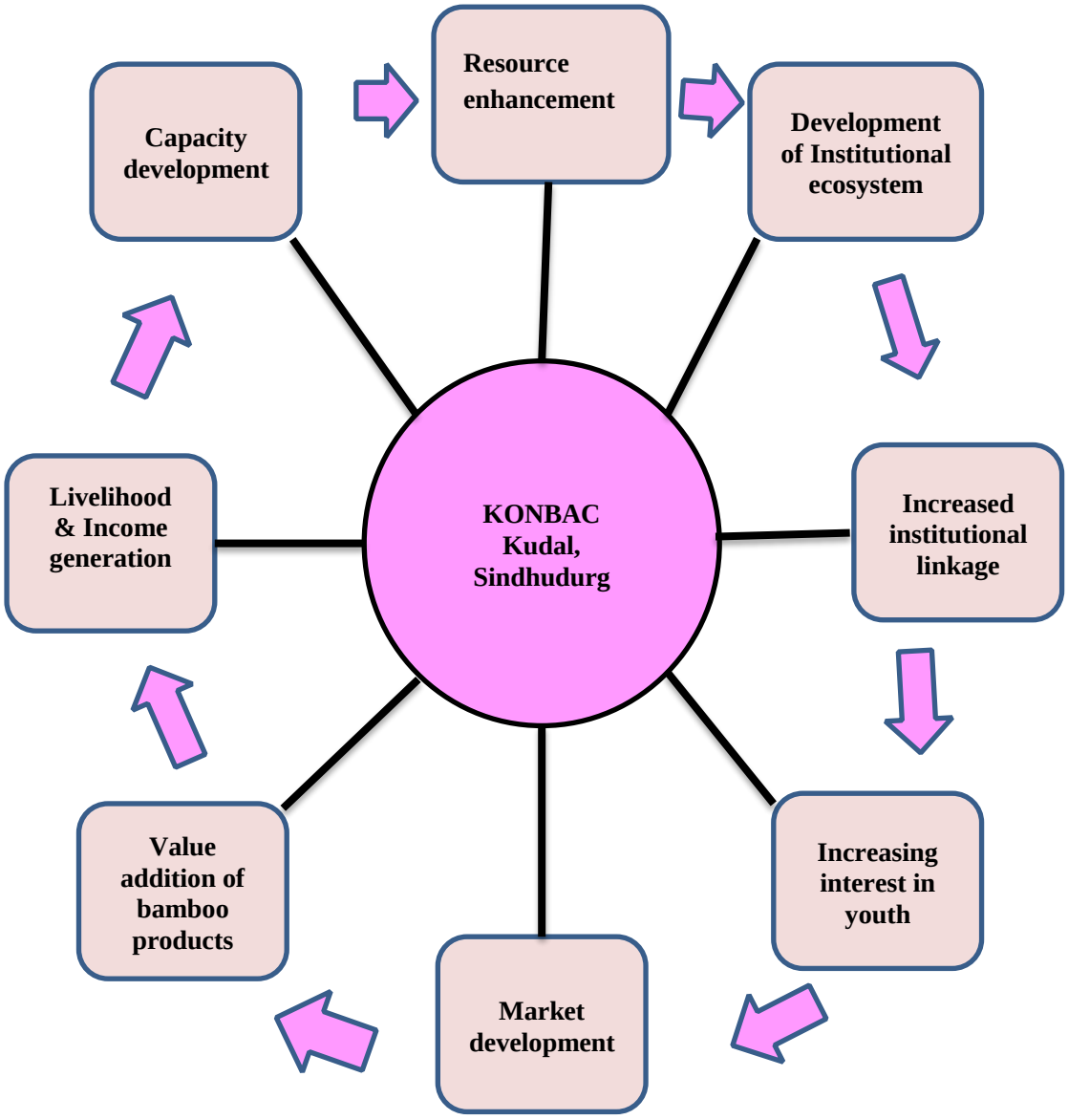


Fig: 4.5: Role played by KONBAC

4.2. The Case Study of Latur

4.2.1. Status and opportunity of bamboo in Latur

Based on Kudal experiences of Bamboo cultivation KONBAC upscaled to Latur district in mharashtra. Latur comes under Marathwada region of Maharashtra, geographically located between 17°52′ North to 18°50′ North and 76°18′ East to 79°12′ East in the Deccan plateau. The major occupation of district is primarily agricultural. Cereals, oilseeds, pulses, grapes are the major crops. Urban population comprises 25.47% of the total population. Latur is a drought prone area with acute water shortage in its city and rural areas. Manjara is the main river, which flows on the Balaghat plateau along with its tributaries, Terna, Tawarja and Gharni. Industrial development is minimal in the district. There is very little bamboo resource in Latur. Only 45-50 farmers grow bamboo in their field. Some use bamboo as live fences to protect their main crop.

Latur is completely different from Sindhudurg in term of geography, economy, and environment. The total geographical area of Latur is 7157000 ha, which is differentiated as non-agricultural use (3.60%), barren and un-cultivable land (2.75%), permanent pastures/ other grazing land (3.24%), cultivable waste land (5.21%), forest (0.25%) and net area sown (70.66%) (Table 4.5). The study was undertaken to gain information about the extended work of KONBAC in collaboration with Phoenix.

Table: 4.5. Land use classification of Latur

District/State	**Latur**
Total area	3.60%
Forests	2.75%
Area under Non Agricultural Uses	5.21%
Barren and Un-culturable Land	6.50%
Permanent Pasture and other Grazing Land	4.58%
Land under Misc. Tree Crops and Groves Not included in Net Area Sown	0.25%
Culturable waste Land	3.20%
Fallow Lands other than current Fallow	70.66%
Current Fallow	3.24%

4.2.2. **The bamboo farming in Latur**

The farmers in Latur grow soyabean, sugarcane, gram and grapes on a large scale. The household economy of villagers is largely dependent on the above crops. However, there are some farmers who grow bamboo in their field. Some of them grow bamboo for protection of main crops. There are only 45-50 farmers in Latur who have undertaken bamboo plantation. In our study, we could

reach only 10 farmers who were growing bamboo on their field. Out of 11 farmers, 8 had a block plantation of bamboo whereas 3 had boundary plantation. The major species of bamboo was *Bamboosa balcooa*. Other species included *Bambusa tulda* and *Dendrocalamus strictus*.

4.2.2.1. Socio-economic attributes of farmers

A total of 11 farmers, who grew bamboo on the farms were interviewed. The socio-economic attributes of the farmers are given below (Table-4.6)

The mean age of the farmer was 58 years. Almost all the farmers have large families with more than five members. The farmers were mostly educated up to with middle school. The mean annual income of farmers was around Rs 299181/-. The mean distance of house to bamboo field was 3.45 kilometres where the mean size of a farm turned out to be 10 hectares.

Table: 4.6 Socio-economic attributes of farmers

Attributes	**Mean**	**Max**	**Min**
Age of the farmers	58	65	48
Family composition	large	large	large
Education	Middle school	Graduate and above	Below primary
Annual income (Rs)	299181.8	580000	100000
Distance from bamboo field (Km)	3.45	12	1
Land holding (ha)	10	28	1

4.2.2.2. Income sources of the respondents

The study reveals that agriculture was the main occupation of people and hence agriculture contributed the highest into their income. However, bamboo based income of farmers could not be recorded because most of the farmers had newly planted the bamboo in their field. Few, who already had the plantation, had not yet harvested the crop yet. Therefore, their income from bamboo could not be recorded.

Observation: In Latur farmers had small land holdings. Only a few who had large lands undertook bamboo plantation due to the efforts and consistent motivation of Phoenix foundation. Mr Pasha Patel (founder of Phoenix) and Mr Sanjeev Karpe (Director of KONBAC) are working effortlessly to promote the bamboo farming in the area. Many farmers acknowledged the sincere efforts of the duo.

Success story of a farmer in Latur

Vijay Deshmukh Pandey, a farmer i n Latur, planted bamboo on his barren land four years back. Then, he did not know about the spacing or the technique of planting bamboo. He did not invest a single penny but the cost of planting materials. Today, his crops are ready to be harvested and he get phone calls from the buyers all over India. Now, he takes pride in the be autiful ambience of his field. "I see a lot of sparrows and peacocks visiting my bamboo field, and the soil under the field has

visibly improved. The absence of weeds amazes me", says the happy farmers while enjoying his evening seated on a bench in his field.

4.2.3. Tissue culture and Nursery unit of Phoenix

The phoenix foundation established a biotech lab and nursery for the production of quality bamboo. As observed, the nursery was producing *Bambusa balcooa* at large scale. *Bambusa balcooa* has high calorific value and fuel value index. Recently, a project on bamboo based ethanol refinery has been approved and will be set up soon in Latur. Since bamboo will be the raw material for the refinery, the aim is to plant bamboo plantation on 5000 acres of land. Hence, Almaq biotech is preparing to produce 5000 samplings per hour. This will definitely boost the rural economy and income of farmers.

The Biotech lab has the capacity to produce approximately 15 lakh tissue culture plants. Besides producing plant materials, the lab also provides employment to the technicians and labours. The lab technicians are the rural villagers who were given training before employing them in the lab. They were trained to perform the tissue culture operations with all the safety measure. As observed, a very neat and clean lab was maintained. Female labours were involved in washing and sterilization of bottles and two female technicians were involved in the tissue culture of bamboo species. On average, a single woman labour washes 600 tissue culture bottles per day. The labours

were paid Rs 250/- per day for their work. Presently there were 80-90 labours working at the nursery and the biotech lab.

The healthy baby plants were taken out in the shade- net nursery and later transferred into the poly bags. The labours were hired to fill the poly bags on a wage basis at Rs 250/- per day.

Labours working at nursery

Photos of Almaq biotech lab and nursery at Phoenix

Almaq Biotech

Trained villagers working in tissue culture lab

Tissue Culture of baby plants

Transfer of baby plants in the nursery

Large scale production of bamboo plants through tissue culture

Transfer of baby plants in the polybag

Model bamboo plants grown from tissue culture

Problems observed:

During the study it was observed that farmers were apprehensive of bamboo flowering. As informed by one of the official staff of Phoenix, *Bambusa balcoaa* is having a gregarious flowering all over the area. The flowering first started in 2016 in Gujarat, but was not so intense. Now it has

spread to all over India and also in Latur. All the *bambusa balcooa* plants are showing gregarious flowering except a few. And once the bamboo plant flowers, lots of seeds are produced and later the plant dies. However, the seeds *of Bambusa balcooa* are sterile. The only option for propagation of the species is through vegetative propagation. The plant materials, which were provided to the early farmers during 2018, are now dying due to flowering. The farmers who were motivated to grow bamboo are now reluctant because of this flowering issue. There is a need of research and development to solve the mystery of bamboo flowering, so that necessary steps can be taken before the plant dies.

4.2.4. Perception of Bamboo artisans

The survey is an entire process that took almost a week together in both the districts. During that process, we succeeded to interview 20 labours and 5 artisans. As the industry in Kudal and Latur are linked together, therefore they are not written separately. The answers of the interview schedule are presented for both the study sites together. During the study, three artisans working in the KONBAC and two in Phoenix were interviewed.

Most of the artisans were provided training before employing them into the company. The monthly salary varied from Rs 12000/- to Rs 15000/-. All the artisans were male with age upto 30yrs and no female. Designing the bamboo products, teamwork, machine knowledge and training the new labour or staff was the main skills involved for artisans. They had to work with Laser machines, computer, designing software, bamboo cutting machines and sanding machines in the factory. They worked for eight hours in a day for any order based production.

4.2.4.1. Interview based answers given by bamboo artisans

- Age, gender, education and training received or not:
  - ✓ All the artisans were young ie, upto 30 years. All the artisans were male. Out of 5 artisans, three of them were graduates who had computer knowledge and knew to read and write in English but two of them were just intermediate. Almost all the artisans were trained before joining the industry.
- Name of the bamboo based industry they work and their working hours and monthly income.
  - ✓ KONBAC and Phoenix are the two bamboo based industry. They worked for 8 hours in a day and income of an artisan was in between an amount of Rs 10000/- to Rs 12,000/- per month on part time basis.

- List of skills and tools they use:
  - ✓ Skills- designing bamboo products, teamwork, machine knowledge, and trainer.
  - ✓ Tools- Laser machines, computer, designing software, bamboo cutting machines and sanding machines ➢ Making of Bamboo products:
  - ✓ Candle shades, Bamboo frames; Bamboo Place mats, Mats, Wall Décor, Basket, Laundry Basket, Flower Basket, Bamboo hanging lamps, Polo lamp, Bamboo toothbrush, Tongue cleaner, Soap case, Table lamps, Bamboo dining chair, Bench, Bench with backrest, Hanging planters, Bamboo foldable chair, Bamboo Reclining chair, dining table, Hunchback two-seater sofa, stools, Bamboo cushion chair, etc.
- Designing of a product and time to take complete the product
  - ✓ The designs were based on buyer's choice.
  - ✓ It depends on the order and time required to finish the order. They work to produce bulk orders on given time
- Importance of bamboo in their culture and tradition:
  - ✓ None of them was traditional artisans.
- Training to upgrade skills:
  - ✓ Yes, they received training. Because working with bamboo needs specific skills.
- Specialized technique for making bamboo product
  - ✓ Making bamboo products is unique and needs specialisation. In terms of liking their work, most of them answered that they get opportunity to innovate new bamboo based furniture designs
- They expressed None were engaged in any other activity ➢ Common problems faced during working hours
  - ✓ Dust and chemical hazards were the common problems. However, they were provided with the safety measures like masks, gloves and the dress code. ➢ Sourcing of raw material and problems while procuring raw material
  - ✓ The raw materials were sourced from local villages. They pre-treated the bamboos with chemicals in our own bamboo treatment plant and then stored them for long.
- Presently there is no provision of insurance at work place

4.2.5. Perception of Bamboo labours

In KONBAC, Kudal there were 80 labours working at the factory and more than 300 labours works from home. They were mostly women working from home. The representation of female labours was more than men. At Phoenix, Latur there were 25 labours out of which 20 were females and 5

were male. All the labours were trained prior to work. The labours had to work with Sickle, hammer, driller, bamboo cutter, handsaw, chisel, sand paper, sanding machine. The labours were satisfied with their work and preferred to work at the factory. The details of the survey are provided in the interview schedule.

4.2.5.1. Interview based answers given by bamboo labours

- ❖ Age, Education, Gender:
  - ✓ Most of the labours were middle aged falling in age group 31 to 50 years.
  - ✓ Most of the labours were illiterate.
  - ✓ Furniture unit of the industry had more male whereas craft unit had higher female representation.
- ❖ Working hours and monthly Income:
  - ✓ 8 hrs, Rs 250/- per day.
- ❖ Time taken to complete the product:
  - ✓ Furniture and bamboo craft
  - ✓ 1 labour prepares 22 bamboo poles for chair
  - ✓ 1 machine prepares 30 bamboo poles for chair
- ❖ Training to upgrade skills Training received by KONBAC and Phoenix ❖ Specialized technique for making bamboo product:
  - ✓ Factory workers were trained labours
  - ✓ Women who worked from home were traditional bamboo workers ❖ Interest in work:
  - ✓ The labours were provided food in Latur at their work.
  - ✓ Farming and cultivation ❖ Workplace routine:
  - ✓ The females finish off their household work and come to the workshop.
  - ✓ Males would directly come to the workshop. They visited their farms on and off.
- ❖ Common problems:
  - ✓ Dust and hand damage
- ❖ Tools that are currently being used in general for a particular project:
  - ✓ Sickle, hammer, driller, bamboo cutter, handsaw, chisel, sand paper, sanding machine
- ❖ Presently there is no provision of insurance at work place.

Treated bamboos as raw material

Cutting of bamboo

Removing knots

Sanding

Cutting according to the desired size

Stacking of poles

Photos of labours working at the furniture unit of Phoenix

Drilling for joints

Assembling

Assembled product

Finished product

Interaction with the labours and artisans in Latur at furniture making unit in Phoenix with Artisans and labours at work

4.2.6. Phoenix foundation

Phoenix was established in 2008, with the aim of educating farmers and rural development. The foundation is working under Shri Pasha Patel who is known as the Bamboo man of Maharashtra. The foundation is currently involved in 25 district level programmes about bamboo cultivation in Maharashtra and 250 village level programmes about bamboo cultivation. The organisation has many branches, mentioned below:

- Almaq Biotech Tissue culture lab (specially for bamboo plants)
- Soil testing lab
- Bamboo furniture making unit- Kalam Krushi Farmer Producer company
- Bamboo diploma college
- Agricultural B Tech and Food technology college
- Radio “PRITHVI RAKSHAN”- to create awareness about farming Driving school

Interacting with Shree Pasha Patel, Founder of Phoenix and Shree Sanjeev Karpe, Director KONBAC

4.2.6.1 Role of Phoenix foundation for bamboo farmers

- Creating awareness: the foundation is trying to create awareness about bamboo farming and the potential role of bamboo in livelihood, income generation as well as in climate change mitigation. Owing to efforts of foundation, the district schools have organised bamboo plantation programme where school children participated in bamboo plantation.
- Bamboo plantation: Since bamboo plantation is the main objective, the foundation has motivated a number of farmers to plant bamboo on their field. Shree Pasha Patel, is the union leader of farmers and founder of Phoenix organisation had run a drive for bamboo

- plantation. Consequently, they planted bamboo along the Manjara river within an area of 30 kms.

- Livelihood & Income generation: Phoenix foundation has created a number of livelihood opportunities for the villagers and rural women. They work in the workshop as labours or trainee and earn Rs 250/- per day. This provides opportunity for rural women to utilise their time and make money.

- Capacity building: The training provided by the phoenix foundation in bamboo furniture workshops, tissue culture lab, and bamboo nursery help villagers in building their capacity.

- Environment conservation and carbon sequestration: Not only economic benefits but bamboo also provides environmental benefits. The bamboo plantation helps in recovery of soil nutrients and restoring the biodiversity in area. As reported by a farmer, bamboo plantation attracts the sparrows, peacocks and improves soil.

- Increased institutional linkage: Phoenix foundation has institutional linkages with many private and governmental organisations, which provide them with economic and capacity building support.

- Increased interest in youth: the foundation is training as well as teaching the importance of bamboo farming among youth. As a result, there is an increased participation of young artisans and technicians in the trainings.

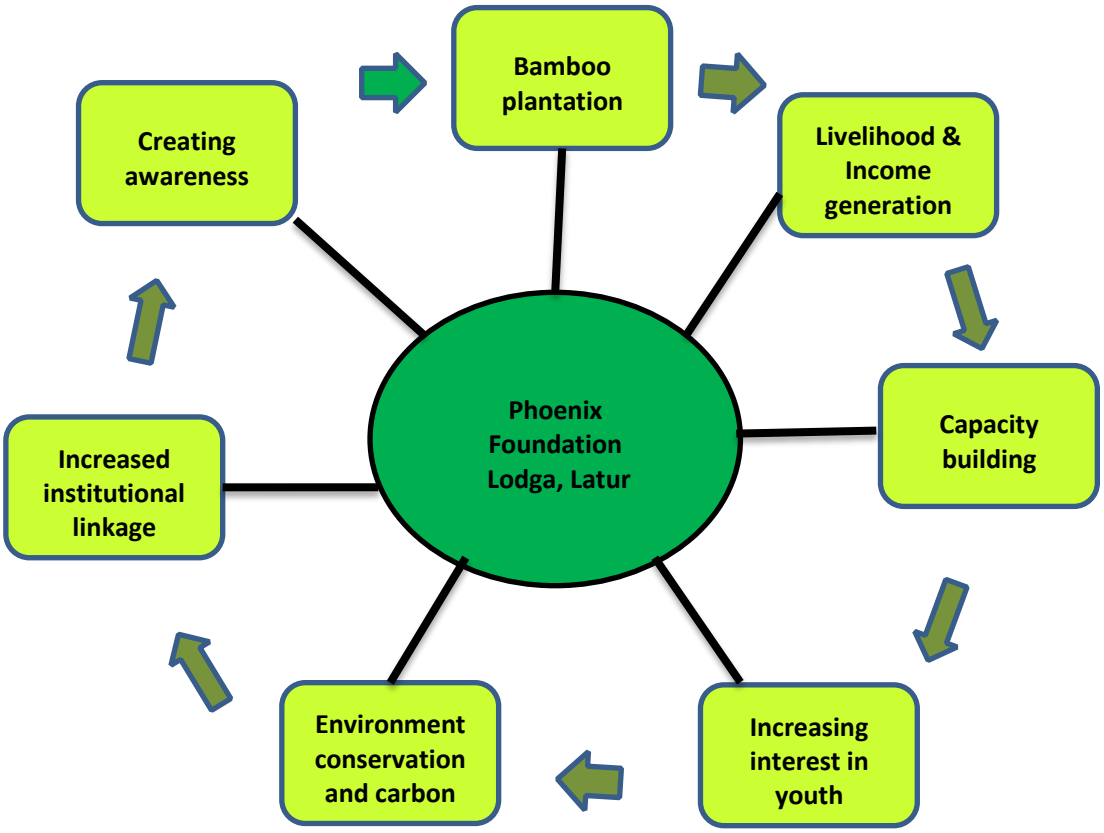


Fig: 4.6 Role played by Phoenix

V. CONCLUSION AND RECOMMENDATIONS

5.1. Impact of bamboo

- *Ecological*: Bamboo is a smart crop that helps in restoring biodiversity while conserving and upgrading soil conditions. The leaves of bamboo fall on the floor and their decomposition helps in restoring the nutrients of soil. The microclimate of the bamboo field is improved and low temperature under bamboo canopy is maintained. This attracts the nearby birds and animals.

- Social: Bamboo based industries help in uplifting and regaining the identity of the communities, which are dependent on bamboo. Ex. Mahar community of Konkan region.

- Economic: The economic benefits of bamboo are many. When planted on a large scale it provides employment to labour and benefit to the farmers. Bamboo is like an ATM. There

is no specific season to harvest bamboo. It can be harvested any time whenever the money is required. Bamboo poles are sold at good prices in every season. It is always a win-win situation for bamboo farmers to get income.

Bamboo based industries provide employment to number of artisans, labours and experts. The bamboo product need special designers because working on wood is different than working on bamboo.

After, the bamboos are harvested, and reach the furniture or the crafts unit, it involves a number of artisans and labours in treatment, production, designing and marketing of the bamboo product. The cycle of economy grows bigger and bigger with the value addition of bamboo. Each stage of bamboo involves a new value chain member hence increasing the beneficiaries.

5.2. Perception of different stake holders

- **Farmers:** Framers expressed that they need policy support and market for plantation of bamboo. Mere motivation is not helpful. Especially the small farmers need instant results in their small farms. Hence it requires some support during initial stages of 3 years because other crops like mango, cashew, etc., have instant market for each season compared to bamboo hence they don't want to shift to bamboo.
- **Artisans:** Need more training on different bamboo products. If artisans get good income from making bamboo product then they would not leave their occupation. Bamboo industries and promotion of bamboo craft are very much needed.
- **Entrepreneurs:** Promotion of bamboo based products is required because if products are not sold they will not be able to run the business. Advertisement and promotion is the most expensive and cumbersome task in bamboo business. The payment of artisans and labours are dependent on the cost of bamboo product. If they get promotional benefits than half of their task would be easy. Required attention more on bamboo cultivation and promotion on bamboo products.
- **Government:** A Very few policy support available for the bamboo farmers. The existing Mahatma Gandhi Rozgar Hami Yojana under NAREGA Act, 2005 provides monetary support of Rs 20200/ hectare for 3 years to farmers who have upto or less than 2 hectares of land. No policy exists for medium and large farmers. Promotional and awareness activities need to be supported to make bamboo locally accepted.

5.3.Recommendations

Based on the study, we recommend few steps to be taken by the government in order to increase the bamboo production in our country

1. Structural and organisational reforms

Strengthening of Bamboo mission.

- Development of bamboo market with focus on being the exporter of bamboo
- Linking up bamboo planation and its utilisation to academic courses in institutions where youths may be motivated for entrepreneurship development and agribusiness ideas.
- KONBAC type of institutions at district to be established across the country.
- Plantation of bamboo on river boundaries, roadsides and along highways and on village lands/panchayat lands, etc.
- Plantation of bamboo on unused lands in government departments or institutions/universities as well as attachment for manufacturing of bamboo products

2. Development for bamboo products as a mitigation strategy for environment

- Education and awareness of importance of bamboo and its environmental benefits among youngsters.
- Government system may strategically work towards replacement of PLASTIC through BAMBOO

3. Livelihood, Entrepreneurship and Market development

- Growing bamboo gardens for agro-tourism and awareness creation.
- Promotion of bamboo products through agribusiness opportunity and support to bamboo based start ups
- Marketing opportunities and facilities.
- Identification of potential areas as bamboo resource and location specific bamboo products may be promoted.
- Identification of Bamboo cluster and promote bamboo culture.
- Categorisation of team of stakeholders
- Long term and short term goals such as target based plantation
- Year wise report on bamboo supply and demand for regulation of bamboo market.
- Development of bamboo market with focus on being the exporter of bamboo

4. Strengthening of extension activities

- Strengthening of Farmers Producer Organisation (FPO) for bamboo farming and market

- Creating mass awareness among the community through different media platforms.

5. Research and Development

- Production of quality planting material through tissue culture.
- Research and development on bamboo flowering.
- Production of intensive and extensive bamboo planting materials.

6. Development of political will

- Prioritising bamboo farming by placing it as a sunrise industry
- Promotion of bamboo farming through local farmer leaders
- Political and economic support to small farmers
- Bamboo policies for small as well as large farmers
- Utilisation of bamboo furniture at government offices and institutions.

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ANNEXURE -1

Interview Schedule
Case study on Bamboo Cultivation

Target Group: Farmers 1.
General information

S. No.	**Item**	**Details**
1.	Name	
2.	Gender	
3.	Village	
4.	*Panchayat* Block	
5.	Age *Young (up to 30 years)/ Middle (31 to 50 years)/ Old (> 50 years)*	

2. Socioeconomic characteristics of Bamboo farmers

S. No.	**Characteristics**	**Details**	**Remarks**
1.	Caste	Scheduled Tribe (1)/ Scheduled Caste (2)/ Other Backward Class (3)/ General (4)	
2.	Education	Illiterate (0)/ Below primary (1)/ Primary (2)/ Middle (3)/ High school (4)/ Intermediate (5)/ Graduate & above (6)	
3.	Family composition	a. Family type: Nuclear (1)/ Joint (2) b. Family size: Small (up to 5 members) (1)/ Large (> 5 members) (2)	
4.	Social participation	No participation (0)/ Membership of 1 organization (1)/ Membership of > 1 organization (2)/ Office bearer (3)/ Public leader (4)	

	Type of organisation	SAG FPO Farmer SP NABARD group/JLG Any other group		
5.	Size of land holding	Landless (0)/ Marginal (up to 1.0 ha) (1)/ Small (1.1 to 2.0 ha) (2)/ Medium (2.1 to 4.0 ha) (3)/ Large (> 4.0 ha) (4)		
6.	Housing status	a. Type: No house (0)/ Hut (1)/ *Katcha* (2)/ Mixed (3)/ *Pucca* (4) b. Number of rooms: 01 (1)/ 02 (2)/ >02 (3)		
7.	Livestock possession	Poultry/ Duck/ Goat/ Sheep/ Pig/ Draught animal/ Milch cattle/ Others		
8.	Main occupation	Wage labour (1)/ Caste occupation (2)/ Cultivation (3)/ Business (4)/ Service (5)/ Any other (6)		
9.	Subsidiary occupation	Enterprises	Total cost	Net income
		Micro		
		Small		
		Medium		
10.	Wealth status (observation)	Crude oven (1)/ Stove (1)/ Sewing machine (1)/ Watch (1)/ Cycle (1)/ Radio (1)/ Wooden furniture (1)/ Pressure cooker (1)/ Improved storage bin (2)/ Tape recorder (2)/ Scooter (3)/ Motor cycle (3)/ Mobile phone (2)/ T.V. (2)/ Computer(3)/ Laptop (3)/ Fridge (2)/ Car (4)/ Any other (1)		
11.	Labour force	No. of workers in the family (Man/ woman)		

2. Biophysical variables

S. No.	**Variable**	**Details**	**Remarks**
1.	Proximity to bamboo field	Household's distance to the bamboo field (km)	
2.	Frequency of bamboo farm visits	Very frequently (daily/ weekly) (3)/ Frequently (fortnightly/ monthly) (2)/ Occasionally (half yearly/ yearly) (1)/ Never (0)	
3.	Resources possession	A. Household's land area under bamboo cultivation(ha)	

		B. Household's land area under agriculture(ha)	
		c. Name of the agricultural crop they are growing	
4.	Urban closeness	Household's distance to the urban areas (km)	

4. Family income and employment composition

S. No.	Livelihood source	Income /HH/annum)
1.	Bambooresources	
2.	Agriculture	
3.	Livestock rearing	
4.	Wage earning	
5.	Business	
6.	Service	
7.	Other activities	
8.	Total	

7. Expenditure and revenues in Bamboo cultivation

S. No.	Year	Expenditure	Amount (₹)	Year	Revenues	Amount (₹)
1.						
2.						
3.						
4.						

Note: 1. Expenditure: Ground preparation (shrub cutting, levelling, ploughing *etc*.), fencing, nursery preparation, plantation, casualty replacement, weeding, cleaning, pruning, thinning, felling, conversion, haulage, maintenance, watch and ward *etc*. 2. Revenues: bamboo, bamboo products

8. Do you want to switch to other farming? Yes/No/Not sure

- **If yes, why?**
- **If No, why?**

9. Any other information:

a) Value chain system
b) Who promoted bamboo?
c) Extension method
d) How long it has taken
e) What type of support is provided by the NGO/Extension To whom do the farmers sell the raw material?

ANNEXURE-2

Interview Schedule

Case study on Bamboo Cultivation Target group: Labours and Artisans

Name of the labour	
Education Illiterate (0)/ Below primary (1)/ Primary (2)/ Middle (3)/ High school (4)/ Intermediate (5)/ Graduate & above (6)	
Illitrate (1)/ Trained(2)	
Gender Male (M); Female (F)	
Age Young (up to 30 years)/ Middle (31 to 50 years)/ Old (> 50 years)	
Name of the bamboo based industry they work	
Working hours	
Monthly income List your skills	
Skills and technologies required	
Type of work they are involved	
Products they make	
Time to complete one product	
Tools Used	
Is this a traditional craft? If yes, what is its importance to your culture?	
At what age did you learn this craft? Who taught you the skill?	
Have you received any training to upgrade your skills? If yes, which?	
Are you known for any specialization or technique? If yes, please specify	
What do you like about the work you do?	
Any specific set of Skill?	
Are you engaged in any other activity part from this? If yes, which?	
Why do you think it's important to continue with this tradition?	
Describe your workplace and your routine.	
What are the most common problems you face during your working hours?	
What are the tools that are currently being used in general for a particular project? Please spell out their local names.	
What are the types of chemicals used, and from where do you source the raw material?	
Do you have any problems while procuring raw material?	
What are the types of products that are being made? List them	
How long does it take to complete a typical product?	
Which product is more in demand in the marketplace?	
How do you decide upon the designs for a product?	
Are there any similarities between your and others' works?	

Is there anything you don't like about what you do?	
Hazard or danger at your work?	
Is there provision of insurance at your work?	
Remarks if any	

ANNEXURE-3

Interview Schedule

Case study on Bamboo Cultivation

Target Group: Entrepreneurs/ Start-ups/Associated functionaries:

Name of the Organisations/Entrepreneurs/ Start-ups	
Nature of organisation Producer/grower Collector (who buy in bulk and sell it to middle men)	
How long they have been in the business.	
Name of Bamboo products they are dealing	
Bamboo species	
No. of labours	
Trained	
Illiterate	
No. of female labours	
No. of male labours	
Role of labours	
Monthly Income	
Monthly Expenditure	
Raw materials they obtain as	
Are you known for any specialization or technique? If yes, please specify	
What do you like about the work you do?	
What are the working hours?	
What are the most common problems you face during your working hours?	
What are the tools that are currently being used in general for a particular product? Please spell out their local names	
Do you have any problems while procuring raw material?	
How frequently do you buy raw materials?	

What are the types of products that are being made? How long does it take to complete a typical product?	
Which product is more in demand in the marketplace?	
How do you decide upon the designs for a product?	
Have you explored with other raw materials apart from the traditional ones?	
Have new techniques been adopted for efficient production? Name if any	
How is your work different from others who do what you do?	
Are there any similarities between your and others' works?	
Is there anything you don't like about what you do?	
How do you judge a piece to see if its good?	
What are the factors for which bamboo products is demanded more? A. Beauty B. Aesthetic C. Need based D. Use E. Size F. Price G. Design H. Others	
How do you decide on the pricing of the products?	
What kind of support do you obtain from other sources? Are there any private organisations or government help?	
What are your methods of marketing?	
Is there any online mode to reach the customers during this time? If yes, specify.	Yes ( ) No ( )
Are you facing difficulties in the sales? If yes, what do you think are the reasons for the same?	Yes ( ) No ( )
Any weakness or problem in your sector? Specify	
Is the provision of loan and insurance?	Yes ( ) No ( )
Is getting loan easy or difficult?	Easy ( ) Difficult ( )