Chapter–3

Bamboo: The Economy-Ecology-Sociology

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This chapter deals with the broadly described conceptual framework used in this study in order to provide a theoretical base for the empirical investigation and guidance for selection of relevant predictor variables.

3.1 The Conceptual Framework of the Study:

Technically, bamboo is a grass belonging to the subfamily *Bambusoideae*. Over 1200 different species grow worldwide. Various species can reach heights of 30 m and more. About 18 million ha of bamboo are distributed in world forest ecosystems, in Asia, Africa, and America. Unlike most timber, bamboo is a self-regenerating natural resource; new shoots that appear annually ensure future raw material after mature culms are harvested. Bamboo provides considerable environmental benefits. In many countries, it is used for ecological purposes such as soil stabilization and erosion prevention on hill slopes and verges. It is a very important forestry plant which is harvested from existing natural forests, plantations, and mixed agroforestry systems. Bamboo silviculture is an option for conserving and protecting tropical forests while creating enduring supplies for the wood and cellulose industries. Bamboo is a multipurpose plant with a myriad of applications ranging from construction materials, furniture, fences, handicrafts, pulp and paper, edible shoots, and animal fodder. In developing countries, it is a basic raw material with numerous traditional uses. It is highly suitable for handicrafts; it can be woven into numerous products including mats, baskets, trays, hats, lampshades, caps, lanterns, etc. Many bamboo products are functional while others serve decorative purposes. Apart from its manifold uses in cottage industries, bamboo is also widely

used in modern wood and paper industries. Governments, research institutions, and private enterprises around the world are taking increased interest in the environmental and economic possibilities of bamboo. In the last decade, there has been a boom of manufacturing industries utilizing bamboo worldwide. Bamboo is also a source of food. The cone-shaped sprouts that emerge from the ground to form tall poles are edible vegetables when harvested young. Bamboo shoots generally appear during the spring or early rainy season. When harvested young, they are a crunchy and nutritious vegetable. Young shoots contain up to 90% water, and are rich in vitamins, cellulose, and amino acids. They have a high nutritional value, are low in fat and high in fiber content. Young shoots vary in size and weight according to species; the edible content of a newly harvested shoot is usually 30% of its weight. Bamboo shoots are sold fresh but are also canned in brine. They are exported worldwide and constitute a multi-million dollar trade commodity. For most products, bamboo processing does not require high capital investments but is labor intensive and contributes significantly to employment. Skilled labor as well as attractive designs and fine finishing are very important in making bamboo products for commercial purposes. The utilization of bamboo fences is widespread in tropical Africa. Applications of bamboo for structural construction, walls, ceilings, Room partitions, windows, furniture, ladders, etc. that are common in Asia could also be developed in Ethiopia and neighboring countries. There has been a growing awareness in recent years that bamboo is a vital component of development and an effective means to improve the livelihoods of rural poor people. Over 600 million people around the world generate income from bamboo. Hundreds of millions of people in the world live in bamboo houses. Women and children, many of whom live below subsistence levels in developing countries, harvest a great part of the bamboo that is used. Bamboo is a natural vehicle for development because rural people generally have adequate access to it. It can be easily grown and harvested in the perimeter of forest areas or under agro forestry schemes. Bamboo agro forestry requires only a modest capital investment and generates steady income to farmers. In many parts of the tropical world, the rural poor are dependent on bamboo for their shelter and daily domestic uses.

History and background of bamboo cultivation:

In Indian mythology there is a belief that there existed a tree which was known as 'Kalpavriksha' and was capable of fulfilling the wish of someone who stood below the tree and made a wish. In our primary school days, we were taught that the coconut tree in the south was like a 'Kalpavriksha', for the residents of the region. Th at was so said as every component of a coconut tree had its use. The fruit no doubt was the main gift of the tree. But similarly the leaves, the trunk, the kernel of the coconut and the coir covering a coconut, everything was useful. Just as coconut had multiple uses for the people in the south, bamboo was the 'Kalpavriksha' for the people of the north-eastern region. Food items, building materials, weapons, utensils for kitchen, bamboo cylinders for storage of water. There was nothing of bamboo which can be discarded as waste. Every farmer either in the hills or the plains of the North-east cannot be without a few clusters of different kinds of bamboo on his land. Bamboo also grew wild. Bamboo is really a 'Kalpavriksha' for the region. It fulfills numerous needs of an inhabitant and enables him to remain self-reliant in many respects. Lately the entire world has started paying attention to putting bamboo to different non traditional uses. We come across new descriptions of bamboo as "Poor man's timber", "Timber of the future", "Green gold" and similar others. Bamboo grew almost in every part of India. But the present-day situation is that the availability of bamboo in most parts is getting scarcer. Even Assam has started facing scarcity of bamboo. However, bamboo is still available in good quantity in the hill states of the region. In today's India, the northeastern region has the largest production of bamboo. The country has focused its attention to promote cultivation and exploitation of bamboo to a maximum possible extent. The country now has National Bamboo Mission. Different states are also being motivated to constitute state-level missions. The main centre for technological input in respect of bamboo is located at Guwahati and it is named as Cane and Bamboo Technology Centre. It also needs to be noted that bamboo is grown and used in almost all South East Asian countries. China in the present-Day world has come out with many advanced technologies and different uses of bamboo. China also has the highest availability of bamboo in the world. India comes next to China.

BAMBOO AND LIVELOHOOD

Bamboo, a social common capital contributes to the social, economic, and ecological development of a region. In India it forms an important component of homesteads, unproductive lands, and is of common occurrence in the natural forests. Bamboo is a universally used plant, contributing to the subsistence needs of more than 2.5 billion (Anonymous 1994, INBAR,1999), an important component of the subsistence economy of bamboo-dependent sectors of the population and tribal forest dwellers, bamboo craftsman and artisans and local rural people (Nair et.al,1982, Muraleedharan et.al, 2007, Jayasankar1996, 2004; Anitha, 2008, 2012) and further estimated to provide employment to nearly 8 million people (Annonymous, **www.mpsidc.org**). For ex, in India it is estimated that there are 2 million traditional artisans whose livelihood depends almost entirely on the harvesting, processing and selling of bamboo and bamboo products, such as, baskets, mats and handicrafts. In China, there are millions of farmers who grow bamboo as a component in integrated farming systems. One of the major advantages of bamboo as an entry point to development is the fact that so many products can be produced from it and most of them can be produced by small and medium-scale enterprises. It can generate important political and economic support which can translate into true sustainable development (Rao and Shastry, 1996). Bamboo shoots provide rural people with income during the lean rainy season when no other major agricultural crops can be produced (Thammincha, 1987). It has many domestic and agricultural uses, ranging from household utility products, ornamentals to houses (Muraleedharan et.al, 2001,2001). It has been traditionally used in housing, raw material for handicrafts, food, fuel, fencing, among others, and in modern days, it is being used as industrial raw material for pulp and paper, engineering products, panel products, furniture, grass interior, among others.

BAMBOO AND ITS SYNONYMS AND ITS DIFFERENT PERCEPTION

In India Bamboo is commonly known as Poor man‘s timber, In China it is known as Friend of the people, In Vietnam it is known as Brother. Likewise in different areas bamboo is popular and branded differently as Miracle, Wonder plant, Medicinal plant, Food crop, Green gold, Global cooling

agent, Carbon sequester, Bio-energy crop, Rich man‘s fancy, Social Common Capital etc.

Trade and economics highlights that the world market for bamboo is vast and growing. Globally, domestic trade and subsistence use of bamboo are estimated to be worth US$4.5 billion per year, and export of bamboo generates another US$2.7 billion (INBAR 1999). Bamboo can now be turned into high-value products, known as ‗engineered bamboo products‘such as floor tiles, panel boards, bamboo mat ply, corrugated sheets and charcoal. India is the world‘s second richest country in terms of bamboo genetic diversity with 136 species spread over around 8.96 hectares of forest area (approximately 12.8% of the country's total forest area) (Forest Survey of India, 2005). Approximately 45 per cent of total production of bamboo of the Country is being utilized in paper industries (Kamesh Salam, year). The size of the domestic bamboo economy has been estimated at around 2000 crores by the Planning Commission. The market potential however is estimated at around 4500 crores. Bamboo based value added industry is expected to grow at a CAGR of 15 per cent in the period 2001 to 2015. India‘s bamboo industry is expected to grow to Rs. 26,000 Cr by 2015. India‘s share in world trade in bamboo which is Rs.2043 Cr. Currently is expected to be 27 per cent of the total market of Rs.100,000 Cr. Recent estimates place the bamboo market at about US $12 Billion and the market is expected to double by 2015. The commercial consumption of bamboo globally is worth around $ 10 Billion, India‘s share of the global market is estimated at $ 1 Billion while china‘s share is currently the highest at $ 5 Billion. Furthermore, the National Bamboo Mission estimated that India has utilized only a tenth of its bamboo-producing potential. Despite these technological improvements and value enhanced high-end production on the one hand the actual benefits have not percolated down to the primary stakeholders, i.e., the traditional bamboo dependent who have hence been gradually marginalized from the mainstream bamboo based social and economic development lacking social security (Anitha, 2008, 2012). According to the United Nations estimates, more than three quarters of the global population do not enjoy social guarantees that would enable them to cope with livelihood risks (Sergie, 2012)

The National Policies regulating forest tenure over a period of time has had adverse impacts on the value base of the resource (*i.e., defining bamboo as*

timber) and on the acceptance regime of the cultivating and dependent population. There has been a shift in focus in utilization of bamboo, the corresponding legal changes and administration, constraints and present dilemmas in bamboo management in the wake of the most recent Forest Rights Act, 2006 (Anitha,2012,2013), that classifies bamboo as Non Timber Forest Produce (NTFPs). The role of bamboo in supporting the livelihood security of the marginalized bamboo dependents (MBDs) is yet to be documented. Besides, the economic and livelihood potential of bamboo in supporting rural livelihoods has received very less attention of the researchers in India.

The pre supposition here goes in a unique way by deriving the following axioms.

AXIOM 1	Bamboo Mission has got decisive impact on the rural economy of Tripura.
AXIOM 2	Income, Productivity, Livelihood is inter woovenly operating to make social ecology dynamic and sustaining.
AXIOM 3	Participatory data generation can reveal the choices and dictum of rural people to internalize natural resources for an extrapolation of Income, Productivity and Livelihood.

SCOPE OF BAMBOO PALNTATION

Bamboo plantations are easy to establish. Saleable culms can be produced in 4-7 years depending on species, inputs and after care. The plantations can be annually harvested by carefully cutting culms of the previous year. Bamboo plantations can be economically viable, if proper species and technology are adopted. Many species can co-exist with important tree species like Teak, Rosewood, Laurel, Gumkino, Benteak, Yellow teak etc. (Teak-Tectona grandis, Rosewood-Dalbergia latifolia, Laurel-Terminalia tomentosa, Gumkino - Pterocarpus marsupium, Benteak- Lagestroemia lanceolata, Yellow teak- Adina cordifolia). Many state forest departments have raised bamboo plantations. Andhra Pradesh Forest Development Corporation raised large blocks of bamboo plantations successfully and derived good revenues. It is regrettable that bamboos have not been given due importance by forest departments and forest development corporations. Developers of Teak can use bamboo as an intercrop with Teak. If enough emphasis is given to Bamboo Resource Development, we can help the

below-poverty-line families in rural communities. Bamboo and bamboo-based secondary product trading is a profitable business in rural regions and a potential sector of employment generation. Bamboo is used extensively by local communities and plays an important role in subsistence strategies for many rural populations. Bamboo enterprises are continuously sustaining the national economy through providing employment opportunities for rural people, including raw material collection, processing and marketing. The analysis reported here indicates that small-scale bamboo-based enterprises could be developed more widely throughout the rural areas for socioeconomic development. Natural bamboo stocks must be utilized on a sustainable basis. Their cultivation on encroached forest land and revenue land should be expanded. Government and NGOs can work with enterprises by encouraging them to manufacture secondary products and promote them in urban markets. The present loan approval procedure, conditions and interest rates also need to be revised and made more flexible to support entrepreneurs. The forest administration can play a vital role in improving existing growing stock and yields and expanding the area under bamboo by planting higher yielding commercially important species.

Establishment of good germ-plasm banks and multiplication facilities of elite stocks for use both in forests and farms can augment supplies to increase the uses of bamboo. Better management, harvesting, grading and preservative practices can lead to higher returns. Bamboo can play a major role in increasing employment potential and improving the rural economy.

National Bamboo Mission

Bamboo, a fast growing, versatile woody grass is found across the country. It is an economic resource having immense potential for improving the quality of life of rural and urban communities with environment regeneration qualities like carbon sequestering. Bamboo provides raw material for large industries like paper and pulp as well as for cottage and handicrafts industry. Some bamboo species can grow one meter in a day. Bamboo shoots are used in the preparation of vegetables and various other dishes and many other horticultural uses. It is grown like any other horticultural crop by tilling the land and is harvested annually, when grown commercially. Bamboo roots, leaves, sap and ash are being used since ancient times as a remedy for minor and major ailments, particularly in Ayurvedic health care.

The world market for bamboo is valued at US $ 10 billion of which China's share alone is to the tune of 50%. Market for bamboo expected to reach about US $ 20 billion by 2015. The size of the domestic bamboo industry is estimated to be about Rs.6505 crores, which may grow to Rs.26,000.00 crores by 2015..

The domestic bamboo sector is faced with many constraints, such as:

- Lack of scientific methods for propagation and cultivation.
- Lack of post harvest treatment and technology for product development.
- Inadequate trained manpower.
- Inadequate infrastructure for large scale harvesting in the event of gregarious flowering.

Keeping in view the potential of Bamboo, its present poor market linkage and sub optimal level technology application for manufacture of value added products in the industrial and cottage sector, the National Mission on Bamboo Technology & Trade development has been mooted by Planning Commission to accord Bamboo development a strategic role in rural economy, Poverty alleviation and bamboo based handicrafts & industrial development. The task for coordinating the National Mission on Bamboo Technology and Trade has been entrusted by the Prime Minister to the Ministry of Agriculture. The Mission document envisages coverage of 2 million ha under bamboo during the X Plan involving an investment of Rs. 2608 crores. The Mission document also envisages the integration different Ministries/ Departments for the holistic development of the sector. The Report, further, envisions an integrated programme expansion of plantations of bamboo species, its scientific management with the involvement of JFM committees, local initiatives and entrepreneurship for presenting this raw material for the Industries and assisting the Industry to access and apply modern technology for producing globally competitive new generation bamboo products. The other features of the Mission include Technology Development and Transfer for Planting, Technology intervention on process and products including standards and codes, Handicraft development including training, Trade and Market Development for bamboo products, and Technology development for building material.

The estimated fund requirement for the 10th Plan is Rs.2608.00 crores covering Rs.2000.00 crores for raising new bamboo plantations in 2 million ha, Rs. 208.00 crores for technology development, Rs.275.00 crores for handicrafts development, Rs.125.00 crores for trade and market development. Part of the cost of the project is required to be met from the Plan allocation for various Ministries by way of dovetailing the on going plan programme with the proposed ones. However, some components would require new provisions partly/ wholly for which resource allocation will be required. These may include R&D, planting program, technology development for processing, design development and promotional assistance for trade and market development.

The economic and social benefits from these activities have been worked out as 8.6 million job creation in the Tenth Plan, building up of 2 million ha bamboo resource and market opportunities worth Rs. 6500 crore with an investment of Rs. 2600 crore, enabling 5 million families of artisans and farmers crossing the poverty line.

Bamboo in North-east India

The "Green Gold" of the 21st Century and commonly known as "Poor man's timber", bamboo played a significant role in human society since time immemorial and today it contributes to the subsistence needs of over a billion people worldwide. It has been traditionally used as fuel, food, for rural housing and shelter, fencing, tools and various other purposes. In modern days, it is being used as industrial raw material for pulp and paper, construction and engineering materials, panel products, etc. Bamboo, which can be grown easily, is much faster in growth than any known tree, and is eco-friendly and adaptable to various locality factors, is now becoming the most promising wood substitute. It has more than 1500 documented applications, ranging from medicine to nutrition and from toys to aircraft. The north eastern region, a landmass of eight states, spread over an area of 262179 Km2 representing around 8% of the total geographical area of the country with a population of about 39.04 million is a region which is abundant in bamboo resources. The region houses about two thirds of the bamboo resources of the country spreading over an area of about 3.10 million hectares where 89 species of bamboos are available. This invaluable gift of nature to the region is integral to life and culture of all the ethnic

groups of North-eastern India. Its multipurpose uses have made it an indispensable resource for the rural people. Being interwoven with the daily life of the ethnic groups, it has been incorporated in their cultural and social occasions also. Efforts backed by a surge in people oriented policies by the State Governments of the Region have begun to bear fruit. Bamboo being a principal natural resource, the people of the region in particular will be better served by this God given bounty, if we all get down to the task of economic taming of this resource. A look at the facts reveal that sustainable and economic utilization of bamboo will throw open a plethora of opportunities, especially for the rural poor. Continued technological advancement and research have put bamboo into more and more uses and as a raw material for several industries. A priority requirement for harnessing its economic potential would be to draw up a well coordinated multilateral approach. The raw stock of bamboo in the region is conservatively valued at Rs. 5,000 crores. Even with a modest target of two-fold value addition to the stock through suitable methodologies, an annual turnover of approximately Rs. 10,000 Crore can easily be generated in the Region. The first bamboo based panel was developed in China in the 1940s. Since then, over 30 panel products have been developed. For instance in China, over 10,00,000 cubic meters of panels of various types are produced annually in some 200 Mills, whereas in India, industrial scale production of panels is confined to bamboo mat board with about 2000 cubic meters board produced by just seven mills. There are also enormous environmental and socio-economic implications and benefits. For example, in India, it is estimated that if Bamboo mat boards replace 1/4th of plywood, it can save 4,00,000 cubic meters of round wood, thereby preventing the disturbance to 30,000 hectares of forests per year. Furthermore, it will generate 16.7 million workdays of employment per year. A large section of the society depends on bamboo for livelihood. Although the people of rural area cultivate a few species of bamboos in homestead land to cater to their domestic needs, most of the tribal people depend on the wild bamboos occurring in forests. Large resource of bamboo in the Region is mainly utilized for domestic, handicrafts and in paper industries. Many of the species which are available in the region have great farming potential. Apart from wastelands and degraded lands, bamboo can be grown in marginal farm and underutilized lands. There is also great scope of increasing the yield and productivity of the bamboo bearing forest areas through scientific

management and by introducing quality planting stock of selected commercially important species. Farming is obviously related to utility, gap between demand and supply of raw materials, economic returns, etc. Therefore, setting up of industries for high value bamboo products, which require bamboo of uniform age, dimensions, quality and color will enable the utilization of the resource in bulk and in turn generate further opportunity for farming. The details of forest cover of the tribal district of N.E. Region and that of all India in the year 2003 are as under:

Name of the	**Total**	**No.**	**of tribal**	**Geographical**	**Tribal**	**forest**	**% of**	**forest**
state	geographical	area	district/	area in sq.	district	cover	cover	in sq.
	area in sq.km.	hill		km.	in sq. km.		km.	
Arunachal	83743	13		83743	68019		81.22	
pradesh								
Assam 1	78438	16		50137	12052		24.04	
Assam 2		3		19153	13158		68.70	
Manipur	22327	9		22327	17219		77.70	
Meghalaya	22429	7		22429	16839		75.08	
Mizoram	21081	8		21081	18430		87.42	
Nagaland	16579	8		16579	13609		82.09	
Sikkim	7096	4		7096	3262		45.09	
Tripura	10486	3		10486	8093		77.18	
NER TOTAL	26217971			253031	170681		67.45	
ALL INDIA	287263187			1103463	407298		36.91	

*Data on 3 hill districts of Assam namely Karbi Anglong, North Cachar Hills and Nagaon covering an area of 19153 Sq.Km.

Mass plantation of bamboos in forest areas and private land will go a long way in mitigating the situation of the depleting forest cover of the country in general and for the North-eastern Region in particular. Bamboo can conserve soil and water in catchments areas, minimize soil erosion and control flash floods in the valleys and plains. It is most effective in controlling landslides and can protect roadsides, riverbanks, canal banks and dam sites. In recent time, bamboo is seen as the

' *Wonder Plant'* of the 21st Century and as substitute of wood. It can mitigate the pressure on natural forests and contribute to conservation of biodiversity. Bamboo is the best plant for carbon Sequestration to retard pace of climate change. The Government of India has launched the " *National Bamboo Mission*", a 100% centrally sponsored scheme through the De partment of Agriculture and Co-operation under the Ministry of Agriculture, to promote holistic growth of the bamboo sector through area based regionally differentiated strategies. Similarly, the North-eastern Regional Bamboo Mission (NERBaM) under North-eastern Council, has also taken up implementation of a comprehensive Short Term, Medium Term and Long Term Plan for development of bamboo for poverty alleviation and saving forest specially for north eastern region.

The Salient Features of bamboo economics in the North-east region

1. Except in Tripura & Sikkim the forest cover in the region is in decreasing trend which is reduced from 160242 Sq.Km. in 1997 to 159108 Sq.Km. in 2001. In case of Tripura & Sikkim, the forest cover has been increased from 5535 Sq.Km. to 7065 Sq.Km. and 3041 Sq. Km. to 3193 Km. respectively. However, over all, the region showed an increase in forest cover which increased from 168818 Sq.Km. in1997 to 169366 Sq.Km. being 64.60% of the geographical area.
2. Tribal communities of the region heavily rely on forest resources for their subsistence and 90% of the population use biomass as an important source of energy.
3. In most of the N.E. States bamboo forms an important non-timber forest produce with immense potential.

4. The NER has a rich heritage of traditional skills in weaving, cane & bamboo crafts, carpentry, wood carving, etc., to meet domestic requirement.
5. About 89 species of 12 genera out of 136 species under 22 genera in the country are found in the North-east. Around two-thirds of the total bamboo resources of India covering 8.96 million hectares exist in the region.
6. The major clump forming bamboo species constituting the growing stock are Dendocalamus strictus (45%), Bambusa bamboos (Kotaba in Brahmaputra valley and Baroowa in Barak valley) (13%), D. Hamiltonii (phulrua in Mizo and Kakopesha in Garo)–(7%), B. Tulda (Jati in Assam, Mirtinga in Tripura) (5%), and B. Pallida known as Makla in Assam, Markel in Tripura, Naohei-Wa in Manipur accounts for 4% of the stock. Melocanna Baceifera, a non-clump forming bamboo popularly known as Muli in Tripura and Mautak in Mizo, accounts for almost 20% of the growing stock and is found all over the North-eastern region.
7. The ten major species used for commercial purposes are *Bamboosa bambos, B. balcooa, B. nutans, B. tulda, B. pallida, Dendrocalamus strictus, D. hamiltoni, Malocanna bacifera, Schizostachyam polymorphum (locally known as Bajal or Nal* in Assam and Wa chall in Garo or Paphals by Lepcha).
8. The major user of bamboo in the North-east is the paper industry, which consumes about 68% of the total annual production from the government forests. In addition, bamboo supports a number of traditional cottage industries including production of handicrafts, incense sticks, and related articles.
9. A steady and reliable source of quality raw material supplies is a fundamental need to the success of any planned economic activity. - In bamboo sector, despite the region and the country having one of the largest resource bases in the world, there are tremendous supply/demand problems that need to be overcome for successful development of the sector.

Bamboo in Tripura

Tripura is one of the major bamboo producing states in India. Bamboo grows all across the state of Tripura covering over nearly 10 to 15 different species. *Muli* Bamboo (*Melocanna baccifera)* is a dominant specie with over 80% coverage. It is primarily used for incense stick and domestic needs such as gate, fencing and construction. Species like *Mritinga*, *Paura, Kanakaich*, *Dolu* and *Barak* with differing properties and more amenable to higher value added products such as handicrafts, furniture and mats are grown in small pockets across the state. Triupra Bamboo Mission (TBM) has a large focus on generating non-muli high value adding bamboo plantations especially as private plantations and homestead plantations. The mission has conducted extensive cluster requirements analysis. Based on results of that analysis, TBM has come out with the following species vs product matrix to arrive at a mix of bamboo species for future plantations.

Bamboo and Tradition of Tripura

With nearly half of the state's forest cover being dense forest, the per capita forest cover of Tripura is a relatively high 0.22 ha (compared with the national average of 0.066 ha). Bamboo features in 38 percent of the total forested area, as either pure or mixed bamboo forest. Although Tripura has 19 species of bamboo, the commonly used species are Muli *(Melocanna baccifera)*, Bari *(Bambusa vulgaris)*, Mirtinga *(Bambusa tulda)* and Barak *(Bambusa balcooa)*. Tripura has a significant amount of homestead bamboo: a clump or two of bamboo in the backyard of rural houses is a common sight. The state estimates bamboo in small holdings at 10,900 ha. Traditions tend to be very strong in Tripura, and bamboo is such a tradition. “Once born, you cannot survive without bamboo,” goes a wise saying among the triba l people of Tripura. This is literally true because in certain tribes, the first time a person comes into contact with bamboo is immediately after birth, when his or her umbilical cord is cut with a bamboo blade. And bamboo accompanies him or her, as bier for the mortal remains, to the last gate of life. In between these two events lies the chain of life, in touch with bamboo at every turn and twist. Bamboo's widespread availability made its role almost indispensable in the local lifestyle. Close to 73 percent (135 million culms) of the bamboo extracted is used in the housing sector. Bamboo culms are used also to construct field and house

fences. Bamboo also finds extensive application in agriculture and fishing, and in making a wide variety of containers. Basketry in Tripura has developed to a fine art: some woven pieces are so finely worked that they look as made of ivory. The traditional garments of the people are woven on a loin or back-strap loom, which is a very simple but effective device constructed from a few bamboo culms. Bamboo shoots are an important part in the local diet. According to Tripura's Bamboo Policy document, the annual extraction level of 184.26 million culms is much beyond the sustainable annual yield of 142.60 million culms; this, combined with bamboo flowering and death of clumps, has resulted in a shortage such that the cottage industry is now purchasing bamboo from traders. The supply chain begins with the tribal extractor who obtains the bamboo from the forest and is therefore the first link in the chain. The tribal people engaged in shifting cultivation are allowed to extract the bamboo free of cost for construction of their huts and other uses. In addition, bona fide users and cultivators from the villages adjoining reserved forests are entitled to a free permit to the extent of 250 culms of bamboo per family per year.

The Tripura Bamboo Mission

The Tripura Bamboo Mission is Initiative of the Government of Tripura to develop the bamboo sector in the state in a holistic manner. The mission aims to double livelihood involvement and the sector turnover in a span of three years. It aims to optimize the end-to-end value chain spanning from plantation & resource generation to marketing of value added finished products. The mission has a subsector specific focus that includes handicrafts, furniture, incense, sticks & blinds, mat and industrial application of bamboo. The project is being implemented by IL&FS CDI based on a Public Private Partnership Framework. TBM will strengthen the bamboo based clusters in the state and build their competitive advantage through an integrated approach of building infrastructure, linking markets and providing technology, skills, design and institutional development.

India's first bamboo park coming up in Tripura

Tripura, which grows 25 varieties of bamboo, is about to make the most of this natural wealth - by developing India's first bamboo park. The idea is to help expand industries based on this produce, also known as 'green gold'.

Industries, Being created over an area of 70 acres, the bamboo park would be ready by March next year.

Bamboo flooring, bamboo-laminated boards, mat board, corrugated roofing sheets, incense sticks, mechanized Venetian blinds, home accessories and utility products, furniture made of laminated bamboo, round bamboo would be among the hundreds of items to be produced in the park and create skilled artisans. Besides trade and business facilitation to bamboo splitting and slivering, all kinds of modern facilities and latest techniques would be available in the proposed park as more than 40 bamboo species are available in the northeastern region with 25 species in Tripura alone. Of the 1,250 bamboo species throughout the world, India has 145. Bamboo forests in India occupy approximately 10.03 million hectares, which constitutes almost 12.8 percent of the forest area of the country. About 28 percent of these bamboo forests are located in northeast India. Tripura is one of the major bamboo producing states, harvesting 1.5 million tones of the total 13.67 million tones of bamboo harvested in the country per annum. Tripura is best positioned to lead the export-oriented bamboo sector in the country on account of the rich bamboo resources available in the state and the large skill base of people who are adept in the various aspects of handling bamboo. The bamboo park is expected to lead to direct employment generation for 1,730 people within the project site and the indirect employment generated is estimated to be five times the direct employment at 10,000 people located in the rural areas. The project has strong linkages with the bamboo clusters in the state and with the preliminary processing facilities in the bamboo growing areas. The Tripura government has been demanding that the central government create a bamboo board like rubber or coconut boards for coordinated harvesting, value addition and export of bamboo-made items and goods. Infrastructure Leasing and Financial Services (ILFS), India's leading infrastructure development and finance company, is the project management agency of the park, which is also expected to attract tourists, researcher and ecologist.

Climate change and bamboo

Bamboos are versatile resources that can help us tackle and live with climate change. Bamboos can help people mitigate and adapt to climate change, whilst growing and processing them to improve their livelihoods. Carbon sequestration is managed in bamboo forests, which indicates that

they are at least as good as comparable fast-growing tree species, and so planting and managing bamboos can help mitigate climate change. Bamboos can help adapt lives and livelihoods to increased occurrences of extreme climatic events, for example to landslides and floods, with a suite of innovative disaster-resilient bamboo houses and innovative ways of preventing erosion with bamboo. Integrated development with bamboo can provide secure livelihoods in the long term, and help many thousands of rural producers to make a living from bamboo where once they did not.

Climate change affects us all, but will affect the poorest the most. Bamboos help us all mitigate and adapt to the effects of climate change by:

- Absorbing and storing carbon;
- Protecting forests and watersheds;
- Insulating environments against extreme weather;
- Providing low-cost, green housing and infrastructure;
- Providing cleaner biofuels;
- Providing renewable, sustainable resource for generating incomes; and
- Increasing the range and season of food sources.

Bamboo can be an efficient tool for both climate change mitigation and adaptation, but there is a lack of scientific knowledge and awareness of its potential, which can be addressed in following way:

- Enhancing scientific and technical know-how of bamboo for climate change;
- Developing a carbon-accounting methodology for bamboo and running pilot sites to verify it;
- Raising awareness at many levels, from global climate change policy discussions (UNFCCC COPs) to local capacity building events; and
- Running climate adaptation demonstration projects to demonstrate the application of relevant technologies (charcoal, biofuels, bamboo housing).

Mitigating Climate Change with The Help Of Bamboo

Bamboos are amongst the fastest-growing plants, growing at up to a meter per day. Unlike trees, bamboos form extensive rhizome and root systems which can extend up to 100 km/ha and live for a hundred years. Culms that emerge from the rhizomes die naturally after about 10 years if not harvested before. The rhizome system survives the harvesting of individual culms, so the bamboo ecosystem can be productive whilst continuing to store carbon, as new culms will replace the harvested ones. The lost biomass is usually replaced within a year.

Bamboos are C_3 plants and have normal photosynthetic capacities, so their main advantage for mitigating climate change lies in their fast biomass generation and in their renewability.

The biomass of newly planted bamboo forests increases rapidly for ten or more years before reaching a plateau, at which point emergence and death of culms each year is approximately equal. The biomass of underground rhizome systems follows a similar pattern. In managed stands, cultivation and harvesting practices enable much higher biomass production per unit area, at least doubling productivity.

It is estimated that bamboo covers 22 million hectares today, which translates into sequestering 727.08 tera-grammes of carbon. Studies show that bamboo could be grown on many millions more hectares of degraded land in the tropics and subtropics, where it could provide additional incomes to farmers without affecting their existing crops.

Substitution of energy intensive products with bamboo can reduce greenhouse gas emissions indirectly. Producing bamboo products usually requires less energy than comparable fossil-fuel based products. Bamboo is selectively harvested and provides woody biomass each year, and can take pressure off other forest resources and contribute to avoided deforestation. These substitution processes not only reduce emissions indirectly, but can also contribute directly to climate change mitigation–the use of bamboo produ cts with long life spans increases the terrestrial carbon sink, through the long-term storage of sequestered carbon.

BAMBOO AND ECOLOGY

Bamboos play a very important role in many Asian ecosystems, both natural and man-made, especially in mountain areas such as the Himalayas. In forest areas they provide useful products as well as valuable wildlife habitats, and annual harvesting without large machinery minimizes environmental disturbance. In many rural areas bamboos are also cultivated to support subsistence agriculture through the provision of animal fodder and manure, fencing and tools, as well as housing, thus reducing pressure on forests and grazing areas. In shifting cultivation, the rhizomes allow rapid reestablishment of soil cover and fast nutrient recycling. In steep or eroding areas their unique rhizome and rooting systems stabilize slopes and reduce soil erosion. Throughout the Himalayas and in many other areas of Asia they are actively helping to maintain the ecological balance in delicate natural and man-made environments. Because the distribution of bamboos is so concentrated on Asia, the ecology of bamboos is a subject of particular regional importance.

Ecological problems in bamboo cultivation

Despite their potential contribution to the stability of the environment there is often considerable reluctance on the part of natural resource managers to either plant bamboos or to develop more organized production and utilization systems. The principle constraint is the unpredictable disruption of production by gregarious flowerings, and the uncertain fate of flowered clumps.Knowledge of the life cycle and reproductive behavior of species is fundamental to the study of their relationship to each other and to the environment, and thus is central to ecological studies. In the bamboos this knowledge has been very limited in the past, and recent important studies on reproductive behavior need considerable reinforcement. Thus the lack of knowledge of bamboo life-cycles, reproductive mechanisms, and population dynamics is essentially an ecological problem, and the lack of knowledge in these areas resulting in their neglect compounds the wider ecological difficulties facing Asian land-use systems in the next century.

BAMBOO AND BIODIVERSITY

Bamboos are distinct and fascinating plants, with a wide range of values and uses. They play a significant role in biodiversity conservation and

contribute to soil and water management. They are important for biomass production and play an increasing role in local and world economies. This study used an innovative approach to map potential current distributions of nearly 1 000 individual bamboo species that occur naturally within remaining forests of the Asia-Pacific region. The maps were also combined to generate regional maps showing potential species and generic richness. By quantifying the area of forest cover remaining within each species' range, this study shows that more than 400 bamboo species are potentially threatened by the destruction of natural forest cover. Conservation and sustainable management of wild populations of bamboo should be a high priority, especially where diversity is high or deforestation is a significant threat. Bamboos are of conservation significance in their own right and as indicators of high biodiversity in other groups. They are an ancient group of forest plants, intrinsically vulnerable to deforestation. The vulnerability of some species is increased by the simultaneous flowering and subsequent death of entire populations in cycles of 20-120 years. Inhabiting moister, more benign habitats in old-growth forests, they are often associated with threatened plants, and there are many specialized animal species that depend upon them. The best known of these in Asia is the giant panda (Ailuropoda melanoleuca), but the red panda (Ailurus fulgens) and the Himalayan black bear (Selenarctos thibetanus) are also heavily dependent on bamboo. The smallest known bat (Tylonycteris pachypus, 3.5 cm) roosts between nodes of mature bamboo (Gigantochloa scortechinii), which it enters through holes created by beetles. The recent discovery of a colony in a bamboo stand in Hong Kong highlighted the conservation importance of bamboos on that island, where all bats are protected (Ades 1999). More than 15 Asian birds live almost exclusively in bamboo; many of these are rare, and many threatened birds use bamboo as a significant proportion of their habitat (Bird Life International 2000). There are also many little-known invertebrates specially adapted to the environment within hollow bamboo culms. Studying these specialized relationships, which reflect a long history of co-evolution between bamboos and other species, can shed light on evolutionary and ecological processes. Because the extensive rhizome system of bamboos lies primarily in the top layers of soil, they often play a major role in stabilizing soils on slopes and river banks, preventing erosion and land slips. This also makes them important in securing the hydrological function of catchments and rivers. Many bamboos

grow quickly and are highly productive. For example the shoots of Bambusa tulda elongate at an average rate of 70 cm per day (Dransfield and Widjaja 1995). Annual productivity values mostly range between 10 and 20 t/ha/yr (Hunter and Wu Junqi 2002). Bamboo stands may achieve a total standing biomass that is comparable to some tree crops (of the order of 20-150 t/ha) and therefore they may sequester substantial amounts of carbon. However, their total carbon storage is likely to be lower than that of well-grown forest on favourable sites (Hunter and Wu Junqi 2002). Bamboos play an important role in local economies and are growing in national and international commercial importance in the Asia-Pacific region. They are multipurpose crops, with more than 1500 documented uses. The most important traditional uses include housing, food and material for handicrafts. Worldwide, more than 2.5 billion people trade in or use bamboo (INBAR 1999). Modern manufacturing techniques allow the use of bamboo in timber-based industries, to provide bamboo flooring, board products, laminates and furniture. Bamboo is becoming a substitute for wood in pulp and paper manufacturing; about 25 per cent of the fiber used in the Indian paper industry each year comes from bamboo (FAO 1998). Bamboo shoots are now an important food crop on the international market as well a locally and nationally. China is by far the leading exporter of bamboo shoot products, with an annual export value of nearly US$ 140 million (Feng Lu 2001). Bamboo furniture is an expanding business in many countries; exports of bamboo furniture from the Philippines in 1998 were valued at US$ 1.4 million (Vantomme et al. 2002). Worldwide, domestic trade and subsistence use of bamboo are estimated to be worth US$ 4.5 billion per year. Global export of bamboo generates another US$ 2.7 billion (INBAR 1999). Due to its many uses and its economic importance, bamboo plays a noteworthy role in improving the livelihoods of poor rural people. Much of the bamboo used is harvested by the poor, and especially by women and children. Because of the scientific, environmental, economic and social importance of bamboos, it is essential that strategies be developed for their sustainable management. However, knowledge to support such planning is limited.

BAMBOO RESOURCES AND THEIR MANAGEMENT

Very little is known about bamboo distribution and resources, especially in natural forests. As a non-timber forest product bamboo is not routinely

included in forest inventories. According to FAO (2001), statistical data on bamboo are available for the period 1954 to 1971 only.

Today, countries that monitor non-timber forest product (NTFP) supply and utilization at the national level remain the exception. The difficulty of assessing bamboo (and other NTFP) resources and use arises from:

- Uncertainty associated with their taxonomy
- Their many uses at local, national and internatio nal levels;
- The fact that many bamboo products are used or ma rketed outside traditional economic structures;
- The lack of common terminology and units of measu rement (FAO 2001).

Although reported figures on the area of bamboo forests are inconsistent, it is widely accepted that China is the richest country in Asia in terms of bamboo resources. China's bamboo forests have an estimated area of 44 000 to 70 000 km^2 (Feng Lu 2001), mostly of Phyllostachys and

Dendrocalamus spp. Their standing biomass is estimated at more than 96 million tonnes. Annual production of bamboo poles in China is 6-7 million tonnes–one-third of total known world production (FAO 2001). Classification of bamboos using botanical nomenclature was formally initiated by Linnaeus (1753), who included one species, Arundo bambos (now known as Bambusa bambos) in his Species Plantarum. Since then the number of species has grown progressively, with no indication that the total number of species has yet been approached . Because traditional plant taxonomy has relied heavily upon floral characteristics, while bamboo flowers are only encountered at long intervals, bamboos are among the least studied of all higher plants. When flowers were available in the past and names and descriptions were given, they have often been difficult to apply until the bamboos flower again, as they may rely upon floral characteristics for the identification of species.

According to Ohrnberger (1999), the subfamily *Bambusoideae* (of the family Poaceae, or Gramineae) comprises both woody and herbaceous bamboos with 1575 species altogether. In the most recent (and narrower) classification (Grass Phylogeny Working Group 2001) the subfamily

Bambusoideae includes two tribes and approximately 1200 species. Description of bamboos is thus still an ongoing process; not only do new species remain to be discovered and described, but many earlier descriptions and classifications of species need to be improved upon. With increasingly superior techniques of identification and classification, such as DNA sequencing and fingerprinting, there will continue to be new discoveries and reorganization of bamboo names for some time. Resources for scientific study of bamboos have been and remain severely limited. The need to target effectively the bamboo research resources available has resulted in international funding being focused on a relatively small set of 38 "priority species" of bamboo that are commercially important and widely distributed (Williams and Rao 1994; Rao et al. 1998) (Annex I). Consequently research on biodiversity and conservation of the remaining forest bamboos has been very limited. The concentration of resources on such a narrow range of common species was justified by the assumption that future increases in productivity would be based on infra-specific genetic improvement (Williams 1998). However, their sporadic flowering and other factors mean that there has so far been little progress in improvement or selective breeding of these plants. Most of the priority species of bamboos in Asia are found in managed plantations, large natural stands, or in and around arable land, rather than under a forest canopy. Actively cultivated for local utilization for millennia, this resource is generally in private or communal ownership, and a combination of security of tenure, access rights, regular management and high value serve to strengthen the likelihood of genetic conservation. Of much greater concern in terms of erosion of genetic biodiversity are the remaining forest bamboos, of which many are highly susceptible to deforestation. Problems of access, ownership, forest management procedures and difficulties in commercialization mean that they are more vulnerable, even though many of them are highly productive and extremely useful. Forest bamboos are also of importance in the conservation of the priority species. For many cultivated strains of economically important plants, one component of their conservation is the conservation of wild races and closely related species (Srivastava 2001). Therefore conservation of the forest bamboo species is necessary not only for their own intrinsic value, but also as a genetic backup in support of related cultivated bamboos, such as the priority species. Against a background of poor knowledge of bamboo identification and

distribution it is inevitable that the vast majority of bamboos have not been evaluated at all in terms of conservation status, and data deficiencies may limit the value of any ad-hoc assessments that have been made. Despite the growing importance of bamboos very few studies of the conservation status of individual species have been undertaken. Currently, the IUCN Red List of Threatened Plants contains 16 species of bamboo (Gillet and Walter 1998) (Annex II), and all of them are from the Asia-Pacific region. However, in India alone (Banik 1995; Biswas 1995; Subramanian 1995) 25-30 species could be classified as rare and thus potentially threatened.

Environmental Impact of Bamboo

Bamboo forests have many environmental benefits because they function as carbon sinks, produce oxygen, control soil erosion, provide organic matter, regulate water levels in watersheds, conserve biodiversity, beautify the landscape, and essentially contribute to the purification and regulation of the environment. All woody bamboos have their environmental importance; however giant timber bamboo species such as *Guadua angustifolia* are particularly outstanding.

Bamboo absorbs huge amounts of CO_2

Bamboo captures huge amounts of carbon dioxide which they generate and convert into oxygen. Scientific studies in commercial bamboo plantations in Mexico show that *Guadua angustifolia* has the capacity to capture **149.9 tons of CO_2** per hectare in the first 7 years after planting (average of 21.41 tons / ha / year). Information, which is fundamental and necessary to enter the international system of carbon trading, and, which can bring additional benefit for investors and farmers who grow and cultivate Guadua bamboo.

Bamboo does not release the trapped CO_2 as it stays captures inside the plant, even after the harvested timber is used in value added products for construction, flooring, panels, etc. it still functions as a carbon sink. One hectare of adult Guadua bamboo can also produce **5.8 times more biomass** compared to most other forest species.

Furthermore, bamboo is a **sustainable and renewable resource** because it continuously spreads vegetatively. This allows the formation of forests much faster compared to most other tree species. Unlike other types of

commercial forestry crops where trees must be clear-cut and replanted, in bamboo plantations only mature stems are harvested while younger stems are left untouched to mature and develop.

All these characteristics have called the attention of industrialized countries, and reveals the environmental impact and potential of Guadua Bamboo as a **high yielding forestry crop**. These countries who according to the Kyoto Protocol must reduce the effects of greenhouse gas emissions, see Guadua bamboo as an alternative that could help solve a global problem, perhaps, even at less costs compared to other expensive technological processes, which are much more complicated as well.

Regulating Water and Soil Erosion Control:

One hectare of Bamboo Forest can store over **30,000 liters** of water in its culms during rainy season which it gradually deposits back in the soil during dry season.

Bamboo regulates the quantity and quality of water, which are essential characteristics when managing watersheds. Bamboo forests also serve for **sediment control**. They form a sort of wall that prevents the loss of flow in rivers.

In addition, the forest cover of their **canopy prevents the evaporation of streams**. Therefore the environmental impact of Guadua bamboo is indisputable if it comes to effective watershed protection.

Guadua bamboo plants with their interwoven system of roots and rhizomes contribute to the recovery and conservation of soils present on riverbanks. Beneath the ground lays an extensive network of rhizomes that ties together and **prevents soil erosion** on hillsides or river banks. Planting bamboo to control soil erosion is recommended in areas susceptible to landslides or slopes in the process of slowly losing its soil. This woven root system acts as a cohesive for colloidal particles, making the plant a very important species as a soil protector near rivers. In the rainy season bamboo absorbs large amounts of water; it stores the water both in its rhizomes as in the stems and soil. This means that **bamboo has a high water storage capacity**. Later on, due to the effects of concentration, the water is returned to the soil, rivers and streams during the dry season.

The leaves of the bamboo plants prevent the impact of raindrops, favoring the **dispersion of the raindrops** into smaller particles. This contributes that ground water is distributed smoothly throughout the forested area. If bamboo does not exist on hillsides or slopes, heavy rains will probably cause **erosion problems** sooner or later. Bamboo also adds a great amount of **organic matter** to the soil. Its large mass of leaves, twigs and dry stalks contribute to nutrient cycling, thus conserving soil fertility in both its physical and chemical aspects.

Bamboo for Wastewater Treatment

As sewage treatment, bamboos are presented as an alternative water pollution solution through the **Root Zone Method** (RZM). There are different methods to treat water pollution and each is applied depending on the nature and extent of contamination.

The water treatment processes are divided into three groups: primary, secondary and tertiary. The primary methods is purely physical, the secondary is biological and the tertiary can be of both types.

The Root Zone Method for water treatment is of the secondary type because it is based on the biochemical activity of **microorganisms** that remove dissolved and suspended materials, or by converting them into less polluting compounds. Most of these processes are aerobic and therefore require the presence of atmospheric oxygen which will be used by microbial populations in the oxidation process.

This method of wastewater treatment is based on the action of microorganisms living in the root zone or rhizosphere of different plants. Thus, the wastewater is biochemically oxidized by bacteria present in this area. Plants provide an adequate supply of dissolved oxygen for this process by transferring atmospheric oxygen via the leaves, stems and roots.

Traditionally, the plants used for this purpose are reeds, tules, cattails and sedges. Studies have been initiated with some bamboo species that can withstand moisture for most of the year. The initial problem to overcome with Guadua bamboo would be the adaptation of the small plants to the wet conditions, which are in the early stages of development **very susceptible to excess moisture**. Another use which is being investigated is the use of **bamboo stem rings**, which are nothing more than Guadua bamboo

internodes of about 5 cm in length. Especially in rural areas, traditional wastewater treatment materials such as stone and gravel are being used. These could be replaced with the tips of the Guadua bamboo as a material in anaerobic filters. The removal efficiency was similar for both materials, but with the advantage that bamboo is cheaper and such rings are virtually scrap when exploiting bamboo.

Bamboo a host of Fauna and Flora

The temperature combined with a gloom atmosphere that occurs inside a mature forest of bamboo, greatly favors the establishment of different animal species and understory plants that prefer to grow in these conditions.

Bamboo Beautifies the Landscape

Guadua bamboo that grows near rivers and streams form spectacular gallery forests that enrich the landscape. Bamboo forests due to the different stages of development of their individual stems, generate a wide variety of greens that enrich the landscape in contrast to other crops or plants nearby.

Key Action to be taken to expand Bamboo Enterprise and Its Importance

- An efficient regulatory institution is essential for markets to grow in a sustainable manner, especially where environment concerns are coupled with business development.
- Transaction costs must be minimal, information availability maximal with a clear focus on maintaining the forest cover. Unfortunately, the regulatory structure as regards the bamboo industry has remained caught in the quagmire of archaic forest laws, whereby bamboo is defined to be a tree, and therefore felled bamboo is classified as timber. This is subject to transit and trade restrictions.
- Bamboo is also subject to harvesting permissions in many parts of the country if grown on private lands and which then becomes the basis for imposing the need for transit permits. This has resulted in throttling of the bamboo sector and has discouraged private plantations.
- The irregular and scant supply of bamboos for processing, despite the world's largest area under bamboos has been a natural corollary. Clearly

the expansion of a bamboo based sector has not happened due to the restrictions in place. If the restrictions are removed, the sector still might not grow, but can impact livelihood benefits percolating down.

- This should justify an initial policy initiative through subsidies, incentives and other handholding measures.
- Economic subsidy can be justified when social benefits outweigh private benefits. So in the bamboo sector the understanding of livelihood benefits is crucial understand.
- Recognizing the multiuse nature of many bamboo plantation and the difficulties of defining access rights, and embracing this complexity by developing localized, adoptive management within a livelihood context that involves all local bamboo plantation resources.
- Reorienting research to be multidisciplinary and demand driven, to bridge between communities and policy makers through greater involvement of bamboo enterprise and indigenous knowledge in research.
- Actively supporting improved, more transparent and accountable management of resources through a partnership between the state and resource users and across national boundaries

Importance: The economic and social benefits for example, from activities related to bamboo based value added products and applications was worked out to be 8.6 million jobs (new) in the Tenth Plan, besides building up large bamboo resource and market opportunities worth rupees 6,500 crore with an investment of rupees 2,600 crore, enabling 5 million families of artisans and farmers crossing the poverty line, according to the National Bamboo Mission5. The expansion of handicraft, cottage and tiny sector can potentially create 3 million jobs, according to estimates of the Planning Commission (2003). On the other hand, generation of power through gasifiers using bamboo resources exemplifies assiduous application of technology that can alleviate the present power shortage in most states and thus help improve the overall economy. There has been a growing awareness in recent years about the importance of bamboo being an important means of economic growth and of improving the socio-economic conditions of the rural poor. Bamboo as an industrial material can substitute

wood to a great extent and that too at low cost. Bamboo has been traditionally harvested from forest lands in India and the homesteads which may have a few clumps of one of the many species of bamboo for household use but very little intervention in terms of purposive planting has been done in the past. Convincing and informing users and policymakers of bamboo's versatility may fit in with a strategy of poverty alleviation and reducing pressure on tropical forests. Smallholders at the forest fringe can, in particular, improve their livelihood by processing bamboo or growing it in their backyard. Bamboo as a resource needs to be seen as a form of development, with the primary value addition done closer to the resource in order to reap the livelihood benefits. At the same time, a large stock of bamboo contributes to broader environmental goals of erosion control, reforestation and watershed management.

The constraints

There were several constraints that were identified in the course of the roundtables and field visits as well as from secondary sources. These can be listed as follows:

- The regulatory constraint on transit of bamboo as well as on harvesting from private plantations,
- The irregular supply of bamboo to industries,
- Poor market linkage of the products,
- Technology application for new product design along with testing, certifying of products,
- Lack of an institute on bamboo application and technology,
- Lack of application of known scientific methods in plantation, poor post-harvest treatment, and up-gradation of skill formation,
- Waste utilization, and
- Competition from Chinese products.

How to exploit the potential of bamboo enterprise:

While there are local practices with respect to production and processing, there is a need for developing appropriate management techniques in the

production-to consumption system. Moreover, there seems to be a perpetual tussle between the forest official and the grower/extractor with respect to its control. Most of the bamboo found in India is forest bamboo. Hence the tussle has also been between the forest department and the artisans, etc. The dialogue has been on de-reservation of forests for bamboos as indicated earlier, reclassification of bamboo as an agricultural crop rather than a tree, etc. In the NE, while most of the land and forests are owned by the community, there exists a *mahaldari* contract system for the sourcing of raw bamboo from the extraction centers. This system leaves a lot of scope for corruption and leakages including trading of the contracts. The large inflow of funds into the NER from the Central Government has resulted in a passive work culture and created government monopoly in employment. Funds earmarked for development of the region have been channellized elsewhere. This has resulted in a marked disparity of income between the grower households and the trader and government class leading to community disharmony. Grower households can increase their income levels by participating in the bamboo-based industry. Sustainable development through community forestry/farming has successfully enabled a number of developing economies to elevate living standards and reduce the divide between the business class and the local communities and thereby set up organised industry based on forest or agricultural-produce. The NER with its substantial bamboo resources and historical strength in the wood industry is highly compatible with the requirements of the sustainable development model. The only weak links in the chain are related with policies and regulations and market development. Changes in these can be brought about through proper presentation of facts to stakeholders in a phased manner. Now is the time for action. The problems that exist in the NER to date–lack of land tenure records, the practice of jhum cultivation and the almost feudal hold of the district councils–can all be put to positive utilization, starting with the humble and endearing bamboo with which the locals are as familiar as with themselves.

The whole lot of the research process has been theorized here to build up a conceptual for the following implication: In any ecosystem, production as a process has got polyhedral impact. Implication to the production process has generated congenital impacts in the form of income, productivity and livelihood etc. since these are congenital by nature, and the impact of any one aspect is expected to spill over the other areas. For example, the change

in livelihood is deriving saps from the fluid of income is collaterally impacted by the derivatives of livelihood.

Next implication production is a process gone characterized by both institution and interactions. The biological magnification has here been a accrued process perceived and keeps adhering to collateral processes like technology socialization, market decision and the personal scale. And thus the entire process has become polyhedral, reticulate and mutually synchronized by nature.

The study thus suggests that and proposes to conduct the heuristic inquiries in such a way as to build up a theoretical frame work for encompassing income, productivity and livelihood from bamboo enterprise under the single canopy of bamboo enterprise.

3.2 Selection of Dependent Variable

The selected dependent variables are Income, Productivity and Livelihood generation in bamboo enterprise. Income is the generation of monetary values in terms of Rupees/head/annum as a result of investment and interaction of both cost and inputs in a given production system.

The Implication of Income

Income is both resource and capability for accessing utilities to the desirable level. Income the other way round, presents the economic means for attaining empowerment. Every income has got respective material and nonmaterial values and its subsequent social perception. Income can be socially perceived as status, power, resource, well being and even the very identity of a person.

The characterization and variation of income along with its source and impact has got tremendous impact in the generation of livelihood and some tangible resources as well. The short-term income and the speculative income have got its typical social character and economic value. On the contrary, assured and long-term income has got social development. The high peak income season again, skewed to a few months or days draws upon the social process and consequences in a unique manner. Again income by women, no matter what the amount may be, has got immense social meaning. In a stratified society same hundred rupees has got different meaning from the poorest to poor to richest to rich. The non-linear nature of

income has got both problem and prospect. But in social sciences and as the present research objective suggest income should happen along bide the productivity and livelihood and vis-à-vis.

The Implication of Productivity

The productivity here has been envisaged through the pace and volume at biological magnification through the intervention of a set of operational, decisional, management and entrepreneurial motivation where production is quantity, productivity is performance expressed in terms of quantity per unit area per time. Every production as well as productivity has got social as well as market values. The fallacy is that reciprocally related while society act as the buffer, in other case, productivity and society are synchronized while market remains as a modifier.

The Implication of Livelihood

Livelihood is the means of wage and man days of thriving a life we demand for secure and decent livelihood. Any livelihood being the building block of life process, needs income support and generate social meaning. It is the process of eking out the basic minimum for sustaining life in a socially defined manner. The other dimension of livelihood is the security, decency, gender, accessibility, expanse and sustainability. In social science, productivity may be biological or physical by natural means is both conceived and perceived through the diodes income and livelihood.

Every livelihood has got a got cultural base, gone patterned over a protractile period and originally linked to the institution around and across.

The Ratio of Income-Productivity-Livelihood

In social ecosystem the three basic elements Income, Productivity and livelihood have formed a reticulate of interactive performances to characterize ultimately the social process to land on a value of social growth. In an ideal situation these three do form a synergic of reciprocal benefits. But in some cases productivity changes livelihood and income remain recessive. The kind at biological ramification could not imbibe any social benefits. Sometimes livelihood generate without pulling of any livelihood perceived. So in this case there is no reason why bamboo growers do come up with expected spontaneity. Then last occasion, income is changing in a positive direction so also production goes changing in the

same direction, but generating a little or no impact on livelihood. In this case, few entrepreneurs turn richer bypassing the interest of redrafts of the common people.

So, this is a heuristic interest undertaken in the interest undertaken in the study, by perceiving that bamboo enterprise is not only a mean of how to increase productivity by applying plethora of technologies or inputs but a social means of creating income for the economically backward people specially those who are along the social periphery.

So the research has been defined in such whether a point of interception could be attained where in,, the three apparently different and innately cognate a objective and probably that would be the most wanted triangulation of objectives for social issues, economic purpose and a biological end.

3.3 Selection of Predictor or Independent Variables:

In the present study the researcher had intended to select a number of predictor variables, which could explain the expression of bamboo grower's behavior with respect to the income, productivity and livelihood generation from bamboo enterprise in selected area of Tripura.

Explanatory type of study, review of relevant literature, discussion with progressive bamboo growers of the research local, panchayet officials, office personnel of Tripura bamboo mission, helped in perceiving the predictor variables relevant to this study.

Among the large number of predictor indicators, which may have theoretical as well as empirical relationship with the Income, Productivity and Livelihood generation from bamboo enterprise, were selected for this research work.

Socio-Personal Variables

Age: Age refers to the number of years the respondent lived since birth at the time of interview and was rounded to the nearest whole number. Persons younger in age are likely to be progressive. Man changes at every moment through exchange in line with a stimulus –receptor relationship. Chronological ages, developed through experience and introspection, exercise influence in orienting income, yield and livelihood generation process in bamboo enterprise. Hence it is predicted that farmers age would

be directly associated with the income, productivity and livelihood generation in bamboo enterprise.

Education: Education is generally believed to have the effect of widening the mental horizon of a person and thereby predispose him to be respective new ideas. Beal and Sibley (1967) pointed out that amount of formal education he possesses will affect the manner in which the individual gathers data and relates himself to the environment.

Education can also be viewed as including all communicating of knowledge and shaping of values. In this sense it is synonymous with socialization. True education results in an ability to group relationships between the facts and ideas, and between one idea and another to place facts and ideas in a system of values, and to see their relevance to one's own life and to his society.

A relationship between education of bamboo growers and income, productivity and livelihood generation in bamboo enterprise is expected.

Family Size: The influence of family member on the income, productivity and livelihood aspects of bamboo enterprise is inevitable. Although the head of the family make the final decision on operation of bamboo enterprise, the member of his family often act as consultants in reaching a decision.

Generally up to five members are regarded as a small size family and more than five members are regarded as a large size family. Large size family, which has more work forces, may be more conducive to better management of farm enterprises. For the present study, a relationship is accepted between the family size and income, productivity and livelihood generation from bamboo enterprises.

Material Possessed: Material possessed by the bamboo growers also indicate impact of bamboo enterprise in their life. Materials possession may vary from one household to another and it is expected to have significant association with the income, productivity and livelihood generation from bamboo enterprise.

Mass Media Exposure: Interaction with different media may be localite or cosmopolite, and action and reaction process ultimately characterize

group and social dynamics. The more the interaction the more will be the openness of the receptive or co-active domains where in all the cognitive, affectional or actional changes are assured and processed as well.

The exposure of bamboo growers to different media like local leader, bamboo mission, newspaper, radio, television play an important role in the upliftment of income, productivity, livelihood of bamboo. The exposure may be found in formal or informal type.

Training Received: Training means to educate a person so as to be fitted, qualified and proficient in doing some job. Training is an overt process, a sequence of experience, a series of opportunities to learn in which the training is exposed in some more or less systematic way to certain materials or events.

Hence, it is hypothesized that training received by the receivers would be directly related with the income, productivity and livelihood generation in bamboo enterprise.

Energy Consumption: The availability of energy is an important determinant of the quality of life in human settlements. Access to modern energy services is fundamental to fulfilling basic social needs, driving economic growth and fuelling human development. This is because energy services have an effect on productivity, health, education, availability of safe water and communication services. Modern energy sources such as electricity, natural gas, modern cooking fuels and mechanical power are necessary for improved health and education, better access to information and agricultural productivity. Furthermore, the way in which energy is generated, distributed and consumed affects the local, regional and global environment with serious implications on livelihoods, income and human development prospects.

Agro-Economic Variable

Homestead land: It is the amount of land an individual possess for dwelling purpose with his family. A relationship between homestead land of a bamboo grower and income, productivity and livelihood generation in bamboo enterprise is expected.

Land under Agricultural Crop: Land under agricultural crop is measure of farm business. It is the amount of land possessed by an individual for the

cultivation of different crops throughout the year. A relationship between land under agricultural crop of a bamboo grower and income, productivity and livelihood generation in bamboo enterprise is expected.

Cropping Intensity: Cropping intensity refers to the proportion of area annually put under the different crops to the total cropped area expressed in percentage. Since a large number of short duration crop varieties are now available, farmers are in a better position to take more number of crops per year annually from the same piece of land for obtaining higher production. A relationship between cropping intensity and income, productivity and livelihood generation in bamboo enterprise is expected.

Annual –Income before Bamboo: It refers to the income generated by the selected respondent annually before the adoption of bamboo enterprise. A relationship between annual income before bamboo and income, productivity and livelihood generation in bamboo enterprise is expected.

Techno-Managerial Variable

Average cost of farm implements when purchased: These are mainly the input cost. Cost of farm implements when purchased were calculated and average of that cost has been derived.

Average cost of farm implements now: Fresh values of those implements were also calculated and also the average of that value has been derived to see the differences.

Land under bamboo: Land is the primary input and factor of production which is not consumed but without which no production is possible. It is the resource that has no cost of production and although its usage can be switched from a less to more profitable one. It is very much predictable that as large will be the possession of land by a bamboo grower, the productivity will be as high.

No. of Rhizome planted: Rhizome is the basic biological input of bamboo production. In botany and dendrology a rhizome is a modified subterranean stem of a plant that is usually found underground, often sending out roots and shoots from its nodes. A rhizome retains the ability to allow new shoots to grow upwards.

No. of Rhizome grew to the fullest: It's not always the case that number of rhizome planted is similar to number of rhizome grew to the fullest, there has been distinct gap between these two situation which effect the productivity of a bamboo orchard.

Distance to Market: Distance to market plays a significant role in the marketing and also pricing of bamboo pole. As longer the distance, higher will be the transportation charge. Sometimes longer also become constraints in marketing**.** A relationship between Distance to market and income, productivity and livelihood generation in bamboo enterprise is expected.

Cost incurred in bamboo cultivation: No new venture, production is possible without a optimum investment. So, as optimum will be the investment as high will be the income. We are using here the word optimum as because bamboo plantation does not require heavy investment, is anyone does so it will lead into law of diminishing utility. Investment cost may incurred in use of plant protection chemical, fencing, weeding, purchase of rhizome, labour charge etc.

Mode of selling: Mature bamboos are saleable in different form to the market. If treatment and processing are done then it will add value to the product. It is very obvious that pricing also vary if marketed bamboos are processed and for the one which are not processed.