ECONOMIC ANALYSIS OF BAMBOO PRODUCTION IN NAGALAND:

A CASE STUDY OF DIMAPUR AND MOKOKCHUNG DISTRICTS

Thesis

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By

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DECLARATION

I, Ms. Walosangla Ao, bearing Ph. D. registration No. 656/2015, hereby declare that the subject matter of the thesis **"Economic Analysis of Bamboo Production in Nagaland: A case study of Dimapur and Mokokchung Districts"** is the record of work done by me, and that the contents of this thesis does not form basis of the award of any previous degree to me, or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any degree in any University/Institute.

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ACRONYMS

BCR	Benefit Cost Ratio
CAGR	Compound Annual Growth Rate
FSI	Forest Survey of India
GOI	Government of India
GSDP	Gross State Domestic Product
GSVA	Gross State Value Added
INBAR	International Network for Bamboo and Rattan
IRR	Internal Rate of Return
NBDA	Nagaland Bamboo Development Agency
NBM	National Bamboo Mission
NBRC	Nagaland Bamboo Resource Centre
NER	North East Region
NMBA	National Mission on Bamboo Application
NPV	Net Present Value
PCI	Per Capita Income

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CHAPTER 1

INTRODUCTION

1.1. INTRODUCTION

Bamboo is an evergreen plant which belongs to Poaceae grass family and Bambusoideae sub family. They are grouped into three tribes: Arundinarieae (546 species), Bambuseae (812 species) and Olyreae (124 species) (Clark et al. 2015)[1]. Bamboo is the common term applied to a wide group of large woody grasses, which range from 10cm to 40m in height (Scurlock et al., 2000)[2]. It originates from Southeast Asia, and is a natural component of the forest ecosystem (Dannenmann et al., 2007)[3]. As per International Network for Bamboo and Rattan (INBAR) report 2019, there are 1642 known species of bamboo, 30+ million hectares of bamboo forest around the world and the global bamboo and rattan sector worth is $60 billion. Bamboo could grow from sea level to as high as 300 meters whilst it attains its full height within 2-4 months (Adekoya 2003)[4]. It is probably the world's most sustainable resource and one of the fastest growing plants in the world, due to a unique rhizome dependent system (Farrelly. D, 1984)[5]. Certain species of bamboo can grow up to 91 cm(35 in) within a 24 hour period, at a rate of almost 4 cm (1.6 in) an hour (a growth around 1 mm every 90 seconds, or 1 inch every 40 minutes 'Fastest growing plant' (Guinness World Records, 2014)[6]. Bamboo

[1]Clark, L. G., Londoño, X., & Ruiz-Sanchez, E. (2015). Bamboo taxonomy and habitat. In *Bamboo* (pp. 1-30). Springer, Cham.
[2]Scurlock, J. M., Dayton, D. C., & Hames, B. (2000). Bamboo: an overlooked biomass resource. *Biomass and bioenergy*, 19(4), 229-244.
[3]Dannenmann, B. M., Choocharoen, C., Spreer, W., Nagle, M., Leis, H., Neef, A., & Mueller, J. (2007, October). The potential of bamboo as a source of renewable energy in northern Laos. In *Conference on International Agricultural Research for Development, University of Kassel-Witzenhausen and University of Gottingen*.
[4]Adekoya, J. A. (2003). Environmental effect of solid minerals mining. *Journal of Physical Sciences, Kenya*, 8, 625-640.
[5]Farrelly, D. (1984). The benefits of bamboo. *The Sciences*, 24(6), 11-12.
[6]Guinness World Record, 2007. https://www.guinnessworldrecords.com/world_records/fastest-growing-plant/ Retrieved on 16/04/2019.

has the capacity to adapt to extreme climate and soil conditions, which makes it a diverse plant, (Hossain et al., 2015)[7].

Bamboo has three important parts that is root, culms and leaves. It is popularly known for rapid growth, flowering and superior physical and mechanical properties (Hung and Wu, 2010)[8]. Bamboo presents a promising alternative to products produced by silvicultural forestry (Hunter, 2002)[9]. Bamboo species in India surpass other trees found in India. It is a superior raw material for making strong and sturdy furniture, construction components, ornaments and novelty items. Wood lumber does not have as much strength and properties as that of bamboo (Langhelle, 1999)[10]. In twentieth century, uses of plastic have caused environmental problems like global warming and other pollution issues (Malanit et al., 2011)[11]. As an alternative to plastic, wood was commonly used but it takes longer years to grow than bamboo. Today, bamboo can be used as substitute of wood and plastic.

Bamboo is an important group of plants, having cultural, economic and ecological values (Liese & Kohl 2015)[12]. It is an important part of rural livelihood in many countries, especially in developing counties like India. In India, forest has been a major contributor to its economy and plays a significant role in providing livelihoods to a number of people. The forests cover spanning up to 68 million hectare, wherein the availability of Non-timber forest products (NTFPs) have also taken a primary position as a source of livelihood for the people. In terms of bamboo production, India is one of the richest providers in the world, second only

[7]Hossain, M. F., Islam, M. A., & Numan, S. M. (2015). Multipurpose uses of bamboo plants: A review. *International Res J Bio Science*, 4(12), 57-60.
[8]Hung, K. C., & Wu, J. H. (2010). Mechanical and interfacial properties of plastic composite panels made from esterified bamboo particles. *Journal of wood science*, 56(3), 216-221.
[9]Hunter, I. R. (2002). Bamboo—Solution to problems. *Journal of Bamboo and Rattan*, 1(2), 101-107.
[10]Langhelle, O. (1999). Sustainable development: exploring the ethics of Our Common Future. *International Political Science Review*, 20(2), 129-149.
[11]Malanit, P., Barbu, M. C., & Frühwald, A. (2011). Physical and mechanical properties of oriented strand lumber made from an Asian bamboo (Dendrocalamusasper Backer). *European Journal of Wood and Wood Products*, 69(1), 27-36.
[12]Liese, W., & Kohl, M. (2015). Bamboo. *The plant and its uses. Switzerland*. Springer International Publishing,

to China. According to India State of Forest Report (ISFR, 2019)[13], bamboo grows in about 12.8% of its total forest area (9.57 million hectares). But the country taps only one tenth of its bamboo potential and contributes only 4% of the global market mainly because of low productivity (around 0.33 tonnes per hectare per annum). The annual bamboo production in the country is estimated at 3.15 million tones. Bamboo is thus an important contributor to the local economy in India, with its annual turnover of about 9,000 crores of rupees with an approximate demand of 26 million metric tonnes annually and it is expected to raise in future (Reddy, 2018)[14].

Bamboo with its vast environmental benefits is quickly becoming more than just a poor man's timber. In recent time, bamboo is also seen as the 'wonder plant' of the 21st century (Kalaiarasi et al., 2014)[15]. It stands as an ideal species capable of achieving eco-restoration of degraded lands, conservation of soil, moisture and providing economic security as well (Swamy, 2011)[16]. Bamboo grows well on steep hillsides, road embankment, gullies or on banks of ponds and streams. Bamboo clumps have extensive rhizome system, thick litter layer, dense plant canopy which makes bamboo forests able to control erosion and landslide, soil and water conservation, protection of riverbanks (Song et al., 2011)[17]. Its valuable features like extensive fibrous root, connected rhizome, leafy mulch and dense foliage helps in controlling soil erosion. The soil around bamboo plants are permeated by a mass of intertwining roots which are effective in holding soil and landslide prevention. The leafy

[13] India State of Forest Report (2019). Published by the Ministry of Environment and Forests, Government of India, retrieved 12th October 2020 from http://www.fsi.org.in/sfr_2020.

[14]Reddy, Jagdish (2018). Bamboo Farming Project Report, Cost and Profit Details, http://www. https://www.agrifarming.in/bamboo-farming-project-report-cost-profit (accessed on 24.11.2020).

[15]Kalaiarasi, K., Sangeetha, P., Subramaniam, S., & Venkatachalam, P. (2014). Development of an efficient protocol for plant regeneration from nodal explants of recalcitrant bamboo (Bambusaarundinacea Retz. Willd) and assessment of genetic fidelity by DNA markers. *Agroforestry systems*, 88(3), 527-537.

[16]Swamy, C. (2011). Employment Generation by Bamboo Resource Development and its impact on rural Communities. *International Journal of Rural Studies (IJRS)*, 18(1), 1-6.

[17]Song, X., Zhou, G., Jiang, H., Yu, S., Fu, J., Li, W., & Peng, C. (2011). Carbon sequestration by Chinese bamboo forests and their ecological benefits: assessment of potential, problems, and future challenges. *Environmental Reviews*, 19, 418-428.

mulch which accumulates beneath collects and conserves moisture. The evergreen leaves, dense canopy and numeral culms helps to intercept considerable amount of rainfall and their ability to grow in a wide variety of soils, from marginal to semi-arid makes bamboo perfect for rehabilitation. Bamboo has the ability for carbon sequestration due to its rapid biomass accumulation and effective fixation of solar energy and carbon dioxide.

1.2. FOREST RESOURCE IN INDIA

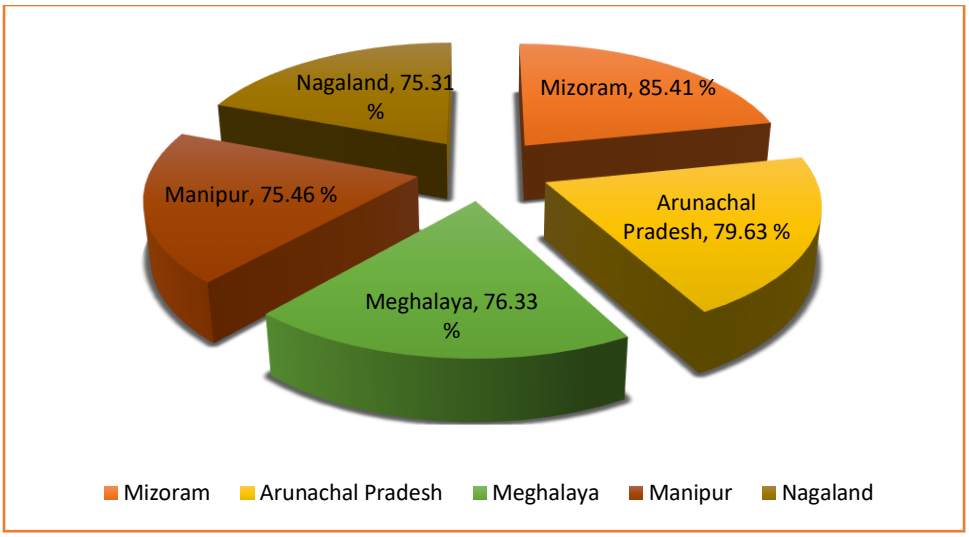
The Global Forest Resources Assessment 2020 reported that the total forest area of the world is 4.06 billion hectare (ha) which comprised of 31 per cent of the total land area. India's forest cover grew at 0.38 per cent annually or at an average 266,000 ha of forest increase every year during 2010-2020. As per FSI (2019) report, India's forest cover is 7, 12,249 sq km which is 21.67 per cent of the total geographical area. There was an increase of forest cover by 0.56 per cent as compared to FSI, 2017 report. The top five states in terms of forest cover as percentage to total geographical area are Mizoram with 85.41 per cent, which is followed by Arunachal Pradesh with 79.63 per cent, Meghalaya with 76.33 per cent, Manipur with 75.46 per cent and Nagaland with 75.31 per cent, respectively. In Northeast India, forest plays a very significant part. It is a way of life for the people of the region. The total forest cover in the Northeast region is 171,306 sq km which is 65.34 per cent of its geographical area.

Table 1.1. Forest cover in India (area in sq km)

Andra Pradesh	1,62,968	29,137	17.88	990	3.52
Arunachal Pradesh	83,743	66,688	79.63	-276	-0.41
Assam	78,438	28,327	36.11	222	0.79
Bihar	94,163	7,306	7.76	7	0.10
Chhattisgarh	1,35,192	55,611	41.13	64	0.12
Delhi	1,483	195.44	13.18	3.03	1.57
Goa	3,702	2,237	60.43	8	0.36
Gujarat	1,96,244	14,857	7.57	100	0.68
Haryana	44,212	1,602	3.62	14	0.88
Himachal Pradesh	55,673	15,434	27.72	334	2.21
Jammu & Kashmir	2,22,236	23,612	10.62	371	1.60
Jharkhand	79,716	23,611	29.62	58	0.25
Karnataka	1,91,791	38,575	20.11	1,025	2.73
Kerala	38,852	21,144	54.42	823	4.05
Madhya Pradesh	3,08,252	77,482	25.14	68	0.09
Maharashtra	3,07,713	50,778	16.50	96	0.19
Manipur	22,327	16,847	75.46	-499	-2.88
Meghalaya	22,429	17,119	76.33	-27	-0.16
Mizoram	21,081	18,006	85.41	-180	-0.99
Nagaland	16,579	12,486	75.31	-3	-0.02
Odisha	1,55,707	51,619	33.15	274	0.53
Punjab	50,362	1,849	3.67	12	0.65
Rajasthan	3,42,239	16,630	4.86	58	0.35
Sikkim	7,096	3,342	47.10	-2	-0.06
Tamil Nadu	1,30,060	26,364	20.27	83	0.32
Telangana	1,12,077	20,582	18.36	163	0.80
Tripura	10,486	7,726	73.68	0	0.00
Uttar Pradesh	2,40,928	14,806	6.15	127	0.87
Uttarakhand	53,483	24,303	45.44	8	0.03
West Bengal	88,752	16,902	19.04	55	0.33
A& N Island	8,249	6,743	81.74	1	0.01
Chandigarh	114	22.03	19.32	0.47	2.18
Dadra & Nagar Haveli	491	207	42.16	0	0.00
Daman & Diu	111	20.49	18.46	0	0.00
Lakshadweep	30	27.10	90.33	0	0.00
Puducherry	490	52.41	10.70	-1.26	-2.35
Total	32,87469	7,12,249	21.67	3,976	0.56

Source: FSI, 2019.

Figure 1.a. Top five states of India in terms of forest cover (% of its geographical area)



Source: Table 1.1

The top five states in India with highest percentage of forest cover in terms of percentage to its total geographical area are all from the North Eastern states.

1. 3. BAMBOO RESOURCE IN INDIA

Northeast is hugely dependent on NTFP, where bamboo is one of the most important NTFP. It is often called as "the poor man's timber" in India, "Brother" in Vietnam and "Friend of the people" in China are some common names for Bamboo, a plant that millions of people depend on for their livelihood. Ecologically, bamboo plants are giant grasses that have tree-like functions in forest ecosystems.

Traditionally, bamboo was used for multiple purposes by various mountain societies in the warmer regions of China and other Asian countries. The importance of bamboo in mountain ecosystems and mountain societies is reflected in the diversity of the species and their utilization. Due to its versatile importance and utilization, it is alleviating poverty,

providing employment, controlling air and water pollution in many countries (Quintans, 1998)[18]. It has been taken as an important source of construction material, fiber, and food, material for agricultural tools, utensils, and musical instruments, as well as ornamental plants etc. Bamboo has thus been and will continue to be an important factor for economic development in these countries. Bamboo is a suitable for wood due to several advantages such as quick rotation period, powerful regeneration ability, and good qualities for wide use, which are similar or even superior to wood. The potential for saving wood in tropical and subtropical regions by utilizing bamboo resources is astounding. Bamboo is also important in the fight against degradation of mountain environments, ecosystems, and natural resources. At present, there are varieties of products made of bamboo which range from household products to industrial uses. Advancement in science and technology has also led to growth in bamboo related sector. It is commercially used by farmers growing at a large scale; use of chemicals for processing and preservation techniques has led the industries to make high end products. In India, bamboo accounts for around 12.8% of the total forest cover and is one of the largest bamboo resources in the world (Loushambam, et al, 2017)[19]. It is estimated that India has the second largest bamboo reserves in the world after China (Panda, 2011)[20]. Bamboo is considered as an evergreen resource with excellent economic value as well as capable of providing ecological security. The North Eastern hilly states of India have nearly

[18]Quintans, K. N. (1998). Ancient Grass, Future Natural Resource: The National Bamboo Project of Costa Rica: A Case Study of the Role of Bamboo in International Development (No. 16). International Network for Bamboo and Rattan.

[19]Loushambam, R. S., Singh, N. R., Taloh, A., & Mayanglambam, S. (2017). Bamboo in North East India. *Indian Journal of Hill Farming*, 30(2), 181-185.

[20]Panda, H. (2011). Bamboo Plantation and Utilization Handbook: Bamboo products manufacturing process, Bamboo Products Processing, Bamboo Products, Bamboo properties, Bamboo pulp manufacturing process, Bamboo Pulp, Bamboo pulp-Making process, Bamboo resources and their utilization, Bamboo Shoots, Bamboo Small Business Manufacturing, Bamboo Technology, Bamboo Used For Paper Manufacture, Bamboo Utilization, Bamboo: properties and utilization. Asia Pacific Business Press Inc.

90 species of bamboos, 41 of which are endemic to Northeast region (Loushambam, et al, 2017)[21].

Table 1.2 Application and utilization of bamboo.

Application and Utilization	
A	Acupuncture needles, airplane skin, alarms, alcohol, anchors, antenna supports, aphrodisiacs, armor, arrow and arrow tips, ashtrays, awnings, ayurvedic medicines
B	Baby carriages, bamboo ashes, bagpipes, barrels, baskets, bamboo beers, baby walker, beads, bedding, beanpoles, beds, bicycles, boat hoods, boats, bolts, bookcases, boxes, bracelets, bridges, broom, buttons
C	Cables, candlesticks, carts, chairs, charcoal, chopsticks, clock, clothes racks, colanders, combs, cooking vessels, chicken coops, cosmetics, couches, cradles, crates, crosses, cups, curtains
D	Dams, desks, diesel-fuel, dirigibles, dolls, dry cell, dustpans, dykes
E	Eggcups
F	Fans, fishnets, fiberboard, fish poles, filaments, filling materials, flag poles, flooring, flowerpots, flutes, flasks, fodder, food supplements, food containers, frames, fuel, furniture
G	Gabions, garments, gas, gates, grain, grain storage, graters, greenhouse, guns, gutter, gypsy vans
H	Hairpins, hampers, handles, handicrafts, hats, hay and forage, head gear, hedges, helmets, henhouse, hinges, hoe making, hoops, hookahs, houseplants, household utensils
I	Incense sticks, insect cages, interior work, irrigation waterwheels
J	Jackets, jars, jewellery, joss-papers, joss sticks
K	Kiosks, kites
L	Ladders, ladles, laptop cover, lamps, lampshades, light bulbs, lofts, looms
M	Mahjong tiles, mats, mattresses, medicines, musical instruments
N	Nails, napkin rings, needles, net floats, nets, netsuke, nutraceuticals
O	Ornaments, oyster cultivation
P	Packing, paper cutters, paper and pulp, particleboard, pegs, pen and pencil holder, phonograph needles, pitcher, pines, pipes, plates, poles, polish jewels, poultry cages
R	Racks, rafts, rafters, raincoats, rakes, rattles rayon, receptacle, retaining walls, rings, rigging, riverbank protections, rocking horse, roofing, ropes
S	Scaffolding, scales, scarecrows, screens, seed drill, ship sails, shades, shoulder bags, shovel, shuttles for weaving, sieves, skincare articles, skewer, small business unit, socks, sticks, stilts, stools

[21]Loushambam, et al, (2017). Op. cit. p.7.

U	Umbrellas, underwear
V	Valiha musical instrument), vegetables, vankhaong
W	Wagons, walking sticks, walls, water jugs, water storage, weapons, weaving products, wheelbarrow, bamboo wine, windmills
X	Xylophones
Y	Yurts
Z	Zithers

Source: Adapted from Sawarkaret l., (2020)[22]

"India is reportedly home to about 125 indigenous and 11 exotic species of bamboo from 23 genera. Bamboos occur in abundance in the deciduous and semi-evergreen forests of the North-eastern region of India and the tropical moist deciduous forests of Northern and Southern India. The major bamboo genera found in India are *Arundunaria, Bambusa, Chimonobambusa, Dendrocalamus, Dinochola, Gigantochloa*etc" (FSI, 2019). North East region of India is the major bamboo producing area, where forest and its resources have influenced their way of life significantly. Total forest cover in the region is 1,70,541sq km., which constituted 65.05% of its geographical area (FSI, 2019). The total number of culms at country level is shown in the table no. 1.3 as below.

Table 1.3. Number of culms at All India level by Age and Soundness in recorded area (in millions)

Culm size class	Green Sound	Dry Sound	Decayed	Total no. of culms 2019	Total culms (ISFR 2017)	Change (ISFR 2017-2019)
Current year*	4917	NA	NA	4,917	5,034	-117
1-2 cm**	6,280	2,176	NA	8,456	NA	NA
2-5 cm	11,842	3,416	NA	15,258	14,119	1,059

[22]Sawarkar, A. D., Shrimankar, D. D., Kumar, A., Kumar, A., Singh, E., Singh, L., Kumar, S., & Kumar, R. (2020). Commercial clustering of sustainable bamboo species in India. *Industrial Crops and Products*, 154, 112693.

5-8 cm	4,470	939	NA	5,409	5,016	393
8 cm+	1,849	230	NA	2,079	1,836	243
			3,335	3,335	2,018	1,317
Total	29,358	6,761	3,335	39,454	28,103	11,351
Percentage to total	74.41	17.14	8.45			

**Size class of culms of current year are not measured*

** * culms of size 1-2 cm are estimated first time for FSI, 2019*

Source: FSI, 2019.

According to ISFR (2019), at the national level, the total number of culms is estimated at 39,454 million where green sound has 74.41%, dry sound with 17.14% and decayed has 8.45%, respectively. Further, it is seen that there has been increased in all the classes of age and soundness of bamboo. There is an increase of 40.39% from 2017 to 2019 in the number of culms.

The state wise distribution of bamboo area in 2011, 2017 and 2019 is shown in the table below.

Table 1.4. State-wise Distribution of Bamboo Area in Recorded Forest.

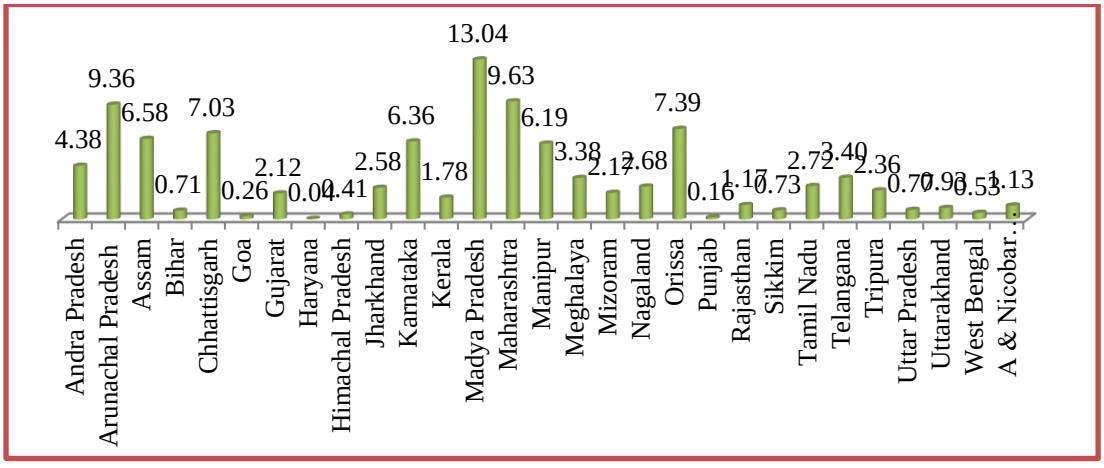
State/ UT	**Bamboo bearing area (in km2)**			
	2011	2017	2019	% change in 2019 w.r.t 2017
Andra Pradesh	8,184	7,578	7003(4.38)	-575(-17.81)
Arunachal Pradesh	16,083	15,125	14,981(9.36)	-144(-4.46)
Assam	7,238	8,955	10,525(6.58)	1,570(48.62)
Bihar	739	1,004	1,136(0.71)	132(4.09)
Chhattisgarh	11,368	11,060	11,255(7.03)	195(6.04)
Dadra & Nagar Haveli	55	58	NA	NA
Goa	308	382	418(0.26)	36(1.11)
Gujarat	4,091	3,544	3,393(2.12)	-1510(-46.76)
Haryana	19	21	72(0.04)	51(1.58)
Himachal Pradesh	508	540	650(0.41)	110(3.41)

Jharkhand	3,603	4,470	4,123(2.58)	-347(-10.75)
Karnataka	8,186	10,442	10,181(6.36)	-261(-8.08)
Kerala	2,882	3,484	2,849(1.78)	-635(-19.67)
Madya Pradesh	13,058	18,167	20,867(13.04)	2,700(83.62)
Maharashtra	11,465	15,927	15,408(9.63)	-519(-16.07)
Manipur	9,303	10,687	9,903(6.19)	-784(-24.28)
Meghalaya	4,793	5,943	5,410(3.38)	-533(-16.51)
Mizoram	9,245	3,267	3,476(2.17)	209(6.47)
Nagaland	4,902	6,025	4,284(2.68)	-1,741(-53.92)
Orissa	10,518	12,109	11,827(7.39)	-282(-8.73)
Punjab	75	44	255(0.16)	211(6.53)
Rajasthan	2,455	1,976	1,874(1.17)	-102(-3.16)
Sikkim	1,181	553	1,176(0.73)	623(19.29)
Tamil Nadu	3,265	4,154	4,357(2.72)	203(6.29)
Telangana	NA	4,778	5,438(3.40)	660(20.44)
Tripura	3,246	3,617	3,783(2.36)	166(5.14)
Uttar Pradesh	1,313	936	1,235(0.77)	299(9.26)
Uttarakhand	451	1,078	1,489(0.93)	411(12.73)
West Bengal	1,042	942	855(0.53)	-87(-2.69)
A & Nicobar Island	NA	NA	1,814 (1.13)	1,814(56.18)
Total	139,576	1,56,866	1,60,037	3,229

Source: India State Forest Report 2011, 2017 & 2019.

(Figures in the parentheses represent percentage in total)

Figure 1.b. Percentage of state wise area under bamboo plantation.



Source: Table 1.4

The table no 1.4 shows that there is an increase in bamboo bearing area in recorded forest from 2011 to 2019. In 2011 it was 13.96 m ha which increased to 15.69 m ha in 2017 and in 2019 it was recorded to 16.01 m ha. State wise distribution of bamboo bearing area shows that Madhya Pradesh has the maximum with 2.0 m ha, second is Maharashtra with 1.54 m ha which is followed by Arunachal Pradesh with 1.49 m ha and Odisha with 1.18 m ha.

Table 1.5. State/UT wise bamboo bearing area under different classes in Recorded Forest Area (area in sq. km) in 2019

State/UTs	Pure Bamboo	Dense	Scattered	Bamboo present but clumps completely hacked	Regeneration crop
Andhra Pradesh	424	3,180	2,975	71	353
Arunachal Pradesh	417	3,389	10,904	0	271
Assam	204	2,350	7,664	0	307
Bihar	0	121	975	40	0
Chhattisgarh	637	1,698	6,056	531	2,333
Goa	0	197	112	11	98
Gujarat	69	891	2,124	69	240
Haryana	0	24	48	0	0
Himachal Pradesh	150	200	250	0	50
Jharkhand	0	103	2,601	550	869
Karnataka	196	1,304	6,008	0	2,673
Kerala	141	563	1,958	0	187
Madhya Pradesh	700	4,358	12,539	1,167	2,103
Maharashtra	810	2,543	8,261	1,762	2,032
Manipur	0	1,383	6,862	995	663
Meghalaya	140	467	4,803	0	0
Mizoram	0	1,370	2,106	0	0
Nagaland	227	1,137	2,730	75	115
Odisha	56	1,351	9,788	407	225
Punjab	0	113	142	0	0
Rajasthan	0	215	547	550	562
Sikkim	141	94	894	0	47
Tamil Nadu	0	551	2,024	740	1,042
Telangana	0	1,683	2,463	1,292	0
Tripura	20	617	3,146	0	0
Uttar Pradesh	0	309	926	0	0

Uttrakhand	0	271	1,151	0	67
West Bengal	0	0	816	0	39
A & N Islands	0	93	1,266	0	455
Total	4,332	30,575	1,02,139	8,260	14,731

Source: FSI, 2019.

Table 1.5 shows that Maharashtra has the highest occurrence of pure bamboo with 810 sq km, which is followed by Madhya Pradesh (700 sq km) and Chhattisgarh (637sq km). Under dense bamboo Madhya Pradesh (4358 sq km) has the highest which is followed by Arunachal Pradesh (3389 sq km) and Andhra Pradesh (3180 sq km). With hacked bamboo clumps Maharashtra (1762 sq km) has the highest which is followed by Telangana (1292 sq km) and Madhya Pradesh (1167 sq km). Karnataka (2673 sq km) has the highest in the category of bamboo regeneration which is followed by Chhattisgarh (2333 sq km) and Madhya Pradesh (2103 sq km).

Table 1.6. State/UT wise number of estimated culms in Recorded Forest Area (in millions)

State/UTs	Green Culms	Dry Culms	Decayed	Total	Total as per ISFR 2017	Changes w.r.t. 2017
Andhra Pradesh	1,237	424	159	1,820	1,076	744
Arunachal Pradesh	4,869	512	388	5,769	4,048	1,721
Assam	3,082	466	281	3,829	2,452	1,377
Bihar	221	25	1	247	353	-106
Chhattisgarh	1,175	660	279	2,114	1,075	1,039
Goa	3	17	10	30	26	4
Gujarat	513	117	47	677	485	192
Himachal Pradesh	356	113	16	485	321	164
Jharkhand	569	146	161	876	666	210
Karnataka	1,305	454	151	1,910	1,166	744
Kerala	780	207	43	1,030	834	196
Madhya Pradesh	2,406	828	361	3,595	2,406	1,189

Maharashtra	1,979	718	274	2,971	1,816	1,155
Manipur	843	205	78	1,126	2,340	-1,214
Meghalaya	1,148	188	185	1,521	1,323	198
Mizoram	863	134	77	1,074	716	358
Nagaland	2,289	98	157	2,544	1,301	1,243
Odisha	1,563	426	302	2,291	1,585	706
Punjab	9	1	1	11	6	5
Rajasthan	465	60	2	527	831	-304
Sikkim	197	12	9	218	135	83
Tamil Nadu	575	283	88	946	777	169
Telangana	615	211	100	926	651	275
Tripura	963	88	59	1,110	797	313
Uttar Pradesh	155	75	6	236	175	61
Uttarakhand	210	115	59	384	267	117
West Bengal	352	20	12	384	464	-80
A & N Islands	616	158	29	803	0	803
Total	29,358	6,761	3,335	39,454	28,092	11,362

Source: IFSR, 2019

Note 1. The difference in the total number of culms from ISFR 2017 is due to inadequate data the culms of Dadar Nagar & Haveli are not included in ISFR 2019

According to the table no 1.6, highest number of green culms is found in Arunachal Pradesh having 4869 million, which is followed by Assam with 3082 million and in the third place is Madhya Pradesh with 2406 million. Madhya Pradesh (828 million) has the highest number of dry culms followed by Maharashtra (718 million) and Chhattisgarh (660 million). There is an increase in number of culms by soundness as compared to ISFR 2017 and the maximum increase is observed in Arunachal Pradesh (1721 million) followed by Assam (1377 million) and Nagaland (1243 million).

Table 1.7. State/UT wise Equivalent Green Weight of culms in Recorded Forest Area (in '000 tonnes)

State/UTs	Green Culms	Dry Culms	Total	Total as per ISFR 2017	Change w.r.t. ISFR 2017
Andhra Pradesh	9,702	6,455	16,157	9,903	6,254
Arunachal Pradesh	22,601	5,331	27,932	18,863	9,069
Assam	17,226	6,838	24,064	14,912	9,152
Bihar	1,544	278	1,822	1,692	130
Chhattisgarh	5,400	6,343	11,743	5,942	5,801
Goa	14	188	202	148	54
Gujarat	6,008	2,869	8,877	6,035	2,842
Himachal Pradesh	1,146	829	1,975	1,156	819
Jharkhand	2,880	1,693	4,573	2,520	2,053
Karnataka	15,423	11,033	26,456	16,538	9,918
Kerala	8,718	4,374	13,092	7,220	5,872
Madhya Pradesh	7,887	6,201	14,088	9,073	5,015
Maharashtra	13,842	12,673	26,515	15,879	10,636
Manipur	4,664	3,090	7,754	15,469	-7,715
Meghalaya	8,770	3,553	12,323	11,462	861
Mizoram	6,475	2,337	8,812	6,217	2,595
Nagaland	18,678	1,869	20,547	11,269	9,278
Odisha	9,675	6,456	16,131	9,864	6,267
Punjab	34	13	47	27	20
Rajasthan	1,288	1,232	2,520	3,661	-1,141
Sikkim	365	64	429	305	124
Tamil Nadu	3,068	4,711	7,779	6,470	1,309
Telangana	4,250	2,531	6,781	5,009	1,772
Tripura	5,053	1,242	6,295	6,494	-199
Uttar Pradesh	483	491	974	641	333
Uttarakhand	580	810	1,390	963	427
West Bengal	943	167	1,110	948	162
A & N Islands	4,929	2,270	7,199	0	7,199
Total	181,646	95,941	2,77,587	1,88,680	88,907

Source: IFSR, 2019
Note: The difference in the total number of culms from ISFR 2017 is due to inadequate data the culms of Dadar Nagar & Haveli are not included in ISFR 2019

According to the table no 1.7, Arunachal Pradesh (22.6 m tonnes) have the maximum weight of green culms which is followed by Nagaland (18.6. m tonnes) and Assam (17.2 m tonnes). Maharashtra (12.67 m tonnes) has the maximum weight of dry culms which is followed by Karnataka (11.03. m tonnes) and Assam (6.8 m tonnes). As compared to the assessment given in ISFR 2017, Maharashtra (10.6 m tonnes) has shown maximum increase in equivalent green weight which is followed by Karnataka (9.9 million tonnes) and Nagaland (9.2 million tonnes)

1.3.1. Bamboo resource in North-East India.

North- East India comprise of eight states- Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim and have total geographical area of 261179 sq.km. Even though it covers only 7.95 percent of India's total geographical area, it contributes 33.45 percent of bamboo forest area in the country. It has one of the largest reserves of bamboo in India

Most of the people in these region depends on bamboo for food, shelter and livelihood. As earthquakes and floods are common phenomenon in these states, bamboo house is safe and commercially affordable (Sajem and Gosai, 2010)[23].

Table 1.8. State wise distribution of bamboo genera in NER

Sl No	States	Genera
1	**Arunachal Pradesh**	*Arundinaria, Bambusa, Chimonobambusa, Dendrocalamus, Gigantochloa, Phyllostachys, Pleioblastus, Schizostachyum, Sinarundinaria, Thamnocalamus and Thyrsostachys*
2	**Assam**	*Bambusa, Dendrocalamus, Dinochloa, Gigantochloa, Melocanna, Oxtenanthera, Phyllostachys, Racemobambos and Schizostachyum*

[23]Sajem, A. L., & Gosai, K. (2010). Ethnobotanical investigations among the Lushai tribes in North Cachar hills district of Assam, northeast India. *Indian Journal of Traditional Knowledge*. 9(1), 108-113.

3	**Manipur**	*Bambusa, Chimonobambusa, Dendrocalamus, Dinochloa, Melocanna, Racemobambos, Schizostachyum and Sinarundianaria*
4	**Meghalaya**	*Bambusa, Chimonobambusa, Dendrocalamus, Dinochloa, Gigantochloa, Melocanna, Recemobambos, Phyllostachys, Schizostachyum and Sinarundianaria*
5	**Mizoram**	*Bambusa, Chinonobambusa, Dendrocalamus, Gigantochloa, Melocanna, Oxytenanthera, Schizostachyum and Siarundinaria*
6	**Nagaland**	*Bambusa, Chimonobambusa, Dendrocalamus, Racemobambos, Schizostachyum and Sinarundianaria*
7	**Sikkim**	*Arundinaria, Bambusa, Dendrocalamus, Melocanna, Phyllostachys, Racemobambos, Schizostachyum, Sinarundinaria and Thamnocalamus*
8	**Tripura**	*Bambusa, Dendrocalamus, Dinochloa, Gigantochloa, Melocanna, Pseudosasa, Schizostachyum, Sinarundinaria, Thamnocalamus and Thyrsostachys*

Source: NESAC-SR-77-2010

From the table given above it can be seen that major genera found in North-east states are *Arundinaria, Bambusa, Chimonobambusa, Dendrocalamus, Gigantochloa, Phyllostachys, Pleioblastus, Schizostachyum, Sinarundinaria, Thamnocalamus and Thyrsostachys, Dinochloa, Gigantochloa, Melocanna, Oxtenanthera, Racemobambos*and*Pseudosasa.* From the following genera the most common which is found in all the states of north-east are *Bambusa, Dendrocalamus*and *Schizostachyum*and have a large number of species. *Schizostachyum* has 27 species which is followed by *Bambusa* with 21 species and *Dendrocalamus*with 13 species. Arunachal Pradesh has the highest number of bamboo genera. In terms of geographical coverage, *Dendrocalamushamiltonii, Bambusapallisa, Melocannabaccifera, Phyllostachysbambusoides, Arundinariasp, Chimonobambusacallosa,*

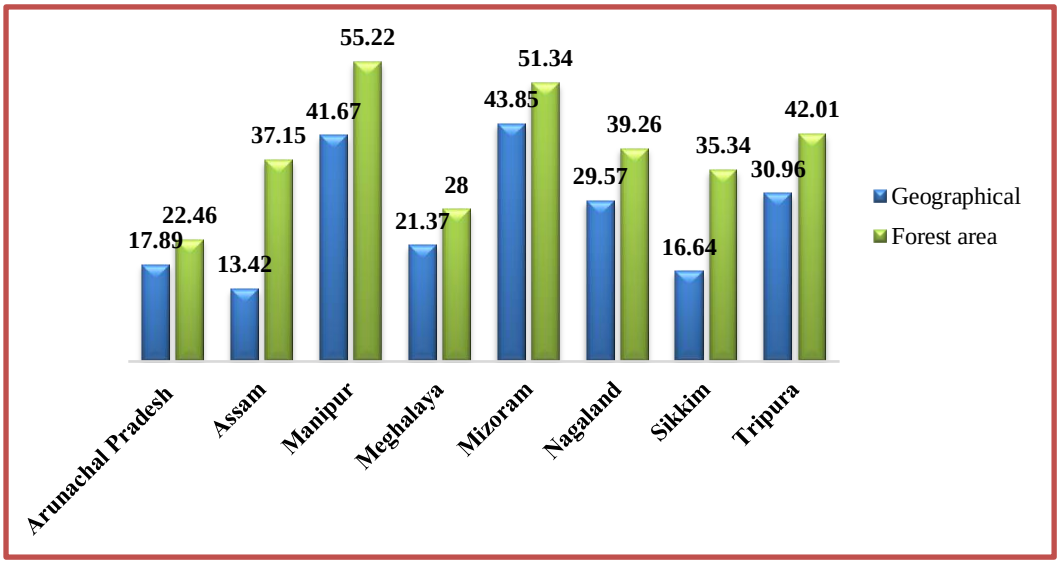
Schizostachyumpolymorphum and *S capitatum* are the prominent with wider distribution and coverage in the north-east region (Choudhary, 2008)[24].

Table 1.9. Distribution of bamboo in North-East states of India, 2019. (area in sq. km)

State	Geographical area	Total forest cover	Area under Bamboo	Bamboo area (%)	
				Total area	Forest area
Arunachal Pradesh	83,743	66,688	14,981	17.89	22.46
Assam	78,438	28,327	10,525	13.42	37.15
Manipur	22,327	16,847	9,903	41.67	55.22
Meghalaya	22,429	17,119	5,410	21.37	28
Mizoram	21,081	18,006	3,476	43.85	51.34
Nagaland	16,579	12,486	4,284	29.57	39.26
Sikkim	7,096	3,342	1,176	16.64	35.34
Tripura	10,486	7,726	3,783	30.96	42.01

Source: FSI, 2019.

Figure 1.c. Percentage of bamboo area to geographical and forest area in 2019.



Source: Table 1.9

[24]Choudhary, M. L. (2008). One year of national bamboo mission in the states of NE Region, West Bengal, Orissa, Jharkhand & Bihar 2007–2008. *Cane & Bamboo Technology Centre Guwahati, Assam, India*.

The table shows that Mizoram have the highest percentage of bamboo area to geographical area which is 43.85 per cent and it is followed by Manipur with 41.67 per cent and Nagaland with 29.57 per cent. In terms of bamboo area to forest area Manipur has the highest percentage of bamboo area with 55.22 per cent, which is followed by Mizoram with 51.34 per cent and Nagaland with 39. 26 per cent.

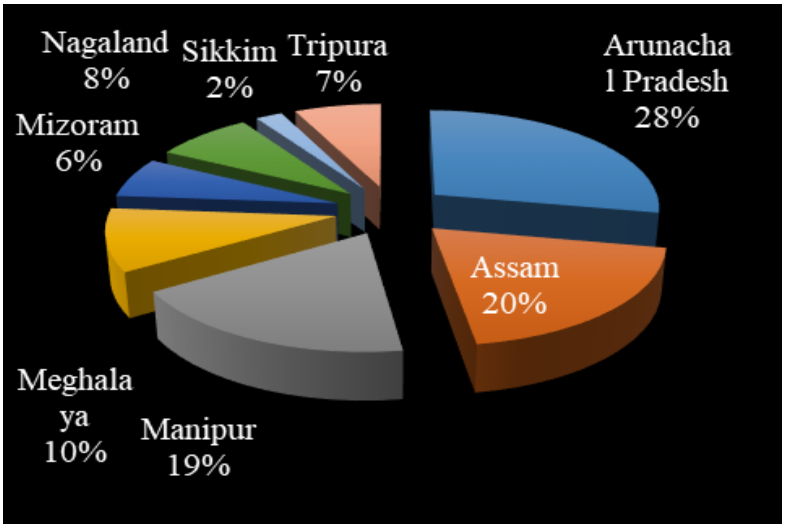
The bamboo area in North-East states of India in 2017 and 2019 is presented in the table below.

Table 1.10. Bamboo area in North-East states of India.

State	2017	2019
Arunachal Pradesh	15,125 (27.92)	14,981(27.98)
Assam	8,955(16.53)	10,525(19.66)
Manipur	10,687(19.73)	9,903(18.50)
Meghalaya	5,943(10.97)	5,410(10.10)
Mizoram	3,267(6.03)	3,476(6.49)
Nagaland	6,025(11.12)	4,284(8)
Sikkim	553(1.02)	1,176(2.20)
Tripura	3,617(6.68)	3,783 (7.07)
Total	54,172	53,538

Source: IFSR 2017 &2019
(Figures in the parenthesis represent percentage in total area)

Figure 1.d. State-wise distribution of bamboo area in North-East State (2019).



Source: Table 1.10

Arunachal Pradesh has the highest bamboo bearing area in North East State with 27.98 per cent of the total bamboo area in the region. This is followed by Assam with 19.66 per cent and Manipur with 18.50 per cent. Moreover, Assam, Mizoram, Sikkim and Tripura showed an increased in bamboo area in 2019 as compared to 2017 IFSR, whereas the remaining states showed decline in bamboo area.

1.3.2. Bamboo resource in Nagaland.

As one of the states in the region, Nagaland has rich biodiversity and home to many species of flora and fauna. The State's total geographical area is 16,579 sq km. with a forest cover of 12,489 sq km., which comprised of 75.33% (FSI, 2019) of total area. According to the ISFR-2019, in Nagaland, 4284 sq.km is bamboo bearing area (constituted 34.30% of its forest area). The spatial distribution of bamboos in Nagaland is shown in table below.

Table 1.11. Spatial distribution of bamboos in Nagaland.

Species	**Distribution**
Bambusabalcooa	Wokha
Bambusapallida	Wokha, Kohima and Peren region
Bambusatulda	Kohima, Jalukie region
Chimonobambusacallosa	Puliebadze above Kohima and Mao
Dendrocalamuscalostachys	Phekerkrima, Dimapur and Kohima
Dendrocalamusgiganteus	Kohima, Mao
Dendrocalamushamiltonii	Dimapur-Kohima road, and Wokha
Dendrocalamushookeri	Kohima, Wokha
Melocannabaccifera	Jalukie
Neomicrocalamusprainii	Puliebadze, Japfu Range
Schizostachyumfuchsianum	Kohima, Zulhami-Kilomi area
Schizostachyumpolymorphum	Longsachu near Workha
Schizostachyumpolymorphum	Yikum near Wokha
Sinarundinariaelegans	Puliebadze, near Kohima
Sinarundinariagriffithiana	Saramati region
SinarundinarianagalandianaNaithani	Niriyo Peak, Wokha
Sinarundinariarolloana	Japfu Range, Kohima

(Source: http://www.nagaland.nic.in)

1.4. GLOBAL TRADE SCENARIO

Bamboo is one of the most valuable forestry product and its value in global market is increasing. According to INBAR report 2018, the international trade value of bamboo products was USD 2.9 billion in 2018.

1.4.1. International trade of bamboo products:

There are 10 major items of bamboo products that were classified for trade. The global traded item of bamboo is given in the table below.

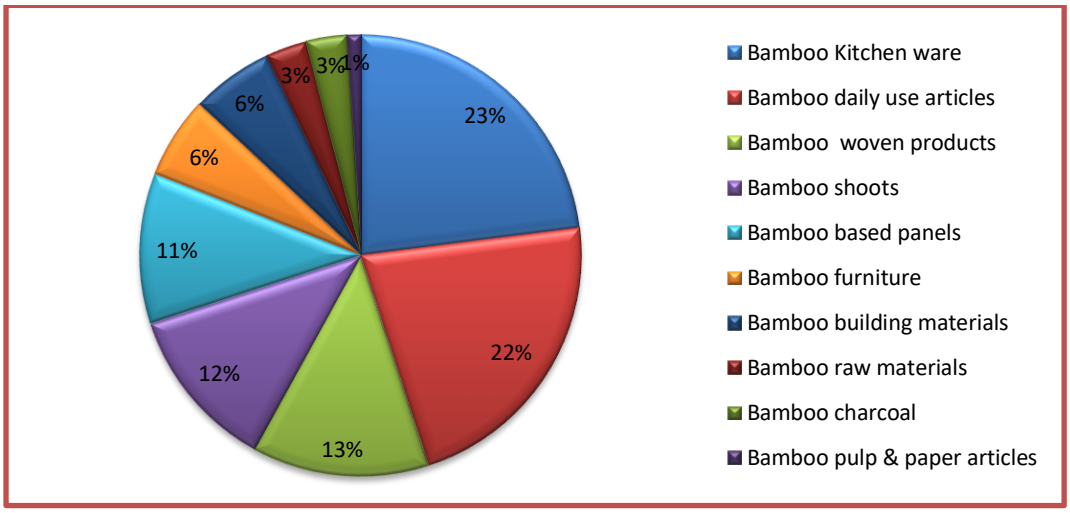
Table 1.12. International trade of bamboo products by category 2018 (unit: million USD, per cent).

Category	Value	% share
Bamboo Kitchen ware	**675**	**23**
Bamboo daily use articles	653	22
Bamboo woven products	367	13
Bamboo shoots	334	12
Bamboo based panels	331	11
Bamboo furniture	176	6
Bamboo building materials	166	6
Bamboo raw materials	89	3
Bamboo charcoal	75	3
Bamboo pulp & paper articles	39	1

Source: UN Comtrade data base 2020[25].

[25]UN Comtrade data base (2020). Product profile. https://comtrade.un.org/data

Figure 1.e. Bamboo trade commodities



Source: Table 1.12

The table 1.12 depicts that bamboo kitchen ware had the highest value with 23 per cent of total exports, which is followed by bamboo articles of daily use with 22 per cent. Bamboo woven products accounted for 13 per cent, followed by bamboo shoots 12 per cent, bamboo based panels 11 per cent, bamboo furniture and bamboo building material 6 per cent each, bamboo raw material and bamboo charcoal 3 per cent each and bamboo pulp and paper article having 1 per cent in the total world market.

1.4.2. Bamboo trade by Region

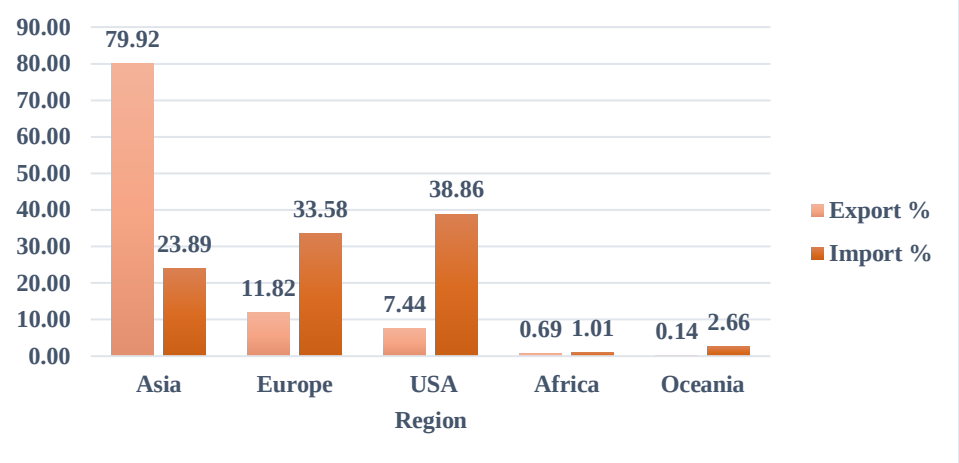
According to UN data, the main trading region of bamboo is classified into five groups namely Asia, Europe, USA, Africa and Oceania. Asia was the major exporter of bamboo products which accounts for 79.92 per cent of global trade. It is followed by Europe, USA, Africa and Oceania which exported 11.82 per cent, 7.44 per cent, 0.69 per cent and 0.14 per cent respectively. Trading of bamboo by region is shown in the table 1.13.

Table 1.13. Main trade regions for bamboo products in 2018 (unit: million USD).

Region	Export value	% share	Import Value	% share
Asia	2320	79.92	683	23.89
Europe	343	11.82	960	33.58
USA	216	7.44	1111	38.86
Africa	20	0.69	29	1.01
Oceania	4	0.14	76	2.66
Total	2903	100.00	2859	100.00

Source: UN Comtrade data base 2020.

Figure 1.f. Trade regions



Source: Table 1.13

The region which imported bamboo products is diverse. USA is the major importer of bamboo products which accounts to 38.86 per cent, which is followed by Europe, Asia, Oceania and Africa with 33.58, 23.89. 2.66 and 0.14 per cents, respectively.

1.4.3. Bamboo trade by country

The major trading countries of bamboo products is given in table 1.14.

Table 1.14. Top 10 exporting and importing countries of bamboo products in 2018 (unit: million USD).

	Export			Import		
Sl.no	**Country**	Value	Percentage	**Country**	Value	Percentage
1	**China**	2057	73.00	**USA**	1007	40.65
2	**EU**	337	11.96	**EU**	895	36.13
3	**Canada**	155	5.50	**Japan**	305	12.31
4	**Vietnam**	77	2.73	**Australia**	52	2.10
5	**India**	68	2.41	**South Korea**	51	2.06
6	**USA**	52	1.85	**Canada**	46	1.86
7	**Thailand**	33	1.17	**India**	41	1.66
8	**Indonesia**	22	0.78	**Russia**	27	1.09
9	**Japan**	9	0.32	**Singapore**	27	1.09
10	**UAE**	8	0.28	**Malaysia**	26	1.05
Total		**2818**	**100**		**2477**	**100.00**

Source: UN Comtrade data base 2020.

China is the largest exporter of bamboo products, which accounted for 73 per cent of the total world export. It is followed by EU, comprising 11.96 per cent and Canada with 5.50 per cent of the total bamboo export. India holds fifth rank in exporting bamboo products. USA is the top importing country of bamboo products comprising of 40.65 per cent, which is followed by EU with 36.13 per cent and Japan with 12.31 per cent of total bamboo import. India holds seventh rank in imports of bamboo products.

1.4.4. India's Bamboo Trade.

Bamboo is found in almost every states in India and it has become living bread for millions of poor traditional artisans and small industries (Bonilla et al., 2010)[26]. India export bamboo products to over 134 countries and 140.47 USD million worth of bamboo was exported in 2020-2021(Connect2India)[27]. The table below shows the top countries which imported bamboo from India in 2020-2021.

Table 1.15. Top 10 bamboo importing countries from India (2020-2021)

Country	Value (USD Million)	Share (%)
USA	39.46	28.09
Turkey	30.63	21.81
Netherlands	13.42	9.55
Bangladesh	10.97	7.81
China	8.06	5.74
Germany	4.4	3.13
Russian Federation	2.98	2.12
United Kingdom	2.41	1.72
France	2.36	1.68
Belgium	2.27	1.62

Source: UN Comtrade data base 2020.

The best destination for India's bamboo is USA, which occupies 28.09 per cent of India's total export. It is followed by Turkey with 21.81 per cent and Netherlands with 9.55 per cent.

[26]Bonilla, S. H., Guarnetti, R. L., Almeida, C. M., & Giannetti, B. F. (2010). Sustainability assessment of a giant bamboo plantation in Brazil: exploring the influence of labour, time and space. *Journal of Cleaner Production*, 18(1), 83-91.
[27]Connect2India (2020). *Trade data.* https://connect2india.com/index.html

The value of India's Import and Export of bamboo product from 2010 to 2020 is presented in the table below. India traded in eight important bamboo products namely Bamboo raw material, bamboo shoot, bamboo charcoal, bamboo flooring, bamboo plywood, bamboo mats, bamboo pulp and bamboo paper.

The table shows that import of bamboo raw materials have increased from $1145492 to $ 83992202 from 2010 to 2020 and it hold top place in import of bamboo products, which is followed by import of bamboo flooring and bamboo pulp. On the other hand export of bamboo raw material hold top place amounting to $ 519335 which is followed by export of bamboo charcoal. It has shown a drastic increase in export from $ 1750 to $ 287342 from 2010 to 2020.

Table 1.16. India's Export and Import of Bamboo products (2010-2020)

Year	Raw material		Bamboo shoots		Bamboo charcoal		Bamboo flooring		Bamboo plywood		Bamboo Mats		Bamboo pulp		Bamboo paper	
	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
2010	1145492	107135	22685	60439	80660	5345	489695	1750	8162589	58712	537523	52546	603799	-	654	96156
2011	2366761	74224	38175	1879	22660	8375	411263	2997	16872397	134233	624330	100621	389511	122	2082	656635
2012	5619830	76085	65159	9424	3566	7950	782841	3413	13837002	79708	786717	251637	553885	1732	1975	714973
2013	8572788	74416	71465	1071	1387	3052	601517	27651	11180539	19921	709602	234487	460355	8585	23078	54843
2014	15514864	37405	116885	-	14802	583	403814	26240	9885614	95071	673748	231206	367412	4337	15295	172649
2015	23973970	38290	105489	44	39470	1762216	605213	275211	7574375	112649	592179	145533	1027645	7898	1654	12522
2016	19115527	30700	102370	121	58023	245989	774616	315434	2185154	47770	454967	3751	945806	17512	4734	1042
2017	28683372	254854	114427	-	115442	65011	799447	352285	460126	187324	519071	69219	1254879	14116	2378	21095
2018	30739709	886091	147732	8576	307672	38519	851032	373975	424621	108597	291847	98537	884717	2866	10947	550
2019	46744102	389810	14231	2291	484136	36112	654416	252364	342580	137287	511404	154014	647565	103020	29431	10917
2020	8,39,92,202	5,19,335	43234	3565	219891	287342	992267	288337	127476	54052	360592	52903	381418	29323	2344	1413

Source: INBAR, 2020

1.5. STATEMENT OF PROBLEMS

Having established that Nagaland possess immense resources of standing bamboo stock as well as widespread distribution of sophisticated craft skills of local people, one can see the potentiality of a large decentralized industrial infrastructure growing in the state. However, despite the available potential under the bamboo sector like availability of land, generation of income, and employment, the sector has not gained the desired momentum in the state. Lack of awareness is one of the main challenges that stand in the way of development of bamboo based activities in Nagaland.

Bamboo has been traditionally raised; to a limited extend, in village commons and homestead gardens. There is a need for changing the 'forestry mindset' to the 'farming mind set' and creating awareness on the commercial viability and profitability of the species. Bamboo processing is a technical activity which requires a certain degree of technical proficiency. Further, while Naga artisans are naturally talented at working with handicrafts, yet their skills are insufficient to allow them to cope with the requirements of industrial process, including efficiency and speed to meet market challenges in the absence of advance technologies.

Lack of proper infrastructure, institutional credit and marketing are the challenges for the sector to develop in the right direction. In Nagaland, the economic activities are further thwarted by transportation bottlenecks, lack of proper road connectivity and electricity. If the sick paper and pulp industry at Tuli, Mokokchung district is revived as expected, then the biggest challenge that stands on the way for the bamboo cultivator to find its market will be solved. Improving the infrastructure would definitely lead to development of bamboo based activities providing a sustainable means of livelihood to the local people.

In recent years, bamboo based sector is gaining importance in some districts of Nagaland; however, there is no reliable database on the nature, volume, and location of products that would serve marketing the products. In the same way there is no systematic research undertaken on cost and benefit generated from these activities although traditionally the people are closely related with bamboo, having strong influence on their art, handicrafts and their economy. Similarly, there is no proper record and study on production of bamboo based products that reveal the nature and pattern of demand and other characteristics to guide the producers. Therefore the aim of the study is to provide a base to study the cost and return structures of bamboo cultivation and assessing the problems faced by cultivators engaged in bamboo production.

1.6. OBJECTIVES OF STUDY

The objectives of the study are as follows:

i)to identify the socio-cultural and economic importance of bamboo in Naga society.

ii)to examine the bamboo production and its determinants.

iii)to analyze the cost and return structures of bamboo cultivation.

iv)to evaluate the problems faced by cultivators engage in bamboo cultivation.

v)to assess the State Government's Bamboo policy.

1.7. HYPOTHESES

i) Annual production of bamboo and monthly income of the bamboo farmers are positively related with socio-economic factors.

ii) Bamboo cultivation is a profitable venture in Nagaland.

iii) Labour cost significantly determines the yield of bamboo in Nagaland.

iv) Lack of infrastructure is the major obstacle for bamboo cultivators in Nagaland.

1.8. AREA OF STUDY

In the current study, the entire districts of the State is analyzed at macro level, while for the micro level analysis, two districts, viz. Dimapur and Mokokchung are selected purposefully. These two districts have the highest bamboo plantation in Nagaland (NBDA, 2014). Moreover, intervention of the United Nation Industrial Development Organization (UNIDO) cluster programmed under Nagaland Bamboo Development Agency (NBDA), a cluster development approach is being implemented in these two districts. The said programme covers Tuli and Longjang clusters in Mokokchung and, Nihoto and Poshito clusters in Dimapur district. Bamboo Charcoal Briquettes at Nagaland Bamboo Resource Centre, Dimapur, Vegetative propagation units, Dimapur and 24 kv bamboo gasifier units at Land Resource Research farm at Razhephema at Dimapur, Bamboo Primary Processing unit for sticks/silvers/ strips set up at Tuli, Anaki mat weaving cluster, *Agarbati* unit at Longjang, all these bamboo based production units are located at Dimapur and Mokokchung districts.

Mokokchung district has a geographical area of 1,615 sq. km with a population of 194,622 and a density of 121 per sq. km. Forest occupies about 83.53% (FSI, 2011) of its total area and 6009 hectares were brought under bamboo cultivation during 2006 to 2012. The literacy rate in Mokokcung is 91.62 % and the total working population is 81046, out of this 58.11% are engage in agricultural sector, 2.39% in household industries and 39.49 % in other sectors (Statistical hand book, 2013).

Dimapur district has a geographical area of 927 sq. km with a population of 378,811 and a density of 409 per sq. km. Forest occupies about 51.72% (FSI,2011) of its total area and 2530 hacter were brought under bamboo cultivation (2006-12). The literacy rate in Dimapur is 84.79% and the total working population is 122358, out of this 20.51% are engage in agricultural sector, 1.91% in household industries and 77.57 in other sectors (Statistical handbook, 2013).

1.9. METHODOLOGY

1.9.1. Data and data sources

Both secondary and primary data were used for the study. Primary data were collected through field survey. The secondary data were obtained from different sources such as Nagaland Bamboo Development Agency, Govt. of Nagaland, Bamboo emporium reports published by government, media reports, published and unpublished dissertation/ thesis, journals, research articles, and reports, visits to Chumpo museum (a private museum), Nagaland Bamboo Research Centre, Government of Nagaland.

1.9.2. Sample Design

The Primary data were collected through purposive sampling method, using questionnaire and interview schedule and also ethnographic method. The survey covered rural areas of the two selected districts. Six villages were purposefully selected, comprising three villages from the each of the two districts. Altogether, the sample survey covers 250 households of bamboo cultivators.

Table 1.17. Distribution of sample households in Dimapur & Mokokchung Districts

Dimapur		Mokokchung	
Village	Households	Village	Households
Nuiland	47	Tuli	35
Phoshito	39	Kangtsung	47
Homeland	48	Anaki	34
Total	134	Total	116

Source: Field survey, 2017-18.

1.9.3. Data Analysis

The data have been tabulated and analyzed using appropriate statistical tools such as:

(i) Compound Annual Growth Rate (CAGR): To find the growth rate in area, production and productivity, the compound growth rate was calculated. CAGR is the mathematical measure for annually compounded basis for a specific period of time, expressed in percentage. It is calculated using the formula;

$$CAGR = (\text{Initial value}/\text{Final value})^{1/n} - 1$$

Where, n is the period of time, in years

(ii) Multiple Regression Analysis: The relationship between income and its determinants, annual production of bamboo and its determinants were examined using multiple linear regression analysis. Multiple regression is a mathematical tool to analyze the functional relationship between two or more variables[28]. The regression equation is given as;

$$Y = a + bX_0 + bX_1 + \ldots. + bX_n + \mathcal{E}$$

[28]Gupta, S.P. (1997). Statistical Methods. Sultan Chand & Sons, New Delhi.

Where, ‘a’ is the intercept.

‘b’ and ‘c’ are the coefficients and

X_0 and X_1 …. X_n represents different independent variables in the observation and Ɛ is the error term.

(iii) Cost-Benefit Analysis: To assess the capital productivity involved in the investment of Bamboo cultivation, Benefit-Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR) were calculated using the formula;

$$BCR = \sum_{i=1}^{n} \frac{Bn}{(1+i)^n} / \sum_{i=1}^{n} \frac{Cn}{(1+i)^n}$$

$$NPV = \sum_{i=1}^{n} \frac{Bn-Cn}{(1+i)^n}$$

$$IRR = \sum_{t=1}^{n} \frac{Bn-Cn}{(1+i)^n} = 0$$

Where, Bn = Benefit in the nth year

Cn = Cost in the nth year

n = number of n years

i = Discounted rate.

(iv) Cobb-Douglas Production Function: To analyze the determinants of Bamboo yield, the Cobb-Douglas type Production Function was applied using the function in log form;

$$\text{Log } Y = \log b_0 + b_1 \log X_1 + b_2 \log X_2 + \ldots + b_n \log X_n$$

(v) Garrett Ranking Technique: To analyze the problems faced by cultivators, Garrett’s Ranking Technique has been used with its formula;

Percent position = $\frac{100(Rij-0.5)}{Nj}$

Where, Rij = Rank given for the i^{th} variable by j^{th} respondents

Nj = Number of variable ranked by j^{th} respondents

1.10. LIMITATION OF THE RESEARCH

There is not enough academic work done on the subject matter in Nagaland. As is the case, the study did not cover the Nagaland Bamboo Policy in depth. It also does not touch upon employment generation in depth leaving enough room for other scholars to venture in. The study is done in selected villages of two districts. However, the study done in those villages can be taken as future reference for other scholars.

There are numerous varieties of bamboo in Nagaland. The study only looks into one popular variants of bamboo called *BambusaTulda* locally called *Jati*as. It has various commercial uses and most commonly cultivated species in the study area. The primary data are based mostly on the recollection of the farmers, as they do not maintain any written records of cost and profit.

1.11. CHAPTERIZATION

The chapters are organized as follows:

Chapter 1: Introduction

This chapter presents the nature and significance of the research while dealing with the theoretical concepts involved in the study. Further gives an overview on the bamboo resources available in different regions/states of the country. The chapter also discusses the background of the study, problems statement, objectives, methodology, and limitations of the study.

Chapter 2: Literature review

It contains the review of relevant research work undertaken on the related topics.

Chapter 3: Profile of the study area and bamboo farmers

The socio-economic profile of the state and the socio-economic characteristics of the sample cultivators in two different districts are presented in this chapter.

Chapter 4: Socio-Cultural and Economic importance of Bamboo in Nagaland.

This chapter gives an account on the importance of bamboo in Naga society as such the need to study the economics of bamboo plantation.

Chapter 5: Bamboo Production and its determinants.

A brief review of the Production of Bamboo in the world, India and Nagaland are presented here, followed by the analysis of the relationship between income and production to socio-economic factors.

Chapter 6: Cost - Returns Analysis of Bamboo Production.

The understanding of cost effectiveness and profitability is essential, thus the cost and returns from bamboo production are studied in this chapter.

Chapter 7: Problems in Bamboo Production and Nagaland Bamboo Policy.

The problems faced by bamboo growers in both the districts are examined using Garrett Ranking Method and also an overview of Nagaland bamboo policy is highlighted.

Chapter 8: Conclusion.

This chapter presents summary of the major findings and suggestions.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

Reviewing the various concepts, research methodologies and analytical tools used by researchers helps to develop clarity and comprehension in any study. It helps in better understanding of the research problems and facilitates to modify and improve the analytical framework in the right direction. Moreover, the findings of the previous studies would guide the researcher. This chapter presents a brief review of the empirical studies and analytical tools, which are relevant to the present study.

2.2. BAMBOO AS A RESOURCE

Bamboo is known as "poor man timber" stands true for the countryside in India. It is one of the most widely used plant resource, and is linked with all spheres of life. With about 22 genera and 130 species, India is the second largest reservoir of bamboos, next only to China (Nath et al., 2009)[1]. India's share in the global bamboo market is estimated to be US $1 billion and is expected to increase to US $5.7 billion by 2015 (Omari, 2009)[2]. The northeastern region of India has abundant and diversity of this perennial arborescent grass (i.e., bamboos). The region has around 58 species under 16 genera of bamboo (Arora & Maurya 1988)[3]. Biswas (1998)[4] however, reported the availability of 63 species of bamboo

[1] Nath, A. N., Das, G. & Das, A. K. (2009). Above ground standing biomass and carbon storage in village bamboos in North East India. *Biomass and Bioenergy*, 33, 1188- 1196.

[2] Omari, M. P. (2009). A Cost-Benefit Analysis of Substituting Bamboo for Tobacco: A Case Study of South Nyanza, Kenya, MSc Thesis submitted to the University of Nairobi.

[3] Arora, R.K & Mauria, S. (1988). Genetic resources of bamboo – an Indian perspective. *The Indian Forester*, 114(9), 539-548.

[4] Biswas, S (1998). Studies on bamboo distribution in north-eastern region of India. *The Indian Forester*, 114 (9), 514-532.

belonging to 15 genera in the region. Barooah and Borthakur (2003)[5] have recorded in Assam, the existence of 40 species, one variety and forma each under 10 genera.

India today exploits only one-tenth of its bamboo-producing potential. Only about 10 are being commercially exploited out of nearly 130 species. These are: *Bambusa arundinacea, Bambusa affinis, Bambusa balcooa, Bambusa tulda, Dendrocalamus strictus, Dendrocalamus hamiltoni, Dendrocalamus asper, Oxytenanthera stocksii and O.travancorica.* Bamboo is well suited to polycyclic harvesting; it can be grown on steep hillsides and along the banks of rivers. Its interlocking root system and leaf deposit inhibit soil erosion. Production of bamboo is reported to improve with the age of plantation, though the percentage of new to old culms declines with age. Harvesting of bamboo is started after 7 years with 10 old and 3 new culms available per clump in the ravine land (Dhruva Narayana, 1993)[6]. Bamboo plantation is useful for enhancing natural resource conservation (Lawler, 1993[7]; Yanhui et al., 1995[8]). In addition, benefits of living biomass and soil organic matter content in bamboo stands have been well reported (Lin et al., 2004[9]; Tong, 2007[10]).

Van der Lugt, & King (2019)[11] stated in the INBAR report 'Bamboo in the Circular Economy' that bamboo could be a critical component in the transition to more circular production. It can be used in creating a varied range of durable and consumer products, which

[5]Barooah, C., & Borthakur, S. K. (2003). Diversity and distribution of bamboos in Assam. Bishen Singh Mahendra Pal Singh (BSMPS).

[6] Dhruva Narayana, V. V. (1993). Soil and Water Conservation Research in India. Indian Council of Agricultural Research, Krishi Anushandhan Bhavan, Pusa, New Delhi.

[7] Lawler, D.M. (1993). The measurement of river bank erosion & lateral channel change: A review. *Earth Surface Processes and Landforms*, 18,777-821

[8] Yanhui W, & Yongmin, L. (1995). Hydrological characteristics of a moso-bamboo (Phyllostachys pubescens) forest in South China. *Hydrological Processes*, 9(7), 797-808.

[9]Yiming, L., Peng, L., & Wanzhang, W. (1998). Studies on dynamics of carbon and nitrogen elements in Dendrocalamopsis oldhami forest. *J Bamboo Res*, 17(4), 25-30.

[10]Jian-ning, T. O. N. G. (2007). Biomass structure changes of Chimonobambusa quadrangularis before and after reclaimed. *Journal of Fujian Forestry Science and Technology*, 34 (1), 110–113.

[11]Van der Lugt, P. & King, C. (2019). **'***Bamboo in the Circular Economy'***.** International Bamboo and Rattan Organisation (INBAR) Policy Synthesis Report 6. Beijing, China: INBAR.

substitute those from man-made materials. Bamboo is rapidly self-regenerating and can store more carbon compared to certain species of trees**.** Industrial bamboo products can be renewable, low-carbon alternative to traditional materials, and also substitute plastic. Bamboo products can be repurposed, recycled, or burned for energy when they reach the end of their useful life.

Abraham (2019),[12] in his article "The New Green Gold of the Poor Farmers Bamboo Cultivation for a Sustained Livelihood", stated that bamboo, with its wide range of uses and advantages, may improve people's quality of life, especially that of the rural population in India, whose earning and living conditions depend on natural resources to a large extent. However, the country has failed in effectively utilizing its potential, which would otherwise, has become a boon to the farmers. Bamboo occupies a prominent place among the under-utilized natural resources in India. In this view, Singh (2020)[13] highlighted that the present government is planning to promote domestic bamboo industry in India, modelling the post-COVID economy. Following COVID-19, India's north-eastern region will be one of its desired business locations with bamboo serving as a significant economic pillar. In order to expand livelihood prospects through bamboo, the government has revised the century-old Indian Forest Act by removing home grown bamboo from the Act's scope. In addition, the decisions to increase the import duty on raw bamboo by 25 per cent is a positive step. This will greatly benefit the domestic bamboo industries such as furniture, handicrafts and production of 'agarbatti' (incense sticks) as well as increase the use of bamboo as building material. He reiterates that National Bamboo Mission should take the lead in making bamboo a popular household item and unlocking the North-eastern region's enormous potential in this

[12]Abraham, B. (2019). 'The New Green Gold of the Poor Farmers Bamboo Cultivation for a Sustained Livelihood'. *Shanlax International Journal of Economics*, *5*(4), 24-33. Retrieved from http://www.shanlaxjournals.in/journals/index.php/economics/article/view/726

[13]Singh, Jitendra (2020). Bamboo industry to play crucial role in post-COVID economy, The Economic Times, Sep 18, 2020, New Delhi.

area. With bamboo as a useful fuel, he believes that the region may become the 'New Engine of New India'.

Buckingham, K et al., (2011)[14] carried out a study on the potential of bamboo, where they argued that the qualities of bamboo like promoting sustainable development, alternatives to timber products, sequester carbon and restoring degraded land could generate benefits for humanity and the environment. Hence, taking advantage of the UN declaration of 'The International year of Forest-2011', policy makers can push to accord bamboo equal status as silviculture in future international forest regimes. Similarly, Rebelo & Buckinghan (2015)[15] stressed bamboo as the opportunities of forest and landscape restoration. Bamboo give ecological and livelihood benefits and therefore, suggested that in order to integrate bamboo, global policy and markets need to change and reassess bamboo's famous "weedy" reputation. Moreover, appraised on how it can be used for climate change resilience and livelihood opportunity.

Coggins, C.R (2000)[16] examined the association between the protection of wildlife habitats and village bamboo management in the Meihuashan, Wuyishan and Long-xishan Nature Reserves in Fujian Province, in China's Southeast Upland. The study found that the degree of local economic dependence on bamboo was highly significant and the adoption of new bamboo-management strategies and subsidiary economic activities reduced and prevented further losses of critical wildlife habitats.

[14]Buckingham, K., Jepson, P., Wu, L., Rao, I. R., Jiang, S., Liese, W., ...& Fu, M. (2011). The potential of bamboo is constrained by outmoded policy frames. *Ambio*, 40(5), 544-548.
[15]Rebelo, C., & Buckingham, K. (2015). Bamboo: The opportunities for forest and landscape restoration. *Unasylva*, 66(245), 91.
[16]Coggins, C. R. (2000). Wildlife conservation and bamboo management in China's southeast uplands. *Geographical Review*, 90(1), 83-111.

Maske, M et al., (2011)[17] highlighted the role of NTFPs (including bamboo) in meeting the needs of rural communities in Gondia districts of Maharastra, India. It was found that many of NTFPs are being used by locals for improvement of their livelihood status. Factors like use of both target and non-target species, total forested area, access and observation of land use patterns in adjacent areas have a huge influence on development of forest as well as extra income during the off-agriculture season, which contributes to supply and the sustainable use. It was realized that, effective marketing of NTFPs should be acknowledged as a major approach for the long-term management and use of forest resources.

Waite, M. (2009)[18] explored the engineering of sustainable textiles using bamboo. He highlighted the advantage of bamboo as raw materials because of its fast renewability, biodegradability, efficient space consumption, low water use and organic status. Some of the limitations of bamboo textiles were high cost/price, energy, water and chemical requirement in manufacturing process. He suggested closed loop manufacturing, eco-chemicals, water recycling and economic tools to overcome the constraints.

Braulin, N. et al., (2009)[19] explained the feasibility and convenience of bamboo through the presentation of design concepts and construction-maintenance techniques. Comparative study on the Life Cycle Analysis (LCA) of structural components made with traditional building materials like wood, iron, concrete and those made with bamboo, demonstrates that bamboo ones were twenty times more sustainable in preserving environment or restoration costs. Incorporating its unique qualities with sound project design

[17]Maske, M., Mungole, A., Kamble, R., Chaturvedi, A., & Chaturvedi, A. (2011). Impact of non-timber forest produces (NTFPs) on rural tribes' economy in Gondia district of Maharashtra, India. *Archives of Applied Science Research*, 3(3), 109-114.

[18]Waite, M. (2009). Sustainable textiles: the role of bamboo and a comparison of bamboo textile properties-Part 1. *Journal of Textile and Apparel, Technology and Management*, 6(2), 1-21

[19]Braulin, N., Chioetto, V., & Miranda, M. D. (2009, January). Using bamboo to build sustainably. In *IABSE Symposium Report*, 96 (4), 204-211. International Association for Bridge and Structural Engineering.

and good engineering practices based on the right theoretical and empirical knowledge will result in high end products. They suggested integration of bamboo resource which is sustainable with academic, governmental or regulatory and financial communities with the world of bridge engineering will benefit the mass.

Rashford, J.H. (1995)[20] examined the past and present uses of bamboo in Jamaica. He found that although bamboo cannot compare in commercial value to the island's principal agriculture crops, it has proven suitable for a wide variety of uses like in making houses, fences, fuel, bamboo containers, bamboo pots and baskets for catching fishes, bamboo rafts for transport and sport, ornaments and toys, musical instruments and in folk medicine. While some uses have disappeared and others are disappearing, many traditional uses still continue and there is no doubt that new uses will be discovered. Bamboo is one of the island's most exotic plant as it is naturalized, plentiful, durable, easy to work and cheap. He concluded that the bamboo could be considered as underutilized resources in Jamaica and its full potential is yet to be realized.

Bajpay & Yadav (2019)[21] explained the versatile uses of bamboo plant species. They highlighted the used of bamboo in landscaping, fencing, housing, raw materials for crafts, pulp for paper industry and fabrics for cloth industry as well as culinary products etc. Young bamboo shoots were used to prepare various delicious foods, processed products and even medicines. Various bamboo species were also utilized in herbal and traditional medication. They concluded that bamboo has a huge potential for solving many problems of environmental and social needs.

[20]Rashford, J. H. (1995). The past and present uses of bamboo in Jamaica. *Economic botany*, 49(4), 395-405.
[21]Bajpay, A., & Yadav, K. S. (2019). Bamboo: a versatile plant. An international journal of floriculture science and landscaping, *The Journal of the Greens and Gardens*, 1(2), 24-26.

Tiwari, S. et al., (2019)[22] in their study on status of bamboo in India reported that there were 3 large genera (*Bambusa, Dendrocalamus,* and *Ochlandra*) of bamboos in India with more than 10 species each, however taxonomist still debate for the exact total number of species and genera in India. Bamboos in India demonstrate great diversity in both habitats and habit of growth. They suggested that significant efforts were required to assemble an adequate information base for policy and management decisions for its conservation and cultivation. Active promotion and expansion of area under bamboo cultivation is needed to meet the market demand and supply gap by developing promising agroforestry models.

Kigomo, B. (2007)[23] explained the factors for which growing of bamboo was hampered in Kenya. The development of bamboo resource was slowed down as it was classified as minor non timber forest product by the Forestry Department. He also pointed that factors like ban on harvesting, lack of awareness on production of unprocessed or semi-processed products, lack of marketing structure, lack of information related to planting materials, propagation methods, crop management and harvesting hindered the growth of bamboo resource.

Akwada & Akinlabi (2016)[24] examined the economic, social and environmental importance of bamboo in Africa. The study showed that a long-term, planned, scientific and holistic approach to the cultivation, processing and management of bamboo can make bamboo a sustainable alternative material for infrastructure development and can play an important role in the restoration and transformation of rural and national economies. They suggested that by adopting and implementing appropriate technology on bamboo and its products, the infrastructure need in African countries can be attained.

[22]Tewari, S., Negi, H., & Kaushal, R. (2019). Status of Bamboo in India. *International Journal of Economic Plants*, 6(1), 30-39.
[23]Kigomo, B. (2007). Guidelines for growing bamboo. Kenya Forest Research Institute.
[24]Akwada, D. R., & Akinlabi, E. T. (2016). Economic, social and environmental assessment of bamboo for infrastructure development. In *5th International conference on infrastructure development in Africa July in Johannesburg, South Africa*.

Mohamed, H.J.A. (2003)[25] reports the macro-proliferation method for *Gigantochloaligulata* (buluhtumpat) at Bukit Saga, Southern Johore. Based on these experiments, an initial 30 seeds sown can produce 266 young plants. Each seed produced 8 young plants by using the macro-proliferation method. The application of fertilisers gave an increment of 48% of young plants after 4 months stage in the nursery. He concluded that this method is successful in producing mass bamboo planting materials especially for plantation purposes.

Embaye, K. et al.,(2005)[26] conducted a study in southwest Ethiopia on the biomass and nutrient distribution in a highland bamboo forest and found that silvicultural treatment, harvesting operation and management actions like sequential removal of trees older than 3 years can lead to more productive bamboo forest. Use of fertilizers like rich in P and K was found to be best suited to incur more yield and suggested harvesting to carry out in dry season.

Hogarth, N. J., & Belcher, B. (2013)[27] conducted a study on the contribution of bamboo to household income and rural livelihoods in a poor and mountainous county in Guangxi, China. Bamboo was a common and widely used resources in all homes for a variety of subsistence purposes in the study area. Bamboo was the single most valuable source of revenue, with dried bamboo shoots farmed in small-scale household plots providing the most of the income. The average bamboo income share was 13.3 per cent, with differences among villages ranging from 0 to 50 percent. The largest absolute bamboo income was found in high income household, but low-income households were the most reliant on bamboo income.

[25]Mohamed, H.J.A (2003). Macro-proliferation of Gigantochloaligulata seedlings for mass production of planting stock and its field performance. *J. Bamboo and Rattan*, 2(1), 13–21.

[26]Embaye, K., Weih, M., Ledin, S., & Christersson, L. (2005). Biomass and nutrient distribution in a highland bamboo forest in southwest Ethiopia: implications for management. *Forest ecology and management*, 204(2-3), 159-169.

[27]Hogarth, N. J., & Belcher, B. (2013). The contribution of bamboo to household income and rural livelihoods in a poor and mountainous county in Guangxi, China. *International Forestry Review*, 15(1), 71-81.

They suggested that bamboo is an excellent pro-poor resource, particularly in isolated, mountainous places where off-farm income opportunities are restricted.

Borah, E. D. et al., (2008)[28] explains the potential of bamboo as an industrial raw material in various sectors like food production, building and construction material, wood substitute, cottage industries, handicraft, pulp and paper, medicinal products, and charcoal production. They found that lack of information about size of the domestic market, unorganised and poor market were the factors that were hampering the growth of bamboo sectors. Development of industries based on bamboo will create value-addition which in turn will lead to bulk consumption and encourage the bamboo growers to grow more bamboo. They suggested that using new technical, marketing finesse and renewed commitment, bamboo could take on the role as the material of the future.

Bajracharya, M. S. et al., (2012)[29] investigates the associate enterprises involving bamboo-based weaving and handicraft making at *Badikhel* Village Development Committee, *Lalitpur* District, and Central Nepal. It aims to assess the socio-economic importance of bamboo craft making. It was found that *Badikhel* permeates four species of bamboo from two genera, *Bambusa* and *Drepanostachyum,* which are important and traditional sources of livelihood for the local people. From the sales of assorted handicrafts, on an average bamboo handicraft maker obtained NRs. 1000-5000 per month. The entrepreneur, on the other hand, did not engage in any significant bamboo management activities. Because of limited involvement by stakeholders' in promotion of bamboo handicraft industry and bamboo management, a larger association of bamboo users is urgently needed to foster the growth and development of bamboo entrepreneurs.

[28]Borah, E. D., Pathak, K. C., Deka, B., Neog, D., & Borah, K. (2008). Utilization aspects of Bamboo and its market value. *Indian Forester*, 134(3), 423-427.
[29]Bajracharya, M. S., Rajbhandary, S., & Das, A. N. (2012). Socio-economic impacts of bamboo enterprises in the Mid-hills of Nepal: A case study on Pahari community at Badikhel Village, Lalitpur. *BankoJanakari*, 22(2), 19-25.

Ogunjinmi, A. A. et al., (2009)[30] tries to find out whether *Bambusa vulgaris* has socio-economic impact on the lives of people living in *Borgu* Local Government Area of Niger State. They examined the nature of participation among different household and found that the lives of the respondents revolve around the use of *Bambusa vulgaris* for one purpose or the other; some being used as medicine others for shelter and fishing. If it goes extinct, the livelihoods of rural dwellers who rely on this versatile species will be seriously harmed. As a result, there should be regular inventory of natural bamboo stands to ensure that the resource is managed sustainably. According to them, efforts should also be made to protect and conserve the rich biodiversity associated with bamboo forests and bamboo growth areas, as well as to promote sustainable development and better understanding of bamboo in order to fully exploit its potential to boost the rural and national economy.

Mekuriaw, et al., (2011)[31] carried out a survey in *Amhara* and *Benishangul-Gumuz* Regional States of northwestern Ethiopia to assess the utilization of two indigenous bamboo species as source of foliage for ruminants. Purposely selected for the study were two zones, one from each region, two districts from each zone and four peasant associations from each district, and a total of 208 households based on the availability, production and utilization of highland grass as ruminant feed (*Yushaniaalpina*) and lowland (*Oxytenantheraabyssinica*) bamboo species. They found that the two indigenous bamboo species are valuable multipurpose crops in northwestern Ethiopia. They suggested that future work must also focus on the development of conservation and processing methods and appropriate feeding system that may enhance the feeding values of bamboo foliage.

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[30]Ogunjinmi, A. A., Ijeomah, H. M., & Aiyeloja, A. A. (2009). Socio-economic importance of bamboo (Bambusa vulgaris) in Borgu local government area of Niger State, Nigeria. *Journal of Sustainable Development in Africa*, *10*(4), 284-289.

[31]Mekuriaw, Y., Urge, M., & Animut, G. (2011). Role of indigenous bamboo species (Yushaniaalpina and Oxytenantheraabyssinica) as ruminant feed in northwestern Ethiopia. *Livestock research for rural development*, *23*(9), 9.

Alamgir, M. et al., (2007)[32] analysed the significance of bamboo-based cottage industry in economic development of rural poor in Chittagong, Bangladesh. A survey was conducted to analyse socio-economic status of the respondents, raw material source, economics of the industry, marketing of the products, gender role and problems of the industry. The majority of the members were found to be illiterate and have extremely small land holdings. The local market and homesteads were the primary sources of raw materials. Bamboo was used to make eleven different types of items. The total expected annual income from making bamboo articles to a family in the study area was USD 1,078. In bamboo-based cottage industry, 66 per cent were women from the members engaged. Scarcity of raw materials and inadequate training facility for artisans were some of the problems faced by the respondents.

Mishra, V. (2015)[33] revealed that from the total area 108,306 hectare plantation, 21.6 million man days equivalent to ₹1,080 million wage earning has already been generated in Madhya Pradesh. It estimated that if corresponding cottage industry can develop, it can generate 97.2 million man days equal to ₹4,860 million wages annually, earning in the cottage industry sector. Every year, harvesting of bamboo from natural forests produced 2.25 million man days which is equal to ₹112.5 million wages. This proved the significance of Bamboo not just as a product to meet consumer's demand, but also as a manufacturing method to generate employment for the impoverished rural poor. The wide gap that existed between the demand and supply of bamboo owing to the growing National and International market, a huge opportunity for the development of bamboo resources both on public and private land as well as improvement in the economic situation of the bamboo dependent

[32]Alamgir, M., Mezbahuddin, M., & Jashimuddin, M. (2007). Role of bamboo based cottage industry in economic upliftment of rural poor of Chittagong, Bangladesh. *Journal of Bamboo and Rattan*, 6, 157À164.
[33]Mishra, V (2015).Bamboo and Its Connectivity to the Different Fields of Economics: A Potential Resource of Modern India. *International Journal of Innovative Research and Development*. 4(2), 140-145.

people were identified. He concluded that the use of Bamboo as resource can create resource and also reduce the depletion of non-renewable resources.

Ingram, V & Tueguhong, J.C. (2013)[34] carried out a study on bamboo value chain in Cameroom. They found that three bamboo species namely *alphineyushania alpine, savannah Oxytenantheraabyssinica and Bambusavylgaris*were commonly used and suggested that integrated conservation, development actions and research can enhance the socio-economic status of those engage in bamboo sector.

Monaco, E. (2019)[35] conducted a study on sustainable development and bamboo value chain in Ethiopia. He found that even though 'National Bamboo Strategy and Action Plan' is implemented, because of weak governance framework which is fragmented and marginally effective this is hindering the expansion of the bamboo sector. He suggested consolidating resource foundation of the whole sector, prioritising the up scaling of industrial value chains of bamboo boards, sticks and bio energy products and intervening in a coordinated manner on policy tools.

Mekonnen, Z. et al., (2014)[36] examine the socio-economic contribution of bamboo resources and typify their marketing value chain across major bamboo-growing and -marketing regions in Ethiopia, in order to promote its sustainable management. They found that crop livestock production, forest management, and off-farm activities are all key sources of income for respondent households. Bamboo revenue accounted for up to 11 per cent of households' yearly cash income with, the lowest (3.4%) at Masha and the highest (38%) at Banja and Bahir Dar Zuria Districts. Cash revenue from bamboo, crop, petty trade, and other

[34]Ingram, V., & Tieguhong, J. C. (2013). Bars to jars: Bamboo value chains in Cameroon. *Ambio*, 42(3), 320-333.
[35]Monaco, E (2019). Sustainable development and bamboo value chain: Ethiopia's green growth opportunity. *Solution Journal*, 10(4), 16-24.
[36]Mekonnen, Z., Worku, A., Yohannes, T., Alebachew, M., & Kassa, H. (2014). Bamboo Resources in Ethiopia: Their value chain and contribution to livelihoods. *Ethnobotany Research and Applications*, 12, 511-524.

NTFPs were found to have a positive and significant association. Farmers, village level traders, town and city wholesalers, small and medium-scale bamboo processing and marketing enterprises, and town and city consumers have all been highlighted as key actors in the bamboo value chain. Fifty-five percent of the respondents showed there was a lack of horizontal and vertical linkage among respondents. The majority of the producers faced market access issues, therefore they sold bamboo culms and other product forms locally, primarily at roadside markets. Despite the inefficient value chains, 85 per cent of the respondents reported that demand for bamboo products is expanding. In contrast to country's resource base, bamboo utilization in Ethiopia is rudimentary, and bamboo product import surpasses export. It's also worth noting that, despite little interventions, resource base is declining disturbingly. They suggested enhancing further research into technical innovation, as well as upgrading and integrating the bamboo value chain and advocating resource management that is sustainable.

Utomo, M., Pieter, L., & Siagian, C. M. (2021)[37] conducted as a case study on value chain structure of the Gunungkidul Regency. Value chain structure of three bamboo-based enterprises namely bamboo toy handicraft, kitchen utensils and chemically treated bamboo were studied. They used snowball concept until the data was saturated and found that the traditional chain was dominant. Bamboo toy handicrafts had the longest value chain and highest actor levels, while chemically treated bamboo had the shortest and lowest actor level. In the production flow, the majority of channels were in the toy handicraft chain, which was followed by kitchen utensils and chemically treated bamboo. The use of credit as a payment method is common in financial transactions, and trust has been highly developed between actors. The flow of price related information was unbalanced. Collaboration in the raw

[37]Utomo, M., Pieter, L., & Siagian, C. M. (2021). Value Chain Structure Analysis as a Starting Point for Bamboo Enterprise Development: Lessons from Gunungkidul, Indonesia. *Forest and Society*, 5(2), 405-420.

material segment was weak in each chain. They observed that the lack of willingness of artisans to be more productive, the weak cooperation among artisans coupled with the lack of support from the government were some obstacles to the development of bamboo as a small to medium enterprise in Gunungkidul, Indonesia.

Endalamaw, T.B. (2013)[38] analyzed the indicators and determinants of small-scale bamboo commercialization from three major bamboo-growing districts (Awi, Sidama, and Sheka) and four urban centres (Masha, Hawassa, Bahir Dar, and Addis Ababa) in Ethiopia. Results revealed distinctive differences in proportion of cash income, value chain structure, and management engagement among the districts. At Awi, Sidam, and Sheka, the percentages of cash income were 60.15, 42.60, and 9.48, respectively. Differences between Sheka and both other districts were statistically significant (p = 0.05), but not between Awi and Sidama. In comparison to Sheka, the value chain structure revealed Awi and Sidama have comparatively large number of participants involved. Distance to market and availability of alternative forest products were the two most important factors in explaining regional disparities in commercialization. Households with bigger family size, higher educational attainment, and availability to training were found to be more involved in commercial extraction in Sheka. They concluded that development of infrastructure for linking resource and consumer centres and expansion of extension education among producers may enhance the commercial engagement of producers and improve the accessibility of bamboo resources for commercial production.

[38]Endalamaw, T.B., Lindner, A., & Pretzsch, J. (2013). Indicators and determinants of small-scale bamboo commercialization in Ethiopia. *Forests*, 4(3), 710-729. https://doi.org/10.3390/f4030710.

Muralidharan, P.K et al., (2004)[39] studied on traditional bamboo houses in Kerala and Karnataka, India, it's the cost of construction, long-term economic benefits and socio-cultural acceptability. They looked at the primary roadblocks and policy adjustments needed to promote bamboo housing. Even though bamboo was available the housing sector experienced significant shortage of bamboos for construction, because the pulp and paper industry buys bamboos in bulk at higher prices. Bamboo houses in the study areas are either thatched with grass or leaves or tiled with rural tiles. Approximately 95 per cent of residents choose tiled houses due to their durability and low maintenance costs. It has also been discovered that tiled-bamboo houses have greater economic benefits and socio-cultural suitability. They discovered deprived economic conditions among the dwellers, as well as low availability of bamboos in the construction sector, high prices of bamboo and lack of title deeds of the land as some of the major constraints and suggests that bamboo houses in the study areas may become more popular by providing more amenities and better appearance for aesthetic satisfaction.

Sundriyal, M., & Sundriyal, R. C. (2011)[40] studied the resource utilization patterns and socio-economic status of bamboo-artisans in Uttarakhand state. Eight bamboo species belonging to five genera were found to be grown naturally in the state namely *Dendrocalamusstrictus (Roxb.) Nees*, Dendrocalamus*somdevae H.B.* Naithani, *Dendrocalamuspatellaris Gamble*, *Bambusabambos (L.) Voss*, *Drepanostachyumfalcatum (Nees) Keng f., Himalayacalamusfalconeri (Munro) Keng f. ,Thamnocalamusspathiflorus (Trin.) Munro, and Sinarundinariaanceps (Mitford) C.S. Chao & Renvoize.* Bamboos were available in reserve forest, civil soyam and Van panchayat. Nearly 600-3000 bamboo and

[39]Muralidharan, P.K., Anitha, V & Simon T.D. (2004). Present status and socioeconomic acceptability of traditional bamboo houses: A study in Kerala and Karnataka states of India. *Journal of Bamboo and Rattan*, 3(5), 31-40.

[40]Sundriyal, M., & Sundriyal, R. C. (2011). Bamboo Trade and Future Prospects in the Central Himalaya: A case study of the traditional artisans of Uttarakhand, India. *Ethnobotany Research & Applications*, 9, 445-454.

ringal articles were used for which shows the importance of trade and income generation. The socio-economic status of the artisans reveals that most of them were living below the poverty line and from schedule caste and they sold their products directly to village people for cash or through barter. Some of the problems faced by the artisans in the study area were resource conservation, developing market linkages, lack of transportation, awareness on government policies and formation of artisans' cooperatives. They suggested use of modern technology, product diversification and registration of artisans to improve trade in the study area.

Sawarkar, A. D. et al., (2020)[41] studied the market value of 27 commercial species using clustering techniques. They highlighted on the uses of bamboo, turn-over, international import-export value of products, and State and Central Government support and thus determining their commercial values and suggesting appropriate intervention plans in various industrial areas in terms of marketing and technological up gradation, which would also provide a way to strengthen cooperation among clusters irrespective of their business operation size.

Bystriakova, N. et al., (2003)[42] in their study found no detailed regional records were made on distribution of bamboo even though bamboo hold a very important place in cultural and economic aspects of Asian region. Information on bamboo distribution and forest cover were combined to analyse the prospective of the existing bamboo species and production. Over 1000 bamboo species from 60 genera were included in the study, allowing for the mapping of individual species, groups of species, and genera, as well as potential species richness and biodiversity hotspots. Bamboo is found across around 6.3 million km^2 of Asian forest, with highest densities found in north eastern India, Burma and southern China, as well

[41]Sawarkar, A. D. et al., (2020). Op cit. p. 8.
[42]Bystriakova, N., Kapos, V., Lysenko, I., & Stapleton, C. M. A. (2003). Distribution and conservation status of forest bamboo biodiversity in the Asia-Pacific Region. *Biodiversity & Conservation*, 12(9), 1833-1841.

as Sumatra and Borneo. The forests of south China, including Hainan Island, have the highest potential species richness (144 spp per square km).

Gupta and Kumar (2008)[43] examined the potential of bamboo in sustainable development and brought out the mechanical and physio-chemical properties of bamboo. They highlighted on the uses of bamboo for bamboo based panels, paper, textiles and board, food, combustion and other bio-energy application, charcoal and activated carbon, housing, flooring, weaving products and crafts and furniture and expressed that bamboo has potential of sustainable development along with the cultural and social growth.

2.3. BAMBOO RESOURCE IN NORTH-EAST

Rao, K.S & Ramakrishnan, P.S. (1989)[44] carried out a study on bamboo species involvement in nutrients conservation during secondary succession in 5, 10 and 15 year old 'fallow' stands after slash and burn agriculture, at three sites that is *Machipani*in *Garo* hills, *Lailad* in *Khasi* hills and *Changki* in *Naga* hills at 200-300 m altitude in north-eastern India. They found that bamboos had a significant role in succession at all three sites, accounting for 40-50 per cent of the total slash biomass, 49-73 per cent of nitrogen, phosphorus and potassium, but only 12-32 per cent of calcium and magnesium. It is concluded that bamboos are shown to have an important role in nutrient conservation in north-eastern India during slash and burn agriculture. In addition, Cajee, L. (2018)[45] presented a broad overview of the diversity of bamboo species and their uses in the north east India. Out of the 78 species and 23 genera prevalent in the north eastern region of India, 6 species belonging to 2 genera

[43]Gupta, A., & Kumar, A. (2008). Potential of bamboo in sustainable development. *Asia Pacific Business Review*, 4(3), 100-107.
[44]Rao, K. S., & Ramakrishnan, P. S. (1989). Role of bamboos in nutrient conservation during secondary succession following slash and burn agriculture (jhum) in north-east India. *Journal of Applied Ecology*, 26(2), 625-633.
[45]Cajee, L. (2018). Diversity of bamboo species and its utilization in the north-eastern region of India. *International Journal for Research in Applied Science and Engineering Technology*, 6(3), 3286-3299.

namely, *Bambusabalcooa*, *B.tulda*, *B. vulgaris*, *Dendrocalamus giganteus*, *D. hamiltonii* and *D. strictus* have been found to be most extensively used in the region. Among the north eastern states of India, the most commonly used species was found to be *D. hamiltonii*.

Tamang, D.K. et al., (2013)[46] conducted a study on bamboo diversity, distribution pattern and its uses in Sikkim Himalaya and found that there were 21 bamboo species found in tropical forest, 28 species in sub-tropical forest, 12 species in temperate forests, 6 species in sub-alpine forests and 3 species in alphine vegetation. *Dendrocalamus*genera has the maximum number of species (8) which was followed by *Bambusa*and *Sinarundinaria* (6 each). Schizostachyum genera have 5 species, Phyllostachys has 2 species and Arundinaria, Melocanna and Thamnocalamus (1 each). They suggested to make extensive study in order to know about the bamboo diversity of the Himalayan state.

Sengupta, A. (2007)[47] investigated the effectiveness, sustainability and future of bamboo planted in Tripura under TBM. In the market, bamboo farmers face price constraint. The study concluded that cluster-based development is necessary, as is government assistance for planting and scientific and technical knowledge development as well as the farmer's zeal, enthusiasm, vision and incentive to efficiently build well-managed sustainable bamboo plantation.

Nath, A. J., & Das, A.K. (2008) [48] studied the bamboo resources in the home gardens of Barak Valley, Assam. Bamboo growers have seven species on hand to meet their social,

[46]Tamang, D. K., Dhakal, D., Gurung, S., Sharma, N. P., & Shrestha, D. G. (2013). Bamboo diversity, distribution pattern and its uses in Sikkim (India) Himalaya. *International Journal of Scientific and Research Publications*, *3*(2), 1-6.
[47]Sengupta, A (2017). The Impact of Private Bamboo Plantation under TBM on the Socio-economic Development of the Rural Livelihoods in the Mohanpur-Hezamara R.D Blocks, West Tripura. *International Journal of Scientific & Engineering Research*, 8 (4), 262-283.
[48]Nath, A. J., & Das, A. K. (2008). Bamboo resources in the home gardens of Assam: A case study from Barak Valley. *Journal of Tropical Agriculture*, 46, 58-61.

ecological, and economic demand, according to species inventory. *Bambusacacharensis, B. vulgaris, and B. balcooa* the most common species in both home gardens and bamboo groves, indicating the locals' preference for these species. *B. cacharensis* had the greatest Relative Importance Value (RIV), followed by *B. vulgaris,* and *B. balcooa*. They stressed the importance of sustainable management of this rural resource that is both commercially and ecologically vital.

Sarkar, P.K et al., (2019)[49] highlighted potentials of bamboo plantation for doubling farmer's income in eastern India. They found that bamboo plantation not only rehabilitate wastelands, non arable or degraded lands but they can also help improve rural people's livelihoods and nutritional security and thereby rural industries too. They concluded that double or more than double income through bamboo plantation can be possible based on farmers' perceptions and knowledge about suitable land, its adaptation, implementation and management.

Bhatt, B. P. et al., (2003)[50] reported that some commercially available edible bamboo species of Meghalaya, Mizoram and Sikkim are *Bambusabalcooa Roxb., Chimonobambusahookeriana (Munro) Nakai, Dendrocalamushamiltonii Nees et. Arn and Melocannabaccifera (Roxb.) Kurz.* Apart from being found in forest, these edible species are grown in homegardens. Edible shoots are harvested from first week of June to first week of September every year for consumption. However, market days for selling it differed from state to state and even by location within a state, with average values of 52.65, 80.71 and 31.50 days/year in Meghalaya, Mizoram and Sikkim, respectively. On average in the three states, 4,420.31, 4,326.34 and 266.39 quintal of bamboo shoots were harvested annually,

[49]Sarkar, P. K., Sinha, A., Das, B., Shinde, R., Dhakar, M. K., & Das, B. (2019). Bamboo plantation: A step forward in doubling farmer's income in eastern India. *Agriculture & Food: e-Newsletter*, 1(2), 1-5.
[50]Bhatt, B. P., Singha, L. B., Singh, K., & Sachan, M. S. (2003). Some commercial edible bamboo species of North East India: production, indigenous uses, cost-benefit and management strategies. *Bamboo Science and Culture*, 17(1), 4-20.

respectively. *D. hamiltonii* tender edible shoots are harvested and consumed most (4,838.10 q/ year), followed by *M. baccifera* (3,610.61 q/year), *B. balcooa* (525.55 q/ year) and *C. hookeriana* (36.99 q/ year), respectively among the various species. In Meghalaya, Mizoram and Sikkim, the gross income was calculated to be ₹19.659 (US$ 41,872.5), ₹13.22 (US$ 28,157.6) and ₹8.197 lac/ yr (US$ 17,459), respectively. Thus, in given three states indigenous tribes might make net revenue to the tune of ₹11.38 (US$ 24,250.4), ₹7.74 (US$ 16,485.6) and ₹7.01 lac/ year (US$ 14,930.8), respectively, by selling young edible bamboo shoots. On average, *D. hamiltonii, M. baccifera, B. balcooa and C. hookeriana* respectively, contributed 51.08 per cent, 35.14 per cent, 6.79 per cent and 6.86 per cent to total monetary benefits earned, irrespective of states. It was observed that besides food value, these species also played an important role in the life of tribal folk, particularly for providing materials for various other quotidian needs, as well as for paper-pulp industries.

Handique, P. et al., (2010)[51] highlighted the use of bamboo and its products in socio-economic development of Nyishi tribe of Arunachal Pradesh. There were 14 species of bamboo that was found in Papum Pare district but only 3 species namely *B.Pallisa, B.Tolda and Dendrocalamushamiltonii* were used mainly for constructions, fencing, firewood, indigenous materials, rituals functions and bamboo shoots. They concluded that bamboo culm and products made of bamboo were high in demand in the study area and there is potential of huge market demand.

Das, P. et al., (2012)[52] studied on traditional bamboo houses in Assam and Mizoram. The patterns influencing these regions the housing styles were topological factors, rainfall and tribal ethos. People in the region used water or mud treatment and smoke treatment to

[51]Handique, P., Rethy, P., Dutta, B. K., Das, A. K., & Doley, B. (2010). Role of bamboo resources in socio economic development of the Tribal people of Arunachal Pradesh with special reference to Nyishi tribe of Papum Pare District. *J Biosci Res*, 1(3), 216-226.

[52]Das, P., Chaaruchandra, K., Sudhakar, P., & Satya, S. (2012). Traditional bamboo houses of North-Eastern Region: A field study of Assam & Mizoram. *Key Engineering Materials*. 517, 197-202). Trans Tech Publications Ltd.

treat bamboo. The parameters influencing bamboo housing were land resource, species of bamboo, local equipment and tools, role of family in construction, duration and period of constructions. They found that bamboo houses were more than 10 years which is sustainable and concluded that traditional knowledge of bamboo housing will aid in addressing the issues of green construction & sustainable development, which in turn will help in mitigating global warming and climate change.

Basumatary, A et al., (2015)[53] highlighted the importance of bamboo as potential source of food security, economic prosperity and ecological security in North-East India. The utilization of juvenile shoots of bamboo as health food is a lesser known fact as compared to its industrial usage. The shoots have high nutritional and therapeutic values which can be opted to make up the deficiencies of nutrients in the diet and utilized to feed the ever increasing human population. It also enriches the socio-economic condition of the common people of North-East region of the India. They also found that bamboo is not only ideal for economic investment but also have capacity to solve ecological problems because of the growth habits and biological characteristics. They recommended putting emphasis on mass plantation of bamboo in large scale in North-Eastern India and helping in controlling the erosion of biodiversity, climate change, dietary deficiencies and insecure economy. It will provide ample scope towards engagement of unemployed directly or indirectly through marketing as well as production of raw bamboo and its value added products thereby enhancing the food, economic and ecological security of the said region.

[53]Basumatary, A., Middha, S. K., Usha, T., Brahma, B. K., & Goyal, A. K. (2015). Bamboo, as potential sources of food security, economic prosperity and ecological security in North-East India: an overview. *Research in Plant Biology*, 5(2), 17-23.

Bendangtemjen, R. (2016)[54] examined bamboo resources and its utilization in Nagaland. The main bamboo bearing district in the state were Mokokchung, Wokha, Longleng, Mon, Dimapur and Peren. The main species found in the state were *Bambusatulda* (Construction, industrial use, handicraft, shoot, pulp), *Bambusabalcooa* (Construction, pulp, implement, fodder), *Dendrocalamushamiltonii* (Handicraft, shoot), *Dendrocalamusgiganteus* and *Dendrocalamuslatiflorus* (Construction, shoot) and *Schyzostachyumdullooa* (Weaving, mat making and shoot). He suggested that conservation measures needs to be taken up with the involvement of the village council and all the stakeholders and sustainable means of utilization should be adopted.

Another study on bamboo cultivation in Nagaland was made by Kithan, L.N. (2014)[55], who examined the bamboo's socio-economic importance among the *Nagas* of Nagaland and found that bamboo resource is a valuable asset to the *Nagas* which is reflected in the lifestyle. From social aspect, bamboo is used for various purpose with certain meaning and connotations. Economically, different section of the society were benefitted through bamboo products and cluster programme and suggested proper planned which requires scientific and holistic approach to the ongoing cultivation and management of bamboos for restoration and rejuvenation. Natarajan and Jamir (2013)[56] carried out a study in six major bamboo cultivating villages in Dimapur, mainly to identify the reasons for cultivating bamboo and the problems faced in bamboo cultivation. It was found that high profit, suitability of soil and climatic condition were the main reason for cultivating bamboo and lack of scientific knowledge for bamboo cultivation and weeds control were the main problems faced the cultivators.

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[54]Bendangtemjen, R. (2016). Bamboo resources and its utilization in Nagaland. *Fazl Ali College Journal*, 6, 118 - 123.

[55]Kithan, L. N. (2014). Socio-economic importance of bamboo among the Nagas of Nagaland. *Journal of Human Ecology*, 48(3), 393-397.

[56]Natarajan, P., & Jamir, I. (2013). Bamboo cultivation in Dimapur, Nagaland-growers perception. *International Journal of Research in Commerce, Economics and Management*, 3(3), 47-52.

2.4. TRADITIONAL IMPORTANCE OF BAMBOO

Bamboos are heavily relied upon by the region's ethnic tribes for a variety of purposes. The works of Laha (2000)[57] about several tribes of Northeast India on traditional uses of bamboo for constructing houses, Sundriyal et al. (2002)[58] on bamboo utilization in Apatani Plateau of Arunachal Pradesh, Sarkar and Sundriyal (2002)[59] on indigenous uses and management of bamboo in Arunachal Pradesh, Bhatt et al. (2003)[60] on indigenous uses and commercial edible bamboos of Northeast India, Handique et al. (2010)[61] on socio economic relevance of bamboo resources in Arunachal Pradesh, and Nath et al. (2011) [62] on traditional bamboo uses among the tea tribes of Assam's Barak Valley have shed light on the importance of bamboo in life and culture of the ethnic groups of Northeast India.

It is found that bamboo has traditional importance around the world. Sattar, M. A. (1995)[63] conducted a study on traditional bamboo housing in Asia and its present status and future prospects. He found that bamboo houses were constructed all over the world in rural and low income groups and highlighted on the physical and mechanical properties, natural durability, drying property and preservative treatment. It was stress that bamboo has lot of prospects in the future as it grows rapidly and can be planted in homestead. It has good

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[57] Laha R (2000). Bamboo uses for housing by different tribes of Northeast India. *Bamboo Science and Culture,* 14(1), 10-14.

[58]Sundriyal, R. C., Upreti, T. C., & Varuni, R. (2002). Bamboo and cane resource utilization and conservation in the Apatani plateau, Arunachal Pradesh, India: implications for management. *Journal of Bamboo and Rattan*, 1(3), 205-246.

[59]Sarkar, J., & Sundriyal, R. C. (2002). Indigenous uses, management and conservation of bamboo resource in Arunachal Pradesh, North East India. *Bamboo Journal*, 19, 24-39.
[60]Bhatt et al. (2003). Op cit. p. 57.

[61]Handique et al. (2010). Op. cit. p. 56
[62]Nath, A. J., Bhattacharjee, P., Nandy, S., & Das, A. K. (2011). Traditional utilization of village bamboos among the tea tribes of Barak Valley, northeast India. *The Journal of the American Bamboo Society*, 24(1), 35-44.

[63]Sattar, M. A. (1995, June). Traditional bamboo housing in Asia: Present status and future prospects. In *IV Ramanuja Rao, Cherla B. Sastry., PM Ganapathy and Jules A. Jassen. Bamboo, People and the Environment. In Proceeding of the 5th International Bamboo Workshop and the 4th International Bamboo Congress,(p. Volume 3). Ubud, Bali, Indonesia* (pp. 1-3).

mechanical properties and can be dried with simple method; simple tools are needed, little damage during earthquake and temporary and quick construction. He suggested to implement regional projects, mechanism for quick dissemination of research to solve technical problems and can develop rural based housing entrepreneurship.

Yuming, et al., (2004)[64] from their study on "Bamboo Diversity and Traditional Uses in Yunnan, China" identified that bamboo resources show rich species and vegetative types diversities. As a result, it is extremely important for the area's social, ecological, and economic development. In Yunnan, They found 250 bamboo species belonging to 29 genera, accounting for half of all bamboo species and three quarters of all bamboo genera known in China. Traditional bamboo uses were very fundamental to the ethnic minorities of Yunnan's cultural variety. Their lives were inextricably linked to bamboo, which had a significant impact on their history, art, handicrafts, music, religion, customs, architecture, and agricultural output. In this hilly province of China, this understanding has aided in the preservation of traditional cultural knowledge systems. In order to develop and utilize the abundant bamboo resources of Yunnan, they recommended to establish intensive high-yield and good quality bamboo plantations provide scientific and technological resources, strengthened macro-management in the bamboo industry, developed bamboo products for replacing wood, and to protect the mountain ecosystems.

Chandrashekara, U.M et al., (2019)[65] undertook a study on socio-cultural and management significance of bamboos in Indian heritage and tradition by documenting the historical record use of bamboo in ancient India like usage in health and well-being, medicinal use, habitations, cultivation and management of bamboo in ancient India, cultural

[64]Yuming, Y., Kanglin, W., Shengji, P., & Jiming, H. (2004). Bamboo diversity and traditional uses in Yunnan, China. *Mountain Research and Development*, 24(2), 157-165.

[65]Chandrashekara, U. M., Tikhile, P, Subbanna, S & Viswanath, S. (2019). Socio-cultural and Management Significance of Bamboos in Indian heritage and tradition. *Journal of Bamboo and Rattan*, 18(4), 64-73.

and religious significance of bamboo in contemporary India, management of bamboo in traditional farming and bamboos in homesteads and farm boundaries. This shows the importance in conservation and management of bamboo. They suggested that through collaborative exercise involving practitioners, natural and social scientists, there could be proper understanding on strengths and relevance of traditional knowledge and practices in bamboo management in different ethnic groups of the country.

Subbanna, S & Vishwanath, S. (2016)[66] examined the various ways in which bamboo is revered and used in different communities through a socio-cultural-religious prism. They found that in Lanten Yao, bamboo paper was used in religious motifs, in North Bengal, bamboo was used for worship by Rajbanshis and in Kerala Oodapoore is used in Kottiyar temple as religious offering. They observed that there is diversity in utilization of bamboo in different cultures and communities and it played an important role in conservation of bamboo diversity.

Medhi et al. (2010)[67] dealt with 32 spices of bamboos identified, documented the traditional knowledge and usage among the ethnic groups of the North Cachar Hills (presently known as Dima Hasao) of Assam State. They pointed the urgent need for conservation schemes with appropriate inputs, both from scientific studies and prevailing indigenous knowledge of the ethnic groups can save these valuable bio-resources otherwise, it is becoming depleted. So, it is urgently required to set up bamboo and rattan garden in the region. Preservation of the traditional knowledge and participation of the local ethnic groups are most important.

[66]Subbanna, S & Viswanath, S. (2016). A peek into the religious and socio-cultural uses of bamboo world-wide. *Bamboo News*, 106, 2-4.
[67]Medhi, P., Borthakur, S. K., & Hore, D. K. (2010). Phyto resources from North Cachar Hills of Assam, India-IV: Bamboos and Rattans. *J Bamboo Rattan*, 9(3), 115-125.

The traditional uses of bamboos among the *Karbis* tribe of Assam in India, and their significance in the social, cultural and religious life is discussed by Teron and Borthakur (2012)[68] and Singha, K. N., & Timung, L. (2015)[69]. Field study undertaken in different parts of Karbi Anglong district of Assam reveals that bamboo is one of the most extensively used plant resources among the Karbis. The uses of certain bamboo crafts are binding during rituals and in social occasions. '*Han-up'*or bamboo shoot is a major source of food when rice is scarce, a traditional festival is held to mark harvesting of bamboo shoots. *Karbis* are also aware of some bamboo-related. Bamboo also is a potential resource for improving rural economy of the rural *Karbis,* thus, suggested for entrepreneurship development based on indigenous crafts of bamboo.

Sarkar, J., & Sundriyal, R. C. (2002)[70] highlight the use of bamboo in traditional system by Tangsa tribe in Arunachal Pradesh. They found that the local people have high wisdom in making traditional crafts of bamboo, however due to non-availability of market for the product, the indigenous knowledge is depleting. They suggested that proper actions need to be taken up for value addition along with capacity building so that it provides good economic return to those engage in bamboo craft.

Lalhruaitluanga, H., & Prasad, M. N. V. (2009)[71] highlighted the importance of bamboo in Mizoram having traditional and economic importance and ecological services. Traditional uses/items made of *M. baccifera* includes houses, different types of baskets for varied purposes, musical instruments, agriculture tools, diverse traditional snares/traps, household items, rain sheath and pipes. It also holds different economic importance through

[68]Teron, R., & Borthakur, S. K. (2012). Traditional uses of bamboos among the Karbis, a hill tribe of India. *The Journal of the American Bamboo Society*, 25(1), 1-8.

[69]Singha, K. N., & Timung, L. (2015). Significance of Bamboo in Karbi Culture: A Case Study among the Karbi Tribes of Assam (India). *International Journal of Advanced Research in Biology and Biotechnology*, 1(1), 1-9.
[70]Sarkar, J., & Sundriyal, R. C. (2002). Op.cit. p. 61.
[71]Lalhruaitluanga, H., & Prasad, M. N. V. (2009). Traditional Uses, Economic Importance and Ecological Services of MeloccanabacciferaRoxb. in Mizoram, India. *Asian and Australasian Journal of Plant Science and Biotechnology*, 3(1), 1-6.

activities like commercial production of canned shoots, raw materials for paper industries, mat-ply, charcoal powder and kiln and modern handicrafts. Moreover, draw lights on the ecological functions such as soil and water conservation and soil erosion control.

A similar study on traditional uses of bamboo was conducted by Patel, A. B. (2005)[72] among the tribes of Gujarat. Bamboo has been used for several purposes like sitting mat, *Ghunghadi* (hat), *khapeto* (partition wall), house roofing, fencing, cart caging, *poharu/kabala* (grain storage), measuring unit, *dalu* (cage), protective basket, *kolaju* (protection to egg), *mali and sato* (fishing tools), hunting instruments, staircase to collect palm tree, musical instruments, traditional medicine, marriage pandal and food. It also played an important role in the social life of the tribal people.

Honfo, H et al., (2015)[73] assessed the traditional knowledge (TK), use and economical values of three bamboo species — *Oxytenantheraabyssinica (A.Rich.) Munro*, *Bambusa vulgaris Schrad. ex J.C.Wendl*., and *Dendrocalamusasper* (Schult. & Schult. f.) *Backer exK.Heyne* in south-eastern Benin. They found that age, gender, and socio-cultural groups were significant predictors of TK and plant ethno botanical use value and bigger bamboo species were more expensive in the market. Bamboo was used for 44 purposes, but the use of bamboo shoots was not reported. Men and older people had more knowledge and valued bamboo more than women and younger people, respectively, indicating that they are important stakeholders in conservation efforts. The culm was the most commonly collected portion of bamboo plant, and its price was dependent on location and size.

[72]Patel, A. B. (2005). Traditional bamboo uses by the tribes of Gujarat. *Indian Journal of Traditional Knowledge*, 4(2), 179-184.
[73]Honfo, H., Tovissodé, F. C., Gnanglè, C., Mensah, S., Salako, V. K., Assogbadjo, A. E., Agbangla, C & Kakaï, R. G. (2015). Traditional knowledge and use value of bamboo in southeastern Benin: implications for sustainable management. *Ethnobotany Research and Applications*, 14, 139-153.

2.6. STUDIES RELATED TO COST AND RETURN

Besides the use of conventional economic analysis, discounted cash flow technique was used in analyzing the economics of bamboo and other plantations.

Abraham, B. (2017)[74] attempted to examine the economic viability of bamboo farming by estimating the cost and income generating capacity of bamboo cultivation. He found that bamboo cultivation is highly economical in nature and yield consistent output, thereby ensuring sustained income to the farmers. Since the plant has self-regenerating capacity, they continue to yield output for a long duration of time if the harvesting is carried out properly. The loss of crop due to heavy rain and drought were very limited as they can sustain even the extreme climatic condition. They also can safeguard against land slide, soil erosion and other environmental damages thereby ensuring protection against natural calamities. He suggested that bamboo resource can promote sustainable farming, protect environment, provide income and thus intervention from the policy makers is needed to promote bamboo cultivation.

Pande, V. C, et al. (2012)[75]carried out economic analysis using data from three major ravine systems, viz. Mahi, Chambal and Yamuna to examine economic viability of bamboo plantation under different soil conditions. The analysis suggested a cash outflow to individual stakeholders in the region ranging from ₹30,550/ha to ₹48,000/ha from the 7th year onwards, in addition to the benefits accrued to society in terms of nutrient value saved through soil conservation (`2125 – 5555/ha) and incremental soil carbon build-up (`41,000/ha) with the recommended practise of harvesting one-third old culms per clump over the life of plantation. According to the report, large set up cost can be addresses by providing financial incentives

[74]Abraham, B. (2017). Op. cit. p. 39

[75]Pande, V. C., Kurothe, R. S., Rao, B. K., Kumar, G., Parandiyal, A. K., Singh, A. K., & Kumar, A. (2012). Economic analysis of bamboo plantation in three major ravine systems of India. *Agricultural Economics Research Review*, 25(1), 49-59.

to the a group or village community on a collective basis, and such policy instruments can be combined with land-based programmes run by central and state governments, such as MGNREGA or similar schemes. Large-scale bamboo plantations might be carried out with the help of such plans, and the remaining plantation cost could be covered by the group/village community in exchange for environmental services provided by the spatial bamboo ecosystems. Bamboo cultivation was recommended in the study as productive and protective use of degraded lands.

Magati, W. O et al., (2012)[76] investigated the economic, financial benefits and costs of producing bamboo as a crop substitute for tobacco in four districts in South Nyanza, Kenya. Results showed that bamboo cultivation is more financially and economically beneficial than tobacco farming because the incremental benefits are positive. A sensitivity revealed that the sign of the net incremental benefit did not change. According to the findings, the Net Present Value for tobacco farmers will be KShs 155,444.51 and KShs 663,272.10 for bamboo farmers at the end of the project. They recommended that bamboo cultivation, if well managed can achieve the goal of providing an alternative source of income to tobacco farming.

Krishnankutty, C. N. (2004)[77] carried out a survey in Kerela of home gardens in two different agro-climatic zones to compare the profitability of bamboo to seasonal-annual crops, perennial crops, and tree crops. Benefit–cost analysis showed that bamboo ranks at least second in terms of profitability among the crop grouping in home gardens in the two zones. The high benefit–cost ratio of bamboo was due to low inputs and high farm price for bamboo. Bamboo growing in home gardens profitable due to the presence of an organised

[76]Magati, W. O. P. O., Kibwage, J. K., Omondi, S. G., & Ruigu, G. (2012). A cost-benefit analysis of substituting bamboo for tobacco: a case study of smallholder tobacco farmers in South Nyanza, Kenya. *Science Journal of Agricultural Research & Management*, 2012(2), 1-8.

[77]Krishnankutty, C. N. (2004). Benefit-cost analysis of bamboo in comparison with other crops in mixed cropping home gardens in Kerala State, India. *Journal of Bamboo and Rattan*, 3(2), 99-106.

wholesale market near the study area and the effectiveness of the bamboo depots make. The study does not recommend increasing bamboo farming at the expense of other crops. It highlighted that bamboo is beneficial in home gardens in villages along with market benefits.

Adejoba, O. R., et al., (2016) [78] assessed the technological and economical values of bamboo in order to assess its potential for furniture manufacture and job creation. The rate of returns and Cost Benefit ratio of bamboo furniture such as beds and tables were investigated to assess the economic worth of the production and the impact bending which determines its strength to resist sudden load was also evaluated along the height to establish the fitness and appropriateness of the laminated bamboo for production of furniture. The Rate of Returns (RORI) of bamboo furniture was above 60% and Cost Benefit Ratio was higher than 1. The mean Impact Bending for laminated bamboo was 0.76±0.17m; it ranges from 0.79±0.18m, 0.77±0.19m, 0.75±0.13m and 0.74±0.16m for the base, 25%, 50% and Top of the total height of the bamboo culms respectively

The cost benefit analysis has been used in economic analysis of agricultural crops, fruits etc. It is found that Das, A., et al., (2010) [79] analysed the cost of cultivation, return and cost-benefit ratio through cutting and tissue culture propagated planting material to determine the economic viability and technical feasibility of stevia cultivation with an experimental plot size of 100x100m each for 3 years. Although, the costs were higher in tissue culture plantlets propagated field, the total sales of dry stevia leaves has generated more income in tissue cultured propagate established fields than cutting propagated field. From the cost benefit ratio of the two projects, it was evident that profits of the two ventures were comparable with each other and both were technically feasible and economically viable.

[78]Adejoba, O. R., Ojo, A. R., Owoeye, A. Y., & Adesope, A. S. (2016). Techno-Economic Analyses of Bamboo Furniture Production in Nigeria. *International Journal of Novel Research in Interdisciplinary Studies*, 3(3), 1-7.
[79]Das, A., Biswas, M., & Mandal, N. (2010). An economic analysis of Stevia (Stevia rebaudiana Bert.) cultivation through stem cutting and tissue culture propagate in India. *Trends in Agricultural Economics*, 3(4), 216-222.

Kshirsagar, P.J. et al., (2001)[80] analyzed the cost of cultivation and establishment cost of kokum plantation at RFRS Vengurle, wherein the total establishment cost has declined from first to third year (₹20,780 to ₹12,441), but rose from fourth year onwards but remain lower than the first year. Thus the study concluded that, over period of time the expenditure for establishment of kokum was reduced.

Beshir, B., & Nishikawa, Y. (2012)[81] examined the Cost-Benefit of Small-Scale Onion and Tomato Farming in Melkassa area, using Net returns. Similarly, sensitivity analysis was implemented to account for any significant changes or dangers that might occur. They found that small-scale vegetable farming was a profitable enterprise and the local average yield was well above the national average yield. Onion returns were more sensitive to yield variation, with a 5-10% increase in marginal yield compensating for price changes of up to 50% below regular season prices. The onion yielded a higher net revenue, and both crops had excellent the profit margins. Onion production was more labour intensive and thus leading to high potential for consistently supporting farm household and rural labour while tomato production tends to be chemical intensive. They suggested that onion and tomato production can be sustained using open pollinated varieties and improved management approaches rather than rushing to use high yielding and imported inputs like hybrid seeds.

Several studies have applied Cost benefit analyses while analysing the economic viability of fruits cultivation. Balamurugan. V et al., (2017)[82] analysed the Cost and Return and profitability in Grape Cultivation in Theni district, Tamil Nadu. It showed that the net profit ratio was 32.62 per cent of total amount in statement of income. They concluded that

[80]Kshirsagar, P.J., Waghmore, G.M., Patil, B.P. & Dalvi, M.B. (2001).Economics of Establishing Kokum Plantation. Proceeding of First National Seminar on Kokum, 12-13 May 2001.46-50.
[81]Beshir, B., & Nishikawa, Y. (2012). Cost-Benefit Analysis of Small-Scale Onion and Tomato Farming in Melkassa Area. *Tropical Agriculture and Development*, 56(4), 143-150.
[82]Balamurugan,V., Mariammal, M,. & Rubini, M. (2017). Cost and benefit of investment in grape cultivation – a case study. *International Journal of Business and Administration Research Review*, 3(17), 70-74.

the Grape Cultivation was financially viable and profitable. Gangwar, L.S et al., (2008)[83] analyzed the economic evaluation of Peach cultivation in North Indian plains. Under the present value summation method, they found that the Net Present Value (NPV) was ₹44807, the Benefit Cost Ratio (BCR) was 1.41 and Internal Rate of Return (IRR) was 22.20. Under the amortization method also the Net Present Value (NPV) worked out to be ₹ 42877 and Benefit Cost (BC) ratio was 1.28. They concluded that Peach cultivation in Punjab and Uttarakhand was a profitable venture. Naik, M. J. (2002)[84] studied the economic feasibility of mango plantation for near sea shore orchards (Group A) and away from sea shore orchards (Group B) in South Konkan of Maharashtra. He worked the Net present value (NPV) in Group A and Group B at 8,10 and 12 per cent discount rates and found the NPV was ₹ 2,52,770, ₹1,50,270 and ₹ 86,400 respectively in group A and ₹ 156020, ₹ 85580 and ₹ 41740 respectively in group B. Further, the payback period (PBP) was 14, 15 and 16 years in Group – A and 15, 17 and 19 years in Group–B for the respective discounting rates. However, it was observed that without discounting the payback period in for the both groups to be 12 years. This indicated that the project required 12 years period for recumbent of investment. The value of IRR was 17.97 per cent in Group-A and 15.38 per cent in Group-B which was greater than prevailing rate of interest (13%) on borrowings in both the groups. The study show that Group A orchard had better comparative advantage as compared with Group B orchards performance.

Bastine, L.C & Radhakrishnan, V (1998)[85] conducted a study on the Economic of Plantain Cultivation in Irinyalakkuda Block of Trichur District of Kerala and found that the cost of cultivation of plantains per hectare was ₹ 36,249. The return per hectare worked out to

[83]Gangwar, L. S., Singh, D., & Mandal, G. (2008). Economic evaluation of peach cultivation in North Indian plains. *Agricultural Economics Research Review*, 21(347-2016-16818), 123-129.
[84]Naik, M.J. (2002). Economic Feasibility of Mango Plantation in South Konkan of Maharashtra, *Indian Journal of Agricultural Marketing*, 10(2), 166-174.

[85]Bastine, L. C. & Radhakrishnan. V. (1998). Economics of Banana Cultivation in Irinjakkuda Block and Trissur District of Kerala. *Indian Journal Agricultural Economics*, 43(3), 514.

be ₹45,068 and the net income as ₹8,819. The contribution of family labour was about 30 to 50 per cent of the total expenditure of the labour cost. It also showed that the contribution of family labour decreased as the size of the holding increased. Sharma, G.D & Pandey, H.K (1972)[86] studied the costs and return of Gava cultivation in Utter Pradesh. The net returns from inter crops during the three year period was estimated to ₹6289.50 per hectare. It was found that the Gava orchard generated net return of ₹ 6,500 per hectare. Patil, S.J (1975)[87] conducted a study on economics of pomegranate cultivation in Ahmednagar district of Maharashtra. The per hectare total cost of pomegranate production worked out to ₹ 8562.37, ₹ 8350.00 and ₹ 8477.40 on small, medium and large sized farms respectively. The net profit was ₹3511.40, ₹ 2262.36 and ₹ 1988.51 per hectare respectively.

2.7. LITERATURE ON GARRET RANKING METHOD

A brief review of literature on the application of Garret ranking method indicates that this method has been conveniently used in analyzing problems in various sectors of the economy.

Mukherjee, A et al., (2012)[88] conducted a study on organizational and functional constraints in privatized agricultural technology delivery system of Tata Kisan Sansar in Aligarh district. The study found that job security of field workers and the lack of co-operation among workers were the major constraints. They suggested for reorganizing the workers by reducing the field workers and employing more of agricultural graduates, conduct appropriate training to remove organizational constraints. To remove functional constraints,

[86]Sharma, G.D & Pandey, H.K. (1972). Economics of Gava production and marketing: A case study, *Indian Horticulture*, 17(1), 5-6.
[87]Patil, S. J. (1975). *The Economics of Pomegranate Cultivation in Rahuri Region of Ahmednagar District (Maharashtra)* (Doctoral dissertation, Mahatma PhuleKrishiVidyapeeth, Rahuri.).

[88]Mukherjee, A., Bahal, R., Burman, R. R., Dubey, S. K., & Jha, G. K. (2012). Constraints in privatized agricultural technology delivery system of Tata Kisan Sansar. *J. Glob. Commun*, 5(2), 155-159.

collaboration with other agencies, reduce price of products and allocating more budget for demonstration and fieldwork were suggested.

Using the same method, Murugan, V. B. (2016)[89] made an empirical study to identify problems faced by growers and marketers of lemon in Dindigul district. High cost of inputs was the major problem faced by the growers, while price fluctuation was the main problem faced in marketing. Another similar study made by Mali, B.K et al., (2003)[90] for banana grower in Jalgoan district and found that high cost of transportation, non-availability of credit, and high price fluctuation were the major constraints. To improve the performance and efficiency they suggested for proper price regulation, marketing policies and adequate institutional credit.

Amarnath, J. S., & Brindha, M. (2017)[91] made a comparative analysis of sustainability in crop and diary production in Tamil Nadu, where they studied constraints faced by farmers of turmeric, sugarcane and dairy farmers. For both turmeric and sugarcane farmers, non-availability of labour (with mean score of 62.42 and 64.44, respectively) was ranked the major problem. Garret ranking by the dairy farmers revealed that lack of grazing land was the major constraint. The study suggested introduction of labour saving machinery to help in solving non-availability of labour in turmeric and sugarcane productions, which will lead to sustainable agricultural development.

[89]Murugan, V. B. (2016). An empirical study on prospects in production and marketing of lemon in Theni with special reference to India. *Refereed Monthly Journal*, 1(1), 5-8.
[90]Mali, B. K., Bhosale, S. S., Shendage, P. M., & Kale, P. V. (2003). Economics of production and marketing of banana in Jalgaon district of Western Maharashtra. *Indian journal of agriculture marketing*, 17, 173-181.
[91]Amarnath, J. S., & Brindha, M. (2017). A comparative analysis of sustainability in crop and dairy production system in Tamil Nadu, India. *Bangladesh Journal of Agricultural Economics*, 36(454-2017-713), 35-51.

Christy, R. J. (2014)[92] carried out a study in Villupuram District of Tamil Nadu on constraints of clinical bovine mastitis control. High treatment costs was found to be the major constraint with mean score of 73.13, followed by shortage of labour with 67.41 and difficulty in diagnosis with 62.20. The study suggested to undertake awareness programmes through mass media, training programmes on livestock rearing and disease control and organize intensive veterinary camp to help the farmers.

Thulasiram, R., & Alagumani, T. (2018)[93] conducted a study to identify the constraints faced by the farmers and exporters of fruits and vegetables. Garrett ranking technique results revealed that the major constraints for farmers were inability to meet the quality requirements for export, poor storage and transport facilities. The poor infrastructure facilities and lack of standardization on postharvest handling were the major problems faced by the exporters. They concluded that there is high potential for exporting fresh fruits and vegetables and export targets in the future are achievable provided a concerted effort is made on production and quality aspects.

The garret ranking method is conveniently use for the studies of problems in industrial sector too. Aleeswari, A., Merline, W. L., & Martin, N. (2019)[94] carried out a study on industrial problems in India using garret ranking method. The study shows that lack of self-reliance (67.91), financial constraint (62.20) and human resource mismanagement (59.11) were major problems. The result will help in assisting policy makers and authorities in framing and formulating measures to solve the problems in the sector. Similarly, Jins Joy,

[92]Christy, R. J. (2014). Garrett's ranking analysis of various clinical bovine mastitis control constraints in Villupuram District of Tamil Nadu. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 7(4), 62-64.
[93]Thulasiram, R., &Alagumani, T. (2018). Status and constraints in fruits and vegetables export: a Garrett ranking approach. *International Journal of Farm Sciences*, 8(3), 13-16.
[94]Aleeswari, A., Merline, W. L., & Martin, N. (2019). Study on Industrial Problems using Garrett Ranking Technique. *BULMIM Journal of Management and Research*, 4(1), 1-5.

P., & Radhakrishnan, R. (2013)[95] tried to identify the causes of work stress among tile factory workers in Kannur district using garret ranking method and Mann-Whitney test and found that among the male workers financial problem/low wages was ranked 1st with a mean score of 55.96. Poor physical environment with a mean score of 53.5 was ranked 2nd which was followed by dual career (52.84), threat to job security (51) and social physical isolation(49.66) as 3rd, 4th and 5th rank. Among the female workers, the major cause of work stress was dual career with 55.46 as rank 1st, followed by financial problem/ low wages (53.6), personal/family problems (53.44), social/ physical isolation(52,88) and poor physical environment as 2nd, 3rd, 4th, and 5th rank. As per Mann-Whitney test, null hypothesis that there is no significant difference between the rankings of male and females tile factory workers for the factors causing stress at work was accepted as the p value was > 0.05 level of significance. The study suggested introduction of Employee Assistance Programme, opportunities for social interaction and actions to reduce work space.

Pandiammal, P et al., (2018)[96] highlighted the major problems faced by the IT employees. Result shows that time bound task takes up the first position with mean score of 65, which is followed by changing requirements of the client with mean score of 58.30 and third rank was assign to psychological fatigue with mean score of 54.18. The employees were made highly constrained, and forced to complete the assigned tasks within the specified time.

[95]Jins Joy, P., & Radhakrishnan, R. (2013). A study on causes of work stress among tile factory workers in Kannur District in Kerala. International Journal of Scientific and Research Publication, 3(9), 1-10.

[96]Pandiammal, P., Martin, N., & Mohanaraj, D. (2018). Ranking the problems of IT employees using Garrett technique. *LITERARY FINDINGS, International Journal 0f Multidisciplinary Research*, 6(11), 38-42.

2.8. CONCLUSION

The review of the previous literatures show that studies on socio-economic benefits of bamboo, its resources, cost and benefits and problems faced by the farmers were analyzed. Some studies focused bamboo as forestry resource and its various uses and some others explored the trade, opportunities and constraints of bamboo sectors. However, it is found that no systematic studies on economic aspect of bamboo in Nagaland was undertaken comprehensively. This research gap has motivated the researcher to undertake a study on economic analyses of bamboo production in Dimapur and Mokokchung districts, Nagaland.

CHAPTER 3

PROFILE OF STUDY AREA AND BAMBOO FARMERS

3.1. INTRODUCTION

Information of the socio-economic profile of the study area contribute in proper understanding of the region. This chapter is organized in brief to highlight the basic information about the State, the sample districts and the general characteristics of respondents in the sample survey.

3.1.1. Geography

Nagaland, the 16th State of India was established in the year 1st December, 1963. It has an area of 16,579 Sq. km located between 25°6´N-27°4´N latitude and between 93°20´E-95°15´E longitudes. Topographically, the State is mountainous and the altitude varies between 194 to 3,048 meters above the sea level. It is bordered by the state of Assam in the west, Arunachal Pradesh in the north, Manipur in the south and it shares international border with Myanmar in the east. Nagaland mostly enjoys monsoon climate with relatively high humidity. Average annual rainfall varies between 1,800 to 2,500 mm, concentrated in the months of May to September. Temperatures range from 21°C to 40 °C, which drops to below 4°C during winter.

The State has twelve districts, viz., Kohima, Phek, Mokokchung, Wokha, Zunheboto, Tuengsang, Mon, Dimapur, Peren, Kiphire, Longleng and Noklak. Kohima city is the State capital. There are 16 major Naga tribes, of which Konyak, Angami, Ao, Lotha, and the Sumi are the largest tribes. Every tribe has its own mother tongue, whereas '*Nagamese*' is used as a common dialect to communicate across the tribes and the official language is English.

3.1.2. Demography

Demographic features of Nagaland as per Primary Census Abstract (PCA)[1], 2011 is shown in table 3.1. The total population of Nagaland is recorded about 19, 78,502 people, of which, 51.8 per cent are male and 48.2 per cent are female. The sex ratio was 931 female per 1000 male, and the density of population was just about 119 per sq. km. The State literacy rate is 79.6 per cent, whereby, males (82.8%) are more literate than the females (76.1%). Total work participation rate was 49.2 per cent, which is comparatively higher than the national average (39.1%). A higher proportion of working population was cultivators (55.2%), followed by other workers (36%). Agricultural labours constituted only 6.5 per cent and household industrial workers were only 2.3%. This indicates that the economy of Nagaland is still agrarian in nature, where 61.7 per cent of its work forces are engaged.

Table 3.1. Demographic features of Nagaland

Particulars	**Nagaland**
Total population	19,78,502
• **Male**	10,24,649 (51.8)
• **Female**	953,853 (48.2)
Literacy	13,42,438 (79.6)
• **Male**	723,957 (82.8)
• **Female**	618,477 (76.1)
Sex ratio (per '000 male)	931
Density of population (per sq km)	119
Total work participation rate	974,122 (49.2)
• **Cultivators**	537,702 (55.2)
• **Agricultural labours**	62,962 (6.5)
• **Household industries**	22,838 (2.3)
• **Other workers**	350,620 (36.0)
Note: Figures in parentheses indicate percentage *Source: Primary Census Abstract, Nagaland 2011*	

[1]Census of India, 2011 Primary Census Abstract, Nagaland.

3.1.3. Economy

The economy of Nagaland state as indicated by Gross State Domestic Product (GSDP) and the sector wise Gross State Value Added (GSVA) during the last decade is presented in this section.

Table 3.2. GSDP at current and market prices (₹ in crores), and percentage contribution of sectors to GSVA at constant prices

Year	GSDP		GSVA (%)		
	Current	Constant	Primary	Secondary	Tertiary
2011-12	12177-	12177-	31.41	12.41	56.17
2012-13	14121(15.97)	12868(5.68)	31.35	12.07	56.58
2013-14	16612(17.64)	13793(7.19)	32.46	8.98	58.56
2014-15	18401(10.77)	14399(4.39)	32.21	9.62	58.16
2015-16	19524(6.10)	14660(1.82)	30.38	11.22	58.40
2016-17 (P)	21488(10.06)	15511(5.80)	29.76	11.54	58.70
2017-18 (Q.E)	24095(12.13)	16182(4.32)	29.38	12.23	58.38
2018-19 (A.E)	26637(10.55)	17147(5.97)	29.39	12.25	58.37

Note: P-Provisional, Q.E-Quick Estimates, A.E-Advance Estimates

Figures in parentheses indicate growth rate

Source: Nagaland Economic Survey, 2018-19[2]

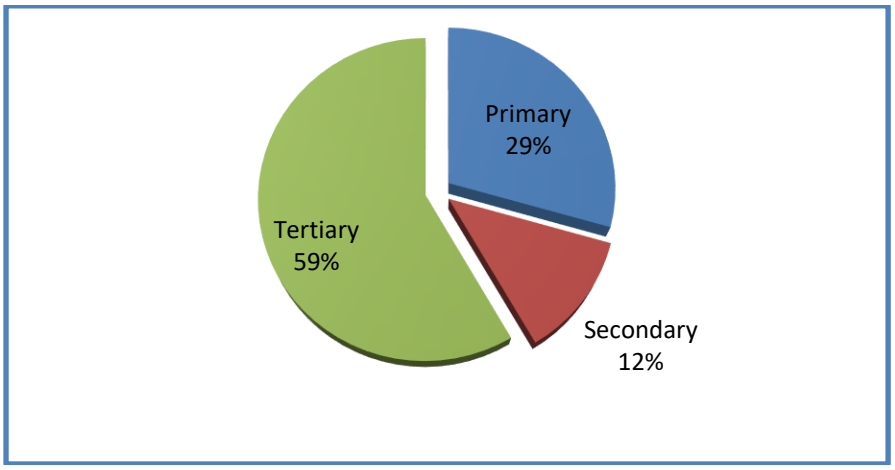
As seen from table 3.2, the GSDP at current prices is estimated to increase from ₹24,095 crores in 2017-18 to ₹.26, 637 crores in 2018-19, achieving a growth rate of 10.55 per cent. At constant price, the GSDP is estimated to increase from ₹16,182 crores to ₹17,147 crores, achieving a growth rate of 5.97 per cent. The percentage growth rates at both current and constant prices were observed lower during the period 2015-16.

The sector wise contribution to Gross State Value Added (GSVA) at constant prices, the share of primary sector is estimated to fall from 32.46 per cent in 2013-14 to 29.39 per

[2]Department of Economics and Statistics, Government of Nagaland. Economic survey 2018-19.

cent in 2018-19. The contribution of secondary sector has shown a marginal increase from 8.98 per cent to 12.25 per cent during the corresponding period, while the tertiary sector contributed more than 58 per cent in the GSVA, the highest to the State economy. Percentage contribution by various economic sectors at constant prices in 2018-19 (A.E) is indicated in Figure 3.a.

Figure 3.a. Percentage share of each sector to GSVA, 2018-19 (A.E)



Source: Table 3.2

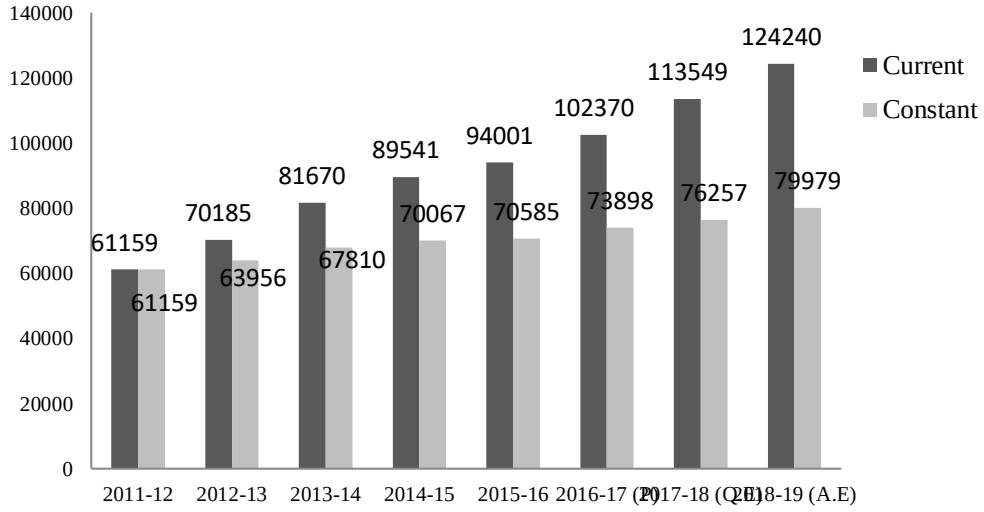
Table 3.3. Per Capita Income (PCI) of the State in Rupees

Year	Current	Constant
2011-12	61159	61159
2012-13	70185	63956
2013-14	81670	67810
2014-15	89541	70067
2015-16	94001	70585
2016-17 (P)	102370	73898
2017-18 (Q.E)	113549	76257
2018-19 (A.E)	124240	79979

Note: P-Provisional, Q.E-Quick Estimates, A.E-Advance Estimates
Source: Nagaland Economic Survey, 2018-19

Per capita income of the State at current and constant prices is shown in table 3.3. It is observed that the per capita income of the State was increased from ₹61, 159 in 2011-12 to ₹1,24,240 in 2018-19 as per the Actual Estimates. This showed a compound annual growth rate (CAGR) of 10.65 per cent from 2011-12 to 2018-19. Graphical representation of State PCI at current and constant prices is shown in Figure 3.b.

Figure 3.b. PCI at current and constant prices (in Rs.)



Source: Table 3.3

3.1.4. Forest Land Use

The status of forest area in the state is given in the table below:

Table 3.4. Forest status of Nagaland

Legal status	Forest Area (Sq.Kms.)	% of total Forest Area
a). Government owned Forests:		
1.Reserved Forests & Wildlife Sanctuaries	264.28	3.06%
2. Protected Forests	34.69	0.40%
3. Purchased Forests	192.47	2.24%
b). Government controlled (Private owned) Forests:		
4. Protected Forests	516.79	5.99%
c). Village Owned Forest:		
5. Virgin Forest	4778.27	55.37%
6. Degraded Forest	2842.80	32.93%
Total(a+b+c)	8629.30	100.0%
d). Ownership		
i) State Government	1008.23	11.70%
ii) Private/Community	7621.07	88.30%
Total	8629.30	100.00%

Source: Department of Environment, Forests & Climate Change, Government of Nagaland: Annual Administrative Report 2020-2021[3].

[3]Annual administrative report, 2020-21, Department of environment, forest and climate change, Nagaland.

The legal forest status of the state represents that government owned forest holds 5.7 per cent of the total forest land, government controlled forests holds 5.99 per cent and the largest portion of forest land is village owned which holds 88.4 per cent.

Nagaland follows a unique land ownership system where 88.30 per cent of the forest area is privately or community owned, while only 11.70 per cent is owned by the State government.

In total forest area, only 55.37 per cent comes under virgin forest, whereas 32.93 per cent is degraded forest.

Table 3.5. District-wise Forest Cover in Nagaland

District	**Geographical Area (GA)**	**2019 Assessment**				**% of GA**	**Change wrt 2017 assessment**	**Scrub**
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Dimapur	927	24.00	161.71	406.38	592.09	63.87	3.09	9.23
Kiphire	1,130	151.72	277.80	405.06	834.58	73.86	-0.42	62.35
Kohima	1,463	131.70	377.68	673.28	1,182.66	80.84	-3.34	57.60
Longleng	562	0.00	125.45	246.95	372.40	66.26	-2.60	33.52
Mokokchung	1,615	1.89	501.89	823.83	1,327.61	82.20	5.61	22.08
Mon	1,786	32.00	431.32	739.50	1202.82	67.35	-4.18	127.00
Peren	1,651	136.06	644.46	634.30	1414.82	85.69	-23.18	76.66
Phek	2,026	272.61	637.83	705.37	1,615.81	79.75	-8.19	85.34
Tuensang*	2,536	438.57	547.10	713.99	1699.66	67.02	26.66	92.35
Wokha	1,628	1.00	465.13	839.68	1305.81	80.21	-0.19	10.47
Zunheboto	1,255	83.64	363.35	491.15	938.14	74.75	4.14	58.89
Nagaland	**16,579**	**1,273.19**	**4,533.72**	**6,679.49**	**12,486.40**	**75.31**	**-2.60**	**635.49**

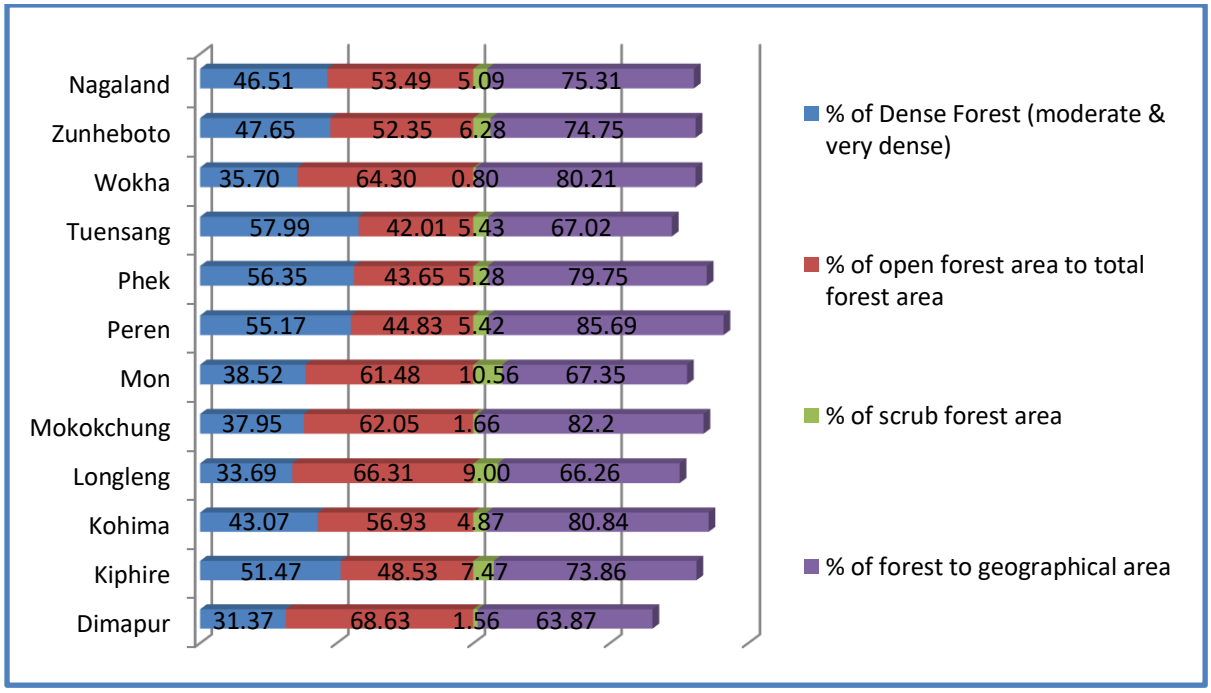
Source: Department of Environment, Forests & Climate Change, Government of Nagaland: Annual Administrative Report 2020-2021.

(* *Noklak district was created on 21st December, 2017 as the 12th district of Nagaland, which has been carved out of Tuensang district. However, secondary data for the district separatelyis not available.Thus the data given for Tuensang represent both Tuensang and Noklak districts).*

The table 3.5 shows that Peren district has the highest percentage of forest area (85.69 %) to geographical area, which is followed by Mokokchung district with 82.20 per cent and Kohima district with 80.84 per cent. The comparison with 2017 assessment it showed that there is a loss of 2.60 Sq.km of forest cover area. On the other hand, Dimapur district has the smallest proportion with 63.87 per cent of its geographical area under forest cover.

The data further reveals that except for four districts viz., Dimapur, Mokokchung, Tuensang and Zunheboto, all other seven districts have shown declined in their percentage of forest area.

Figure 3.c.District-wise Percentage in Total Forest Cover Area in Nagaland, 2020



Source: Department of Environment, Forests & Climate Change, Government of Nagaland: Annual Administrative Report 2020-21.

Figure 3.c shows that for most of the districts, the proportion of open forest area is larger than that of dense forest area in Nagaland. Among the sample districts, Dimapur has the largest proportion (68.63 %) and Mokokchung with 62.05 %, both are under the category.

Whereas, Tuensang district has the largest proportion of dense forest cover with 57.99%, follows Phek with 56.35% and Peren with 55.17%. The data reveals that more than 40 % of the forest area is under open and scrub forest area for all the districts and for the State as a whole, which area has the potential to bring under bamboo plantation for commercial purpose in Nagaland.

3.1.5. Bamboo Bearing Areas and Bamboo Species

Table 3.6 and table 3.7 show the bamboo bearing areas in the state and common species of bamboo found in Nagaland. The detail list of the same is indicated in the annexure 3.1 of this chapter, indicating 43 known species and their uses in the State.

Table 3.6. Bamboo bearing areas in the State

Sl.No.	DISTRICT	BAMBOO BEARING AREAS (Block)
1.	Mokokchung	(a) Japu- Changdang- Lirmen (b)Changtongya-Asangma-MerangkongYimchenkimong (c) Molungyimsen (d) Kangtsung-Wamaken
2.	Wokha	(a) Bhandari- Merapani (b) Yamparasa
3.	Longleng	(a) Namsang
4.	Mon	(a) Jaboka (b) Lapa- Wangla (c) Naginimora- Hodohadi
5.	Dimapur	(a) Seithekiema- Chumukedima (b) Razaphiema- New Chumukedima

		(c) Nieuland- Khuboto
6.	Peren	(a) Ntu- Tening (b) Ngwalwa- Heningkunglwa- Jalukie (c) Besumpui-Khelma
Source: Department of Environment, Forests & Climate Change, Government of Nagaland: Annual Administrative Report 2014-2015[4].		

Table 3.7. Some common species of bamboo and their uses in Nagaland

Sl. No	**Species**	**Uses**
1	*Bambusatulda*	Construction, industrial use, handicraft, shoot, pulp
2	*Bambusabalcooa*	Construction, pulp, implement, fodder
3	*Dendrocalamushamiltonii*	Handicraft, shoot
4	*Dendrocalamusgiganteus*	Construction, shoot
5	*Dendrocalamuslatiflorus*	Construction, shoot
6	*Schyzostachyumdullooa*	Weaving, mat making, shoot
Source: Nagaland Bamboo Development Agency (NBDA), 2015[5] **Detail account of the Bamboo Species and their uses are given in annexure 3.1 of the chapter).*		

3.2. BASIC INFORMATION OF SAMPLE DISTRICTS (DIMAPUR AND MOKOKCHUNG)

3.2.1. Dimapur was initially a part of Kohima district, which was bifurcated in December 1997 and inaugurated as the 8th district of Nagaland in April 1998. It is situated in the Southwest of Nagaland and surrounded by Assam in the North and west, Kohima district in the East and Peren district in the south. Dimapur district extends between 25°48´N-26°00´N

[4]Annual administrative report, 2014-15, Department of environment, forest and climate change, Nagaland.

[5]Nagaland Bamboo Development Agency. (2015). The decadal issue, 10 years of resource and enterprise development in Bamboo. *Infomag*, 19.

latitude and between 93°30´E-93°54´E longitudes. The district is spread over an area of 927sq km. The topography of the district is largely of plains and valleys, located at an altitude of 260 m. and receives about 1504.7 mm average rainfall annually.

As per Census report of 2011, the total population of Dimapur district is recorded about 3,78,811, of which 52.11 per cent are male and 47.89 per cent are females. The sex ratio was 919 female per 1000 male. The district has the highest density of population in the state with 409 per sq km. The district literacy rate is 84.79 per cent, where male literacy rate is 87.54 per cent and female is 81.77 per cent. Total work participation rate was 39.95 per cent which is comparatively lower than the State average.

3.2.2. Mokokchung district was instituted into the Naga Hills District of Assam under the then British rule as a sub-division on 28th February, 1890. After the independence, it was upgraded to a fully-fledged district on 1st December, 1957. It is situated in the Northern part of Nagaland. It is surrounded by Tuensang district in the north, Zunheboto district in the south, Wokha district in the southwest and shares the state boundary with Jorhat district of Assam in the northwest. The Mokokchung district extends between 26°10´N-26°45´N latitude and between 94°15´E-94°45´E longitudes. The district is spread over an area of 1615 sq km. Mokokchung town is the district's headquarter, located at an altitude of 1352 m. and it receives about 250 cm average annual rainfall.

The total population of Mokokchung district is recorded about 1,94,622 according to census report (2011), of which, 51.94 per cent are male and 48.06 per cent are females. The sex ratio was 925 female per 1000 male, and the density of population was 121 per sq km. The district literacy rate is 91.62 per cent, where male literacy rate is higher (92.18 per cent) than that of female (91.01 per cent). Total work participation rate was 51.42 per cent which is comparatively higher than the State average.

3.3. SOCIO ECONOMIC PROFILE OF THE RESPONDENTS

The socio-economic profile of the respondents (bamboo cultivators) in the sample survey is discussed in this section. The sample data indicates general characteristics like gender, age, marital status, educational level, and years of experience in bamboo cultivation, family size, main source and level of income, basic amenity of household, cultivated area etc., as these factors have implications on the further analyses in the study.

3.3.1. Age-wise Distribution

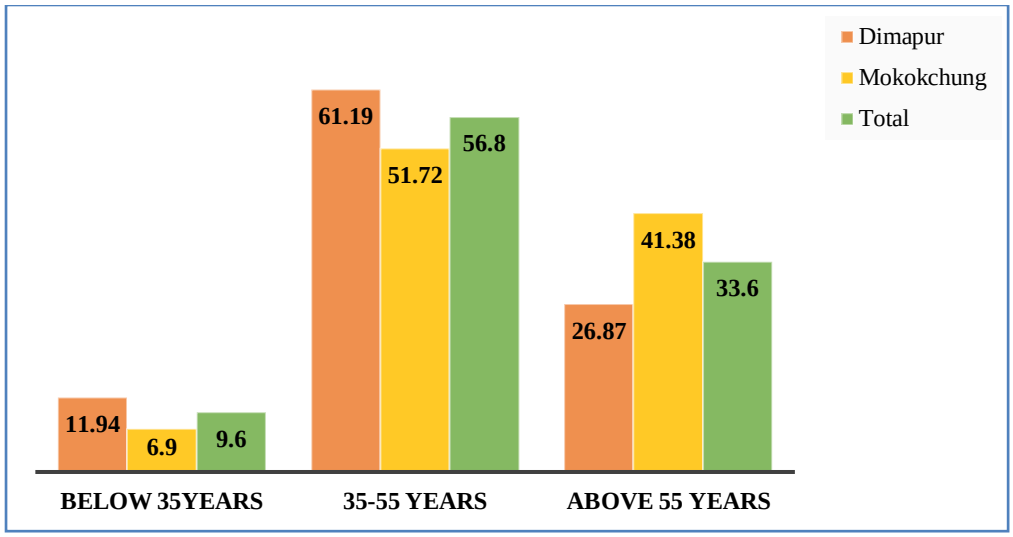
Age is an important parameter to study the influence of socio-economic characteristics of the farmers in order to get a microscopic view of the cultivation patterns and strategy one applies for. The respondents in the present study is categorised as 'below 35 years' as younger age group, '35 - 55 years' as middle aged and 'above 55 years' as elders. The distribution of respondents on the basis of their age is presented in Table 3.8.

Table 3.8. Distribution of Respondents by Age

District	Dimapur		Mokokchung		Total	
Age group	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Below 35years	16	11.94	8	6.90	24	9.6
35-55 years	82	61.19	60	51.72	142	56.8
Above 55 years	36	26.87	48	41.38	84	33.6
Total	134	100	116	100	250	100

Source: Field survey, 2017-2018.

Figure 3.d. Age composition of the respondents (in percentage)



Source: Table 3.8

The data in table 3.8 shows that the largest proportion of respondents was at the middle age group of 35-55 years (with 56.8 per cent). This was followed by the age group of above 55 years (33.6 per cent) and the least was the younger age group of below 35 years that constituted 9.6 per cent of the total respondents.

The age distribution in the sample districts shows similar distribution from that of the average, where majority of the bamboo farmers belong to the middle age group, followed by elders and the least was of younger age group.

Farmer age has often been reported to have a negative relationship with the awareness and adoption of new technologies (Ryan & Gross 1950[6]; Prokopy et al. 2008)[7]. Only 9 per cent of the respondents have attended training in the age group of above 55. It is believed that

[6] Ryan, B., & Gross, N. (1950). Acceptance and diffusion of hybrid corn seed in two Iowa communities. *Iowa Agriculture and Home Economics Experiment Station Research Bulletin*, 29(372), 1.

[7]Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of soil and water conservation*, 63(5), 300-311. doi: 10.2489/jswc.63.5.00.

this relationship is due to a reduced planning horizon, diminished incentives to change and less exposure to new technologies among very older farmers (Tey & Brindal 2012)[8].

3.3.2. Gender

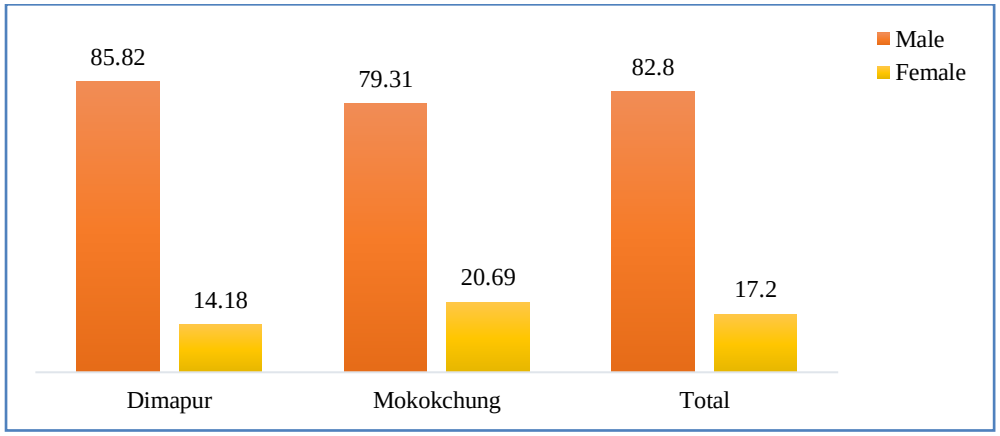
The classification of bamboo cultivators by gender draws light on the gender-based participation in bamboo cultivation. The distribution of sample respondents by gender is given in table 3.9.

Table 3.9.Distribution of Respondents by Gender

District	Dimapur		Mokokchung		Total	
Gender	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Male	115	85.82	92	79.31	207	82.8
Female	19	14.18	24	20.69	43	17.2
Total	134	100	116	100	250	100

Source: Field survey, 2017-2018.

Figure 3.e. Distribution of Respondents by Gender (in %)



Source: Table 3.9

[8]Tey Y.S, & Brinjal, M (2012). Factors influencing the adoption of precision agricultural technologies: a review for policy implications. *Precision Agriculture*, 13, 713-730. doi: 10.1007/s1119-012-0273-6 6

Table 3.9 shows that the bamboo cultivators are overwhelmingly of male, constituting 82.8 per cent of the total respondents and the remaining 17. 2 per cent respondents are female. One reason is that the *Nagas* being a patriarchal society, so most of the respondents were male who represented the family. Moreover, landed property belong to male in the society, consequently female generally lacks land and other resources of their own to undertake such long-term investment as plantation of bamboo.

The situation is almost same in both the sample districts of Dimapur and Mokokchung as shown in the figure 3.e.

3.3.3. Education

Education is not limited to being able to read and write but it makes a person enable enough to differentiate between right and wrong and more so, to take judicious decisions especially under critical situations. Education raises agricultural productivity by improvement in farmer's skills, enhancement of farmer's ability to obtain, understand and utilize new input and improvement in overall managerial ability. Moreover, technical efficiency is enhanced, which is the farmer's capability to make better choices in terms of input and make better economically rational decisions (Pudasaini, 1983)[9].

It is apparent that returns of education on agricultural productivity vary for different educational levels (primary, secondary and tertiary levels of education). It is also being realized that there are positive externalities from schooling in the form of higher agricultural productivity whereby other farmers benefit by adopting technology and practices used by one educated farmer (Appleton and Balihuta, 1996)[10]. Further, it is believed that formal education does not necessarily affect productivity but non-formal education does in the form of access

[9]Pudasaini, S. P (1983). The Effects of Education in Agriculture: Evidence from Nepal. *American Journal of Agricultural Economics*, 65 (3), 509-515.
[10] Appleton, S., & Balihuta, A. (1996). Education and Agricultural Productivity: Evidence from Uganda. *Journal of International Development*, 8 (3), 415-444.

to extension services, trainings and sharing of information from farmer to farmer which has a greater influence in the adoption of and practice of best technology (Weir, 1999[11]; Appleton and Balihuta, 1996)[12].

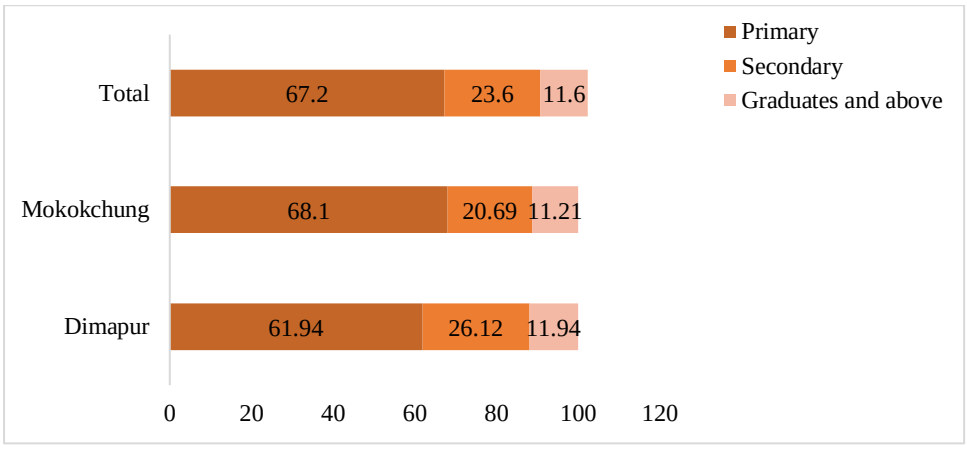
The respondents in the survey, on the basis of their educational levels, have been classified into three groups namely, primary level, secondary level and graduates and above. The educational levels of the sample farmers have been highlighted in the Table 3.10, which indicates the levels of educational qualification of the respondents.

Table 3.10.Educational profile

District	Dimapur		Mokokchung		Total	
Educational Level	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Primary	83	61.94	79	68.10	162	67.2
Secondary	35	26.12	24	20.69	59	23.6
Graduates and above	16	11.94	13	11.21	29	11.6
Total	134	100	116	100	250	100

Source: Field survey, 2017-2018.

Figure 3.f. Education attainment of the Respondents (in %)



Source: Table 3.10

[11] Weir, S. (1999). The Effects of Education on Farmer Productivity in Rural Ethiopia. Oxford: Centre for the Study of African Economies, Department of Economics, University of Oxford; 12. See note 10.

The figures in table 3.10 show that majority of the respondents have completed only primary level of education that accounted 67.2 per cent. It is followed by secondary with 23.6 per cent. Only 11.6 per cent of the respondents came under the category of graduates and none were found above graduate and all were literate in the sample total.

Both the sample districts of Dimapur and Mokokchung pointed towards a similar scenario where majority of respondents were with primary level of education, followed by secondary level. Whereas, Graduates were very few and none were with postgraduate level of education. This fact indicates the limited capability amongst the respondents to adopt improved techniques of cultivation in the area.

3.3.4. Access to training

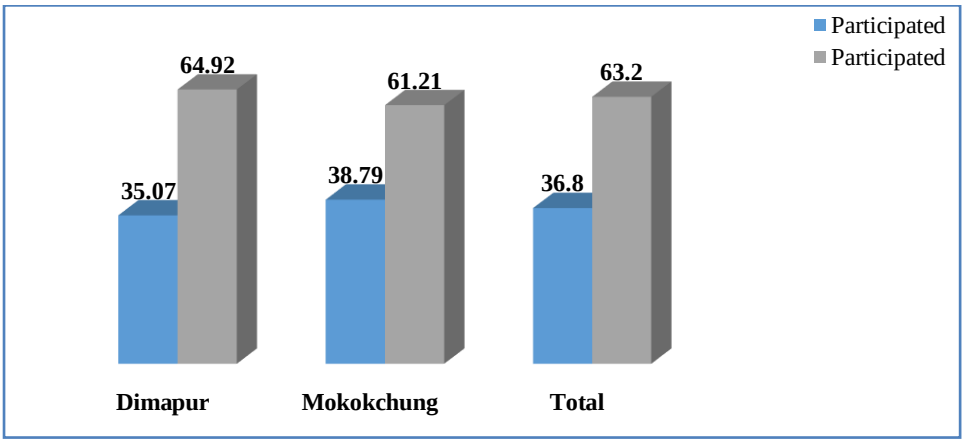
For most farmers, farming is a life-long activity. Therefore, there is a need for personal investment in trainings in order to know the preference of the consumer, to increase productivity, to make it sustainable and profitable.

Table 3.11. Participation in Training

Districts	**Dimapur**		**Mokokchung**		**Total**	
Participation in Training	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Participated	47	35.07	45	38.79	92	36.8
Not Participated	87	64.92	71	61.21	158	63.2
Total	134	100	116	100	250	100

Source: Field survey, 2017-2018.

Figure 3.g. Participation in trainings (in %)



Source: Table 3.11

Result from the table shows that 63.2 per cent of the respondents never received any training on bamboo cultivation, this depicts the low level of information and skill on production. There were 36.8 per cent who had undertaken training programmes related to bamboo plantation. Individual districts also depicted similar feature.

3.3.5. Distribution by Family Size

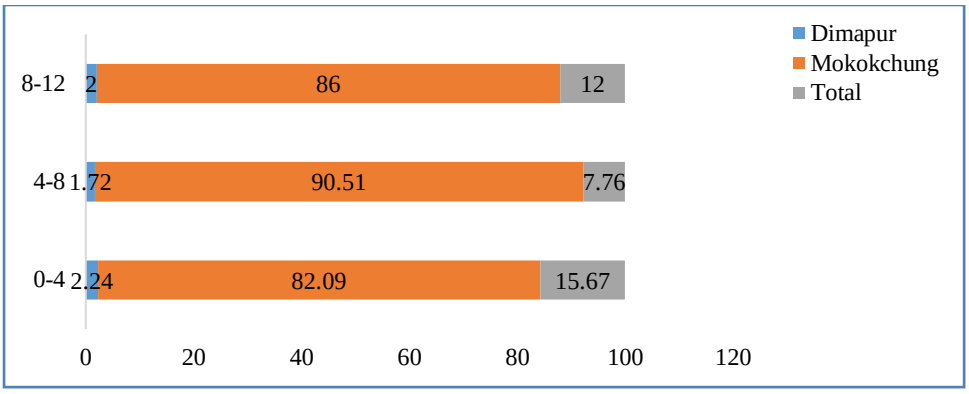
The family size and its composition are related to occupation and income. It influences the family operations in cultivation as they contribute to sharing of workload and carrying out the work. Table 3.12 gives the details about the family size of the sample farmers.

Table 3.12. Family size

Districts	**Dimapur**		**Mokokchung**		**Total**	
Family size	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
0-4	3	2.24	2	1.72	5	2
4-8	110	82.09	105	90.51	215	86
8-12	21	15.67	9	7.76	30	12
Total	134	100	116	100	250	100

Source: Field survey, 2017-2018.

Figure 3.h. Size of family (in %)



Source: Table 3.12

The data reveals that in total 86 per cent of the farmers have family size of 4-8 people, and 12 per cent were with very large family size of 8-12 members and only 2 per cent with smaller size of less than 4 members.

Amongst the sample districts, in Dimapur 82 per cent of the households are with 4-8 members and the same in Mokokchung is higher with 90.51 per cent. The proportion of larger family size is higher in Dimapur (15.67%) than that in Mokokchung (7.76%).

3.3.6. Motive of Cultivation

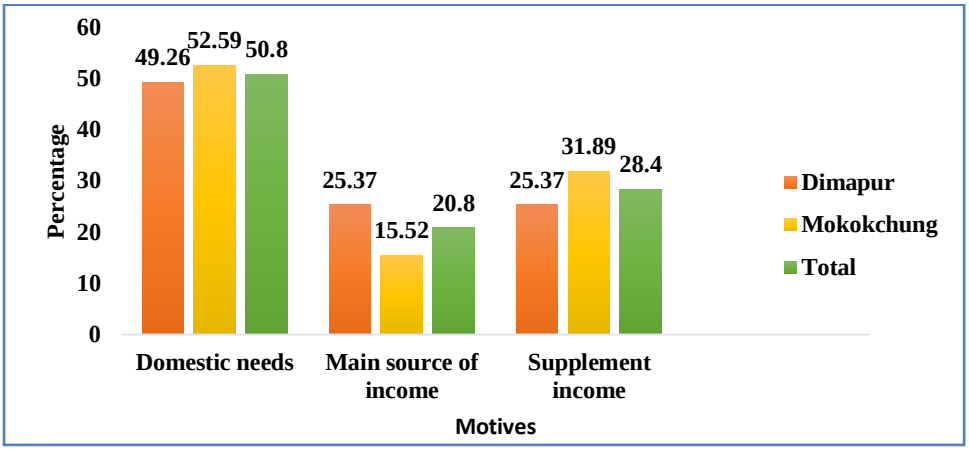
There are several reasons which thrust the farmers to take up bamboo cultivations and these motives/reasons helps to find the main thrive in the bamboo cultivation. The motive of starting bamboo cultivation is categorized into three heads: out of domestic needs, bamboo cultivation as the main source of income and in order to supplement income. Table 3.13 presents motive of cultivation.

Table 3.13. Motive for bamboo cultivation

Districts	Dimapur		Mokokchung		Total	
Motives	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Domestic needs	66	49.26	61	52.59	127	50.8
Main source of income	34	25.37	18	15.52	52	20.8
Supplement income	34	25.37	37	31.89	71	28.4
Total	134	100	116	100	250	100

Source: Field survey, 2017-2018.

Figure 3.i. Main motive of starting bamboo plantation (in %)



Source: Table 3.13

Among the respondents, the most important reason for bamboo cultivation is to meet their domestic needs with 50.8 per cent in total sample population, which constituted of 49.26 per cent of households in Dimapur and 52.59 per cent in Mokokchung districts. In sample total, the reasons as main source of income and of supplementary income constituted 20.8 per cent and 28.4 per cent, respectively. The same for Dimapur district is 25.37 per cent each. Whereas, in Mokokchung district, cultivating bamboo as the main source of income constituted for 15.52 per cent of the respondents and for 31.89 per cent as supplement to their income.

3.3.7. Experience in Cultivation

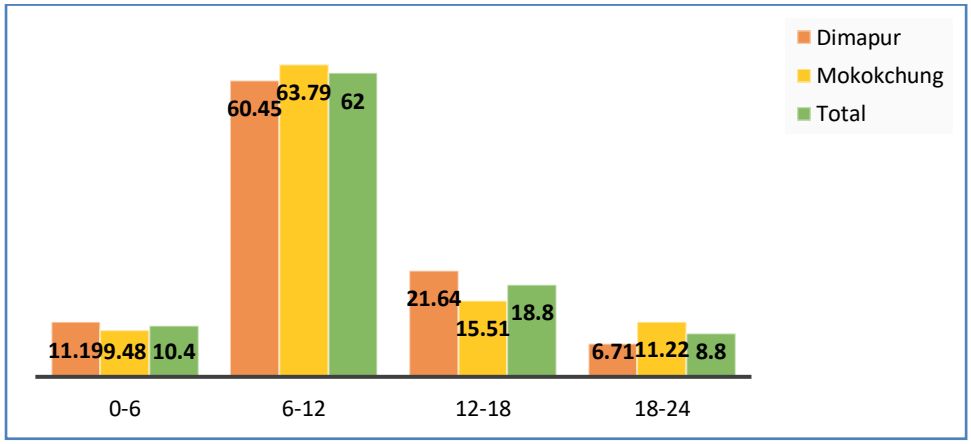
Experienced business persons have in their narratives presented an argument that with experience come good productivity. Experience also enhances the skilfulness of the farmers and their capacity to perform. Experience and performance are directly proportional to each other and highly inter-relatable. The table 3.14 presents data on years of experience in bamboo cultivation of the respondents.

Table 3.14. Number of years in Bamboo Cultivation

Districts	Dimapur		Mokokchung		Total	
Number of years	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
0-6	15	11.19	11	9.48	26	10.4
6-12	81	60.45	74	63.79	155	62
12-18	29	21.64	18	15.51	47	18.8
18-24	9	6.71	13	11.22	22	8.8
Total	134	100	116	100	250	100

Source: Field survey, 2017-2018.

Figure 3.j. Experience in bamboo cultivation (in %)



Source: Table 3.14

Table 3.14 shows that, in the sample total majority (62 per cent) of the farmers are into bamboo cultivation for shorter period that ranging from 6- 12 years, followed by 18.8 per cent of farmers with 12 -18 years of experience. Only 8.8 per cent have longer years of experience of 18 - 24 years and 10.4 per cent with very short period of experience of below 6 years. Both Dimapur and Mokokchung districts show similar scenario in regards to the respondents' year of experience in bamboo cultivation.

3.3.8. Area under Bamboo Cultivation

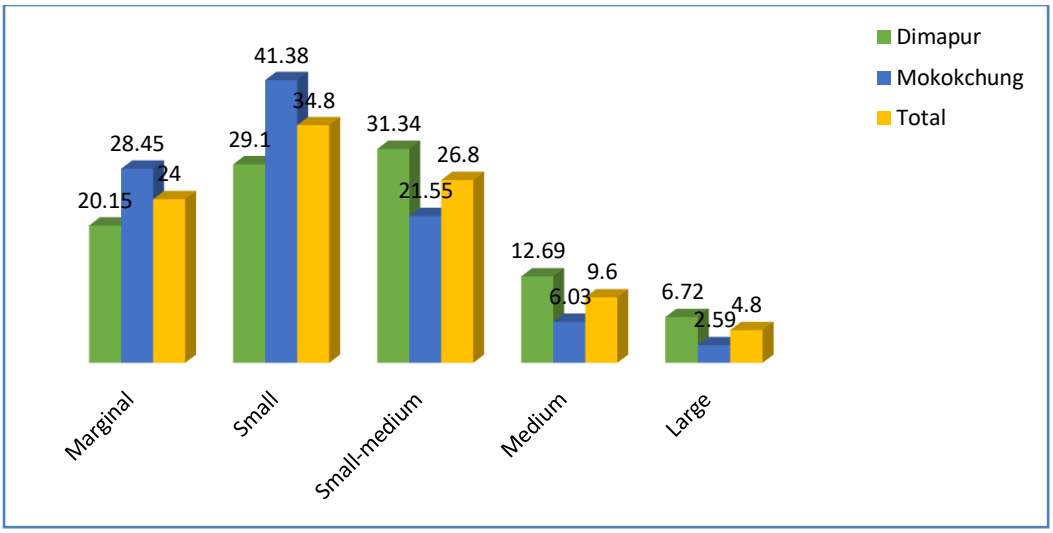
Production depends on the size of cultivating land area. According to agriculture census, the operational holding are categorised in five classes viz., marginal, small, semi-medium, medium and large. Accordingly, the operational holding areas under bamboo cultivation for the respondents are categorized as follows:

Table 3.15. Area under Bamboo Cultivation

Size of Farm (hectare)		**Dimapur**		**Mokokchung**		**Total**	
		Number of hh	% of total	Number of hh	% of total	Number of hh	% of total
Marginal	Below 1.00 ha	27	20.15	33	28.45	60	24
Small	1.00-2.00 ha	39	29.10	48	41.38	87	34.8
Small-medium	2.00-4.00	42	31.34	25	21.55	67	26.8
Medium	4.00-10.00 ha	17	12.69	7	6.03	24	9.6
Large	10.00 ha & above	9	6.72	3	2.59	12	4.8
Total		134	100	116	100	250	100

Source: Field survey, 2017-2018 hh=household

Figure 3.k. Farm size (in %)



Source: Table 3.15

Table 3.15 reveals that in Dimapur district, nearly 31.34 per cent of the respondents were holding small-medium size of farm that ranges from 2 to 4 hectares of land, which is followed by small size with 29 per cent, and 20 per cent were of marginal farmers. In Mokokchung district, nearly 41.38 per cent were of small size, which was followed by 28 per cent of marginal size and 21.55 per cent of small-medium farm size.

On an average, majority of bamboo cultivators were of small and small-medium farmers with 34.8% and 26.8%, respectively. Marginal farmers comprised of 24 % and medium and large farmers were very few, with 9.6% and 4.8 %, respectively.

3.3.9. Occupation of sample farmers

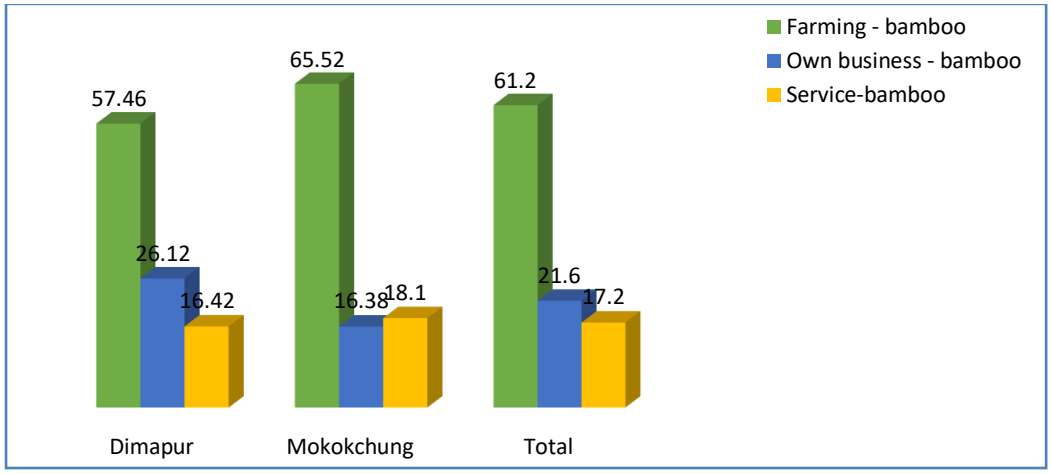
The farmers were found to have taken up other economic activities alongside the bamboo cultivation. Majority of them were involved in cultivation of crops besides rearing of live stocks, chicken etc., while others engaged in business (other than farming) and employed in government service. Table 3.16 shows the details of principal occupations of bamboo cultivators; which is categorized as agriculture, own business and service.

Table 3.16.Distribution of Bamboo Farmers by Principal Occupation

District	Dimapur		Mokokchung		Total	
Occupation	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Farming - bamboo	77	57.46	76	65.52	153	61.2
Own business - bamboo	35	26.12	19	16.38	54	21.6
Service-bamboo	22	16.42	21	18.10	43	17.2
Total	134	100	116	100	250	100.00

Source: Field survey, 2017-18.

Figure 3.l. Main occupation of the respondents (in %)



Source: Table 3.16

The respondents' principal occupation data shows that agriculture is the main occupation for 61.2 per cent of the bamboo farmers in sample total, so is the same for sample districts of Dimapur (57.46 per cent) and Mokokchung (65.52 per cent). 21.6 per cent of the respondents have own business in sample total, while in Dimapur the proportion was 26.12 per cent and in Mokokchung was 16.38 per cent. Services accounted for 17.2 per cent of the respondents in sample total, while in Dimapur the proportion was 16.42 per cent and Mokokchung was 18.10 per cent. It is found that besides bamboo cultivation, all the respondents have other occupation, such as farming, business and services.

3.3.10. Distribution by Monthly Income

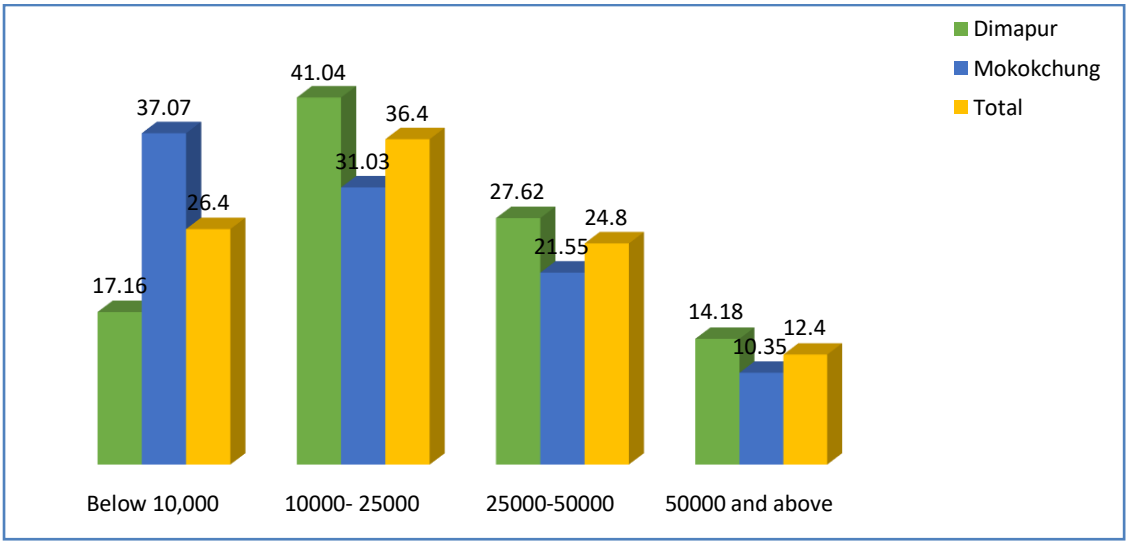
Respondents in the survey are divided by levels of monthly income, ranging from below ₹10,000,₹10 thousand to below ₹25 thousand, ₹25 thousand to below ₹ 50 thousand and ₹50,000 and above, which are indicated in the table 3.17.

Table 3.17. Monthly Income distribution

Income category (₹per month)	No. of persons			% of the total		
	Dimapur	Mokokchung	Total	Dimapur	Mokokchung	Total
Below 10,000	23	43	66	17.16	37.07	26.4
10000- 25000	55	36	91	41.04	31.03	36.4
25000-50000	37	25	62	27.62	21.55	24.8
50000 and above	19	12	31	14.18	10.35	12.4
Total	134	116	250	100	100	100

Source: Field Survey, 2017-18.

Figure 3.m. Monthly income of the respondents (in %)



Source: Table 3.17

It is observed from table 3.17 that in Dimapur, majority of the farmers' income ranges between ₹10000-₹25000 which accounted for 41.04 per cent of the respondents, that is followed by ₹25000-₹50000 income group which comprised of 27.62 per cent. In Mokokchung district, majority of the respondents were earning below ₹10000 which comprised of 37 per cent, followed by ₹10000-25000 with 31.03 per cent. The table further shows that for majority of the farmers the average income ranges between ₹ 10000-₹ 25000, however very few were at the higher income range of ₹50000 and above per month.

3.4. CONCLUSION

Nagaland is predominantly a hilly state in the Himalayan range, where forest occupies 75.31 per cent of the total geographical area and it plays an important role in the Naga society. However, more than 40 per cent of the State's forest area falls under open and scrub forest area, which is common for all the districts in the State. Thus, such area has the potential to bring under bamboo plantation for commercial purpose in Nagaland. There are about 43 species of bamboo found in the State are having multiple uses and commercial values.

Furthermore, majority of the workforce in the State are engaged in agriculture, so by taking up bamboo production on commercial scale will help to diversify the sources of livelihood in a sustainable way.

The socio-economic characteristics of the respondents in the study shows that most of them are in the middle age comprising of 35-55 years with 56.8 per cent, who are more energetic, responsive to changes and ready to take up new ventures. The respondents are predominantly of male that constituted 82.8 per cent. However, the matter of concern is the low level of education among the respondents that 67.2 per cent have completed only primary level and only 11.6 per cent were of graduates. There were only 36.8 per cent of the

respondents who have participated in formal training of bamboo cultivation which is mostly conducted by the Nagaland Bamboo Development Agency.

To meet domestic needs happens to be the drive for taking up bamboo cultivation, which constituted 50.6 per cent of the respondents. This shows that most of the farmers did not have business motive other than to use it in day-to-day activities and domestic needs. So bamboo cultivation is considered as a supplementary source of income for majority the farmers.

Majority of the respondents have experience of 6-12 years in bamboo cultivation which implies that they must have acquired reasonable skill and knowledge in bamboo cultivation. Most of the bamboo plantation is undertaken by small farmers.

Occupation data of the sample farmers show that besides bamboo cultivation, all of them were engaged in agriculture and other services. Moreover, 62.8 per cent of the farmers earn income below ₹ 25,000 per month and only 12.4 per cent of them earn ₹50000 and above per month, showing income disparity among the bamboo farmers, where majority of the farmers are at the lower spectrum in income distribution.

ANNEXURE 3.1. Some identified bamboo Species in Nagaland:

S.N	Scientific Name	Vernacular names	Dia(cm)	Major uses
1	Ampelocalamuspatellaris (Gamble) Stapleton	Guso (Rengma); Mao, Mau (Konyak)	2.5 – 3.75	
2	Bambusaalemtenshi iNiathani	Alulem(Ao); Tuku (ChokriChakhesang); Vupa (Angami); Ei-vong (Phom)	20-30	
3	BambusabalcooaRoxb.	Avuthi,Chungthi (Lotha); Otu, Warok(Ao); JÜterie(Angami); Zuthi (Chakhesang); Awoti,AtsuiApiche,Aicho(Sema); Zhutu (Chokri,Chakesang); Sho-ngat (Konyak); Nokphihuh (Yimchunger);Njatnayu (Chang); Beibui(Zeme); Tsuleongne (Khiamniungam); Ghuti (Santam); Apvuchyi(Rengma); Kovong(Phom)	12-16	Storage bin,fenching,roofing and scaffoldings.
4	Bambusabambos(Linn.) Voss	Huhvong(Phom); Hurie(Angami)	2.7-10	Medicine, Shoots edible and fencing
5	BambusaguaduaHumbolt. &Bonpl.		10-15	Building,Scaffolding,rafts and paper
6	BambusajaintianaMajumdar	Peking(Zeliang); Chajurie(Angami); Yenlievong(Phom)	0.8-3	Basket making, fences and ornamental purpose
7	Bambusamizoramia naNaithani		20	Pandal making and baskets
8	Bambusamokokchu ngeanaNiahani	Longpanglongmei(Ao)	25	
9	Bambusa multiplex (Lour.) Raeush. Ex J.A. &J.H.Schult	Peiha(Konyak), Peivomg(Phom), Chakharie(Angami)	1.5-2.5	Fishing rods, flutes, construction and handicrafts
10	Bambusa multiplex var. riviereorum R. Maire		3-5	Ornamental
11	Bambusanagalandea naNaithani	Latnyan(Konyak)	10-12	Suitable for landscaping
12	BambusanutansWall.ex Munro	Beirang(Zeliang); Vuchu(Angami); Ratho,Kura(ChokriChakhesang),Longmisigju(Ao), Ngetmei(Phom)	9-12	Pulp and paper industries and agarbatti
13	Bambusapallida Munro	Tsero, Tsuro(Lotha); Kera, Vuteya,Vuyie(Angami),Watoi(Chakesang);Achegho(Sema); Anuh,Hukehuh(Yimchunger);Thampa(chang);Veosethe(Khiamniungam),Eshi,Asi,Longmisanju(Ao);Weisa Wakhoi(Konyak);Phei(Rengma);Ngoha(Phom)	5-7.5	Basket making,mats,vessels to hold water,fishing rods and hedges
14	BambusapolymorphaMunro		7-15	Building purpose,toolshandles
15	Bambusarangaensis Borthakur&Barooah		2-3.5	
16	BambusatuldaRoxb.	Longmi(Ao);Auoti(Sema);Tsuntsan(Lotha);Rotha,Khoprei(Angami);Beking,Biurang(Zeliang);Gunyon(Rengma);Apishe,Api,Apiba(Sema);Chera(Chakhesang);Vuzhe(ChokrI Chakhesang);	5-10	Furniture,mats,hats,toys,boatroofs,wall plates and wall hanger

		Throngjak(Yimchunger);Shixu(Sangtam);Hauh,Haoh,Longmi,Ngat(Konyak);Nyet(Phom);Ngat(Khiamniungan)		
17	Bambusa vulgaris Schred. Ex Wendl.		5-10	Construction and handicraft
18	Bambusa vulgaris var.vittata A.&C. Riviere	Vounglavong(Phom);Riehe(Angami);Awune(Sema);Aphiyak(Yimchunger);Tenenya(Ao);Amuing(Sangtam);Konglen-ngat(Chang);Hakvu tsuntsang(Lotha);Anyannget(Konyak);Mehukura(Chokri-Chakhesang);Mezukavu(Khezha-Chekhesang); Hamph(Khiamniungan	5-12	Poles and construction
19	Bambusa vulgaris f.wamin Wen		5-15	Used as ornamental
20	Cephalostachyumcapitatum Munro	Runyu(Angami);Runi(Chakhesang);Lanhu(Khezha-Chekhesang); Dibu(Ao);Chiha(Phom);Ticha(Lotha);Kheyi(Rengma)	1-3	Bows and arrows
21	Cephalostachyumfuchsianum Gamble	Meyong(Ao);Enye,Themo,Kepru(Angami);Lyong(Chang); Leih(Khiamniungan);Akhao(Sema);Pvurhya(Lotha);Kunye (Chakhesang);Me(Yimchunger);Nu(Sangtam);Hema(Zeliang);Ahlung(Phom)	2-6	Seeds used as food and culms used for basket making
22	CephalostachyumlongwanumNaithani	Nahnju(Konyak)	15	Edible young shoots throughout the year
23	Chimonobambusacallosa Makino	Ruchii,Kipha(Angami);Nkyip(Lotha);Ruki(ChokriChakhesang);Munak(Chang);Lea(Khiamniungan);Auchi(Sema); Thumetulak(Yimchunger);Shohai(Phom)	1.5	Construction of house and tying the thatch of houses
24	ChimonobambusanagalandeanaNaithani	Riecu,Rucu(Angami);Nkip(Lotha)	2.5	
25	Chimonocalamusgriffithianus Hsueh& YI	Anuk(Ao);Muna,Anugha(Sema); Thuma, Thumetopu(Yimchunger);Mo(Chang);Hong(Konyak); Shohuh-nget(Phom)	2	Tying the thatch in native houses,dry culms for fencing
26	Dendrocalamusasper Backer ex Heyne		12	Building materials for houses and bridges
27	Dendrocalamusgiganteus Munro		18-25	Handicraft and scaffoldings,shoots for eating
28	DendrocalamushamiltoniiNees&Arn. Ex Munro	Vupie,Vupa(Angami);Yiza,Tsuntsankip,Transakiptareo,Santakape,Vepu(Lotha);Watsa,Nung,Songkumyong,Rumsuyong,Kiyo,Tajungbayong,Eshi(Ao);Duling(Sangtam);Apo Khogou,Chentsu(Rengma);Hepai,Chepai,Paichang(Zeliang);Aghakhaub(Sema,Dimapur);Apibo,Shehubo(Sema,Zunheboto);Ratho,Gipri,Vijaya(Chakhesang);Remhuh,Luhg(Yimchunger)Woa,Talum(Chang);Weang,Gungmag,Phumpho(Konyak)Vongnyu(Phom)	10-18	Walling native huts,constructions,basketmaking,mats,watervessels,shoots for food
29	Dendrocalamushookeri Munro	Mpa(Angami);Vepvru,Ehayeejugo,VepvuPvulan Terio(Lotha);Pani(Chakhesang);Turubo(Sema);rongpanglumi,Nung(Ao);Tsushvu, Teronyu-Gunyo(Rengma)	10-15	

30	Dendrocalamuslatiflorus Munro	Warok(Ao);Hisera,Vunei,Vunyi(Angami);Onung(Lotha);Kupho,Uphokupho(Chakhesang);Apho(Sema);Bonghuh(Yimchunger);Othiungu(Khiamniungan);Kalon,To(Konyak);Aphu(Rengma);Mung(Phom);Deiyei-ngat(Chang);Chehabei(Zeliang);Bho(Sangtam)	9-20	Shoots for food,Rafts for fishing,making paper,
31	Dendrocalamussikkimensis Gamble	Annung,Wakap(Ao);Gunyin(Rengma);Vuyo(Chakhesang);Ming(Konyak)	10-18	Water container
32	DendrocalamusstrictusNees	Kirok(Ao);Ohamnget(Phom);Tephrierie(Angami)	6-10	Bashetmaking,charcoal,thatching and roofing,mats, furniture.
33	Melocannabaccifera Kurz	Turiah,Vushu,Vuruphrie(Angami);Teriangle(Zeliang);Tanria(Zeme);Molupang(Ao);Guso(Rengma)	2.5-6	Paper pulp,toys,hats,basket
34	NeomicrocalaumsmanniiMajumdar	Takai(Zeliang)	1.25-2.5	Binding material in building huts,fencing and basket making
35	NeomicrocalaumsprainiiKeng f.& Wen	Sampit, Keve,Kevoa(Angami);Kuvu,Kevu(Chakhesang);Bakbunget(Phom)	5	
36	Phyllostachysmanni Gamble	Ashijang(Ao);Hong(Konyak)	2.5-5	Walking stick,fencing and construction
37	Phyllostachysedulis J. Houzaeu		20	
38	Pleioblastusfortunii Nakai		1-2 mm	
39	Pseudostachyumpolymorphum Munro	Keu(Angami);Ticha,Titsa(Lotha);Kheu,gee(Rengma);Kehiu,Nria(Zeliang);Aklu(Sema);Kuyi,Uyipu,Runi(Chakhesang);Esup (Chang);Thingsuh(Khiamnuingan);Khyupong(Sangtam);Kiupong(Yimchunger);Jipju,Jijo(Ao);Chaan(Konyak);Niishin-ah(Phom)		Rice bear suckihn pipe and fishing net frames
40	Sinarundinariaeleganns Chao &Renvoize	Jilli,Julei(Angami);Kibitobe,Kushutso,Mesuk(Yimchunger);Setchu,Setsuja(Chang);Kuti(Chakhesang)		
41	Sinarundinariarolloana Chao &Renvoize	Thipfu,Zupfu(Angami);Nu(Sangtam)		
42	Teinostachyumdulloa Gamble	Anih,Ano,Ana(Ao);Ticho,Kichu(Lotha);Vepru(Chakhesang);Hebei,Bei,Chebiu(Zeliang);Gushye,Gushu,Temvu(Rengma);Chisahu,Asheqhu(Sema);Anuh(Yimchunger);Nouabiuba(Sangtam);Drah,Lah,Aah(Konyak);Ah(Phom)		Quiver,mats,basketscarrying water
43	Thyrsostachysoliveri Gamble	Tavatusu(Phom)	3-5	Agriculture impliments,lance staves and broom handles

Source: Bamboos of Nagaland, 2011[13]

[13]Naithani, H.B (2011). *Bamboos of Nagaland.* NEPED & NBDA.

CHAPTER 4

SOCIO-CULTURAL AND ECONOMIC IMPORTANCE OF BAMBOO IN NAGALAND.

4.1. INTRODUCTION

The association of men with bamboo in India is as old as human civilization (Chandrashekara, 1997)[1]. The growth and usage of bamboo for various purpose and activities has been in existence for long in India. Use of bamboo can be found in the text of Atharva Veda. Aiyer (1949)[2] mentioned about a prayer in the Atharva Veda- 'I offer you dried sugarcane, white sugarcane, reeds and bamboos'. Sharma, G (2006)[3] referred to hymn from Atharva Veda- 'the people who plant bamboos rise from the mud and become rich. This truth is undisputed'. Every part of bamboo, from roots to leaf and to stem, is useful. Even the waste bamboo can be used to make charcoal. All the parts of bamboo is made use and nothing is discarded or wasted. Bamboo is used from solid to liquid form.

Bamboo has lot of potential for alleviating many of the socio-economic and environmental problems in many countries (Quintans, 1998)[4]. It has been regarded as the major resource that meets the multiple requirements of common people and a poverty alleviator (IFAD, 2014)[5]. It is utilized as wood in construction work, furniture, utensils, fibers and paper. Bamboo charcoal is used as it is three times as porous as wood and releases more energy and gives huge fuel backup. It is used as medicines, food, vinegar, beverages, and natural pesticides and material

[1]Chandrashekara, U.M., (1997). How culture influences the uses and management of bamboo in India. *INBAR Newsletter*, (10).
[2]Aiyer, A. K. (1949). Agriculture & allied arts in Vedic India. Bangalore Press, Bangalore.
[3]Sharma, G (2006). Ways to attract wealth. Diamond Pocket Books Pvt. Ltd. New Delhi.
[4]Quintans, (1998). Op. cit. p. 7.
[5]IAFD. 2014. Annual Report 2013. International Food and Agricultural Department, Rome.

in construction of houses; bamboos have multiple uses (Hammond, 2006)[6]. It is estimated that about 8.6 million people depend on bamboo for their livelihood (FSI, 2019)[7].

In Nagaland, bamboo is found abundantly and the socio-economic life of the *Nagas* revolves around the different uses of bamboo and its products. As Naithani, H.B (2011)[8] has quoted the statement of an old man from Khar village in Mokokchung district of Nagaland " With a grove of bamboo I am always a rich man, I construct my house with bamboo, use bamboo utensils and equipment in the bamboo house, burn bamboo as fuel, use bamboo torches and eat bamboo pickles". This chapter highlights the socio, culture and economic importance of bamboo for the *Nagas.*

4.2. TRADITIONAL IMPORTANCE OF BAMBOO

Bamboo is like a ubiquitous phenomenon with its presence in one form or to the other. Among different knowledge bases, indigenous or local traditional knowledge systems, developed through experimentation, adaptation and co-evolution over long periods of time can provide valid and useful knowledge, as well as methods, theory and practices for sustainable resource management (Kimmerer, 2002; Hirsch Hadorn *et al.*, 2008)[9]. The traditional knowledge is not merely limited to its use; it also expands to better growth and management of bamboo (Chandrashekara, et al., 2019)[10]. However, this rich resource is yet to be tapped in order to be viable for the economy of the state. The importance of this resource is such that its multiple uses cannot be bypassed by a community dependent on it. It continues to play a predominant role in

[6]Hammond, K. O. (2006). Cultivate bamboo for employment and income generation. *Ghanaian Chronicle*.
[7]FSI. 2019. India State of Forest Report 2019, Volume 1. Forest Survey of India, Dehradun
[8]Naithani, H.B (2011). Op. Cit. p. 107.
[9]Kimmerer, R. W. (2002). Weaving traditional ecological knowledge into biological education: a call to action. *BioScience*, 52(5), 432-438.
Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wisemann, E. & Zemp, E. 2008. Handbook of trans-disciplinary research. Springer. *Berlin*, Dordrecht.
[10]Chandrashekara, et al., (2019). Op. cit. p. 62.

the life of the *Nagas* till date in every walk of life that ranges from agricultural tools to shelter and food, and that bamboo is used for variety of purposes.

Traditional knowledge is unique and locally or regionally maintained, adapted, and transmitted both orally and in practice (Nakashima *et al*., 2012)[11]. Bamboo has a very strong relationship with the rural community of the *Nagas*. As part of the tradition of the people, bamboo handicraft is an important source of livelihood especially in the rural areas where most of the artisans are neither educated nor employed, and their skills are passed down from one generation to the other through practice. As time passed, bamboo has started to gain economic importance. It is considered as an aid to the rural populace.

4.3. USES OF BAMBOO IN NAGA SOCIETY

In olden days Bamboo were used in Naga society in a crude way. They used bamboo for everything, from kitchen to farm and became a way of life for the *Nagas*. At present there are many options and alternatives available in the market to meet the needs of the people, however, in the olden days, almost every product was made of bamboo. It can also be ascertained that it was organic and natural. Ranging from ethnic cuisine to utensils, bamboo had a vital role in the day to day lives of the people then and its uses were plenty as compared to present.

The Naga society continues to depend on bamboo. For one to study a Naga village 'closely', one has to make amend with the fact that Naga society has its identity associated with bamboos. There has been a wide range of bamboo made items available then and now. As opined

[11]Nakashima, D., McLean, K. G., Thulstrup, H. D., Castillo, A. R., & Rubis, J. T. (2012). Weathering uncertainty: traditional knowledge for climate change assessment and adaptation. UNESCO and UNU, Paris.

by Varuni (2017)[12], "The making of baskets is an age-old craft of leisure which was practiced by the male elders of the family in the traditional rural economy of Nagaland. It was never a profession in the traditional context, and hence this skill is dwindling in present times. Bamboo and cane basketry is not art in tribal economies like Nagaland, but an intrinsic part of daily life and activity that produced essential household items like baskets to carry firewood, or bamboo tubes for water, for food and grain storage, vessels, plates, furniture, containers, spoons, and fishing and hunting traps". We found many articles made of bamboo and well-crafted by gifted artisans. Unlike in the olden days where bamboos crafts were created individually, today bamboo cluster groups are also engaged in this work due to the increased commercial market for bamboo products. The important species of bamboo found in Nagaland are *Dendrocalamushamiltoni*, which is used to make baskets, *Bambusabalcooa* for house construction, *Melocannabaccifera* for making floor and walls.

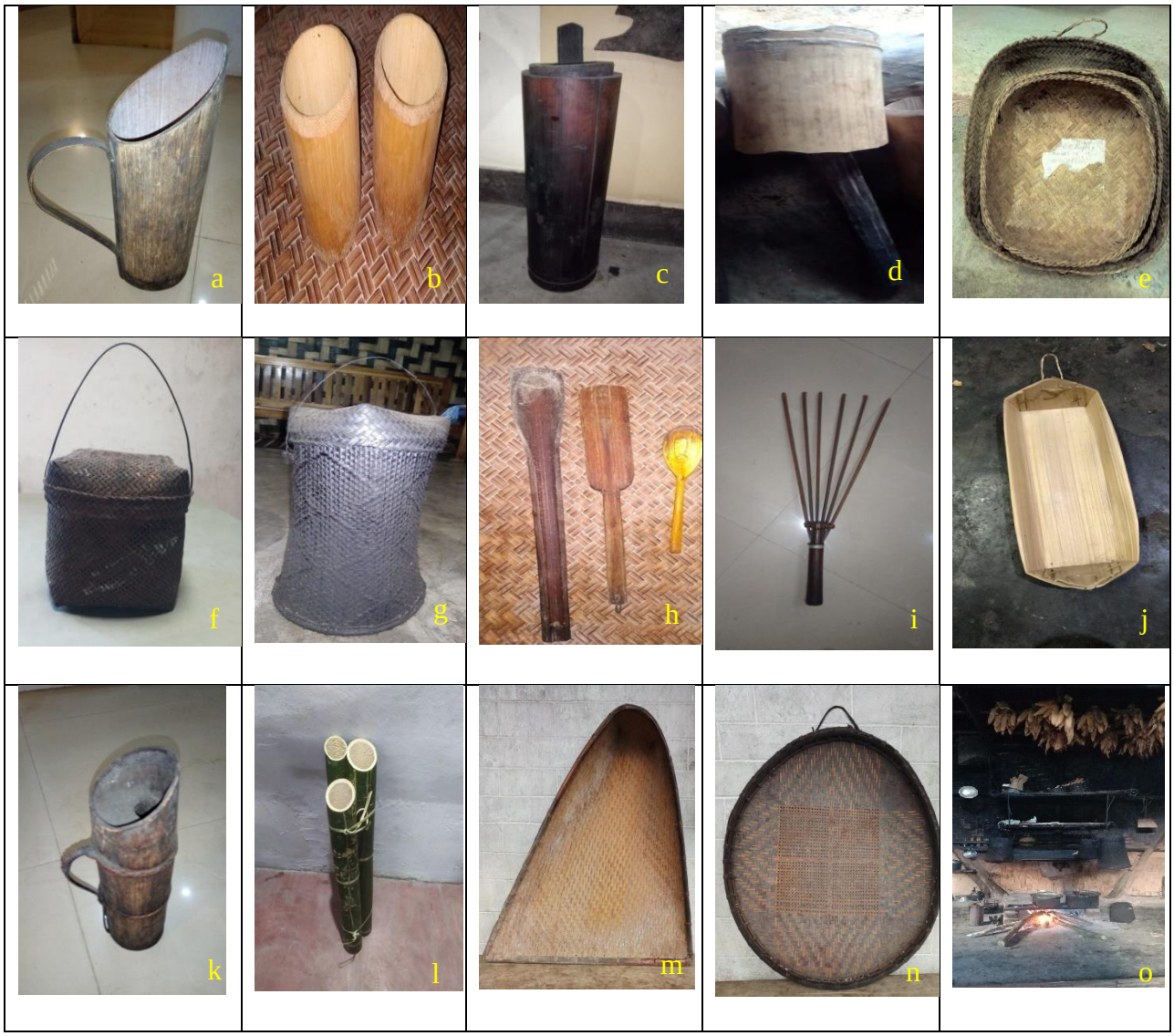
4.3.1. Traditional products of bamboos

4.3.1.1. Kitchenware

A typical Naga kitchen comprised of several products made of bamboo. They are used as kitchenware items. Some of the products are shown below:

[12]Varuni, R. (2017). Bamboo and Cane Basketry Traditions of Nagaland. Retrieved from https://www.sahapedia.org/bamboo-and-cane-basketry-traditions-of-nagaland-0 on 30 June, 2019.

Figure 4.a. Some traditional kitchenware items



(a). Jug, (b). Cups, (c). Salt container, (d). Grinder, (e). Basket, (f & g). Tiffin Basket and container to keep dry seeds and fish, (h) spoon and spatula, (i). Rice paddle, (j) plate (k) flask, (l) Water storage, (m & n). Sieves and (o) Naga kitchen.

Even before the use of plastic, bamboo jugs were already in use in the traditional Naga societies. Multipurpose bamboo cups used for rice beers and drinking water during the olden days can be seen. Container used for storing salts is often kept near the fire place. The lid is designed in a manner that it fits the container. Bamboo made grinder used often for preparation of side dish such as *chutney,* which forms an important part of Naga diet.

The *Nagas* are naturally gifted in making baskets which is highly developed. Baskets in different designs were used for different purposes like keeping vegetables and fruits, dry meat and fish, and preserved seeds as seen in figure e, f & g. Zeme tribe used a double weave basket known as *Kelung* to store paddy. *Kola* a type of basket use for storing rice made of split bamboo is popularly used by Angami tribe. According to the Ao tribe folk tale, the indigenous people inherited the art of making baskets from the magician *Chankichanglangba* on the sixth day of his death. The use of bamboo basket has various advantages as it is healthier, safer and organic which is good for the environment. It is heat-resistant, antimicrobial, light weight and durable. The most common bamboo species used for basketry in Nagaland are *dendrocalamushamiltonii* and *melocannabaccifera*.

Bamboo was used as serving spoons in different shapes for different food items like rice, curry and soup. Culm of 35mm diameter is shaped so that one nodal diaphragm is retained. A thick split from the node is shaped to form the handle. The lower part of the node and diaphragm are shaped using *dao* to create a soft rounded form. Usually the flat ones are used to serve rice while the oval ones for curry as depicted in (h). Bamboo stirring spatula was conventionally used for stirring rice beer (i).

Plates made of bamboo were used for serving and eating purpose (j). Bamboo plates and platters with improved designs are in demand in the market today as it is disposable and environmental friendly. Bamboo were also used as flask as shown in (k). A small hole is made in the nodes of bamboo and they were used for carrying hot water.

Bamboo was used as bucket for water storage in olden days as shown in (l).Bamboo trunk to carry water from the mountains to the fields is found among the Nagas (Rizui & Roy,

2006)[13]. During the dry season which starts from February till April, the bamboo water can called '*tsushi'* in Ao dialect is a mandatory item that every household should keep filled with water. It acts as a water reserve in case of incidence of fire outbreak which happened quite often in villages. This custom is still found in practice.

Sieves in different shapes were used for cleaning rice and other food grains as shown in (m & n). It separates the lumps and clumps from the fine material as they are flexible and durable. Small knife and '*daos'* were used to make such fine products. A typical Naga kitchen is incomplete without some containers made of bamboo hanged mostly by the fire place (o). Just above the fire place, placed a hanging shelf where meat, fish and seeds are dried.

4.3.1.2. Household products

Household items ranging from bed, chairs, mat to dry grains, basket used as wardrobe were all made of bamboo. Figure 4.b shows some of the household items made of bamboo.

Figure 4.b. Household items made of bamboo

[13]Rizui, S.H.M & Roy, S (2006). The Nagas. New Delhi: B.R Publishing Corporation.

(a and b). Mats used for drying grains and also as bedding mat, (c). Stone hummer Handle, (d). *Dao* handle, (e). *Dao* hanger, (f). Bed, (g). Bamboo bench (h). Cloth storage.

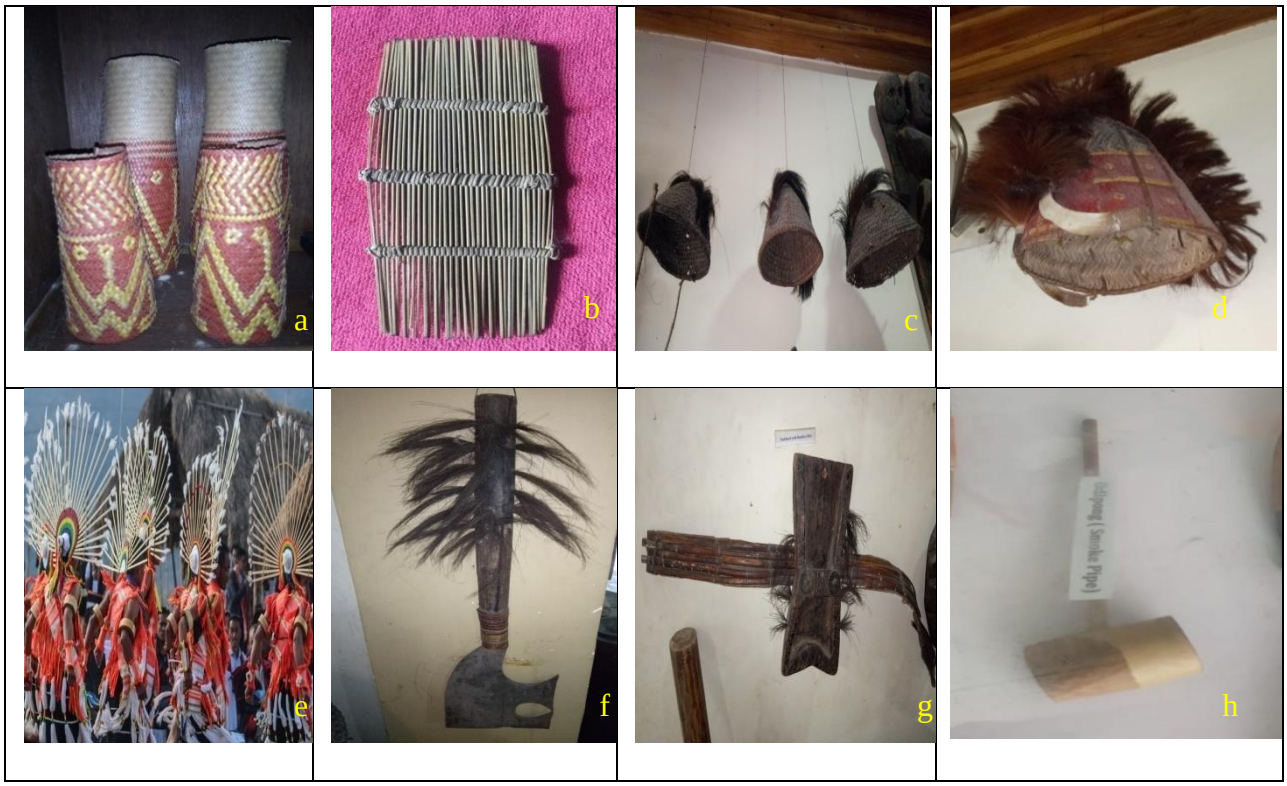
The material used for making mats and baskets is split bamboo. The length of the splits ranges from 30 cm to 60 cm and only the outer layer of the bamboo is used for making the splits. The mats are closely knitted and form an important part of a traditional room set up, for drying paddy and leaves and sleeping mats (a & b).

The hammers are usually made of heavy stones fixed to a long bamboo handle (c). It was also used as *dao* handle (d), which is an important tool for the *Nagas*. Bamboo was also used as *dao* hanger as shown in (e). It was used in making beds and chairs (f & g). The traditional wardrobes (h) were huge bamboo baskets used for keeping clothes and other treasured items.

4.3.1.3. Traditional ornaments

The *Nagas* were fond of wearing ornaments, which is worn by both men and women folks especially during festivals times. Bamboo made accessories were the ultimate jewelries during olden times and it is still in use during modern times.

Figure 4.c. Bamboo ornaments



(a). Armlet and calf let worn by the Male folk of Angami tribe, (b). Bamboo Comb (c, d &e). Head gear,(f) Decorative dao used by all the Naga tribe during festival, (g). Waist belt used by Khiamniungan and Konyak tribe (h) Smoking pipe used by women folk.

Angami men wore armlet and calf let called '*Phipha'* which were made of bamboo (a) Comb (b) made of bamboo known as '*Kushu'* was popularly used by Yimchunger and Chang tribes. It was made of bamboo splits and was presented as gifts to the women folk.

'Tsula, Tsukhru, Tsuphie, Teirhutsula and *Tsuzei'* are different types of head gear worn on different occasions by Angami tribe (e). Decorative *dao* handle made of bamboo were used during festive occasions by men folk of almost all Naga tribes (f). Waist belts for carrying *dao* were as well made of bamboo (g). Smoking pipe made of small bamboo were commonly used by women folk (h).

4.3.1.4. Infrastructure building

Bamboo has wide acceptance for construction of houses due to its desired structural properties of size, shape, flexibility and strength (Laha, 2000)[14]. Worldwide, more than 1 billion people live in traditional bamboo houses (Paudel & Lobovikov, 2003)[15]. Traditional method of treating bamboo is by dipping the material in the water and smoking it above the fire place which helped in its longevity. This has been in practiced for centuries by almost all the Naga tribes. The tensile strength of bamboo is 28,000 per square inch which is more than that of steel which is 23,00 per square inch (Kaur, 2018)[16].

Figure 4.d. Infrastructure items made of Bamboo

[14]Laha, (2000). Op.cit. p. 60.
[15]Paudel, S. K., & Lobovikov, M. (2003). Bamboo housing: market potential for low-income groups. *Journal of Bamboo and Rattan*, 2(4), 381-396.
[16]Kaur, P. J. (2018). Bamboo availability and utilization potential as a building material. *Forest Res EngInt J*, *2*(5), 240-242.

(a). Bamboo slits used for making different type of baskets and also use as rope, (b). Pipe for collecting water from running river, (c) Bridge, (d & e). Boundary wall and fences, (f). Balcony and (g).Ladder, (h) Hut.

Rope, water pipes, bridges, fences, verandah and houses were mostly made of bamboos. Some of the basic infrastructures made of bamboo signify protection, shelter, leisure space and support. Bamboo splits were used as ropes for tying of bamboo pole in constructions (a). It was used as water pipes to bring water from the streams (b).To connect from one village to other or from one place to another, bamboo bridges played a major role (c). Bamboo bridges are made across the stream or river, which are sturdy and long lasting. Fences made of bamboo were used as boundary wall (d & e). Balconies were a common part of a traditional house (f). Ladder made of bamboo was used for several purpose for climbing (g). Bamboo serves as sturdy material for making roof, posts, rope, ladder, wall and floor. A traditional Naga house is constructed with about 90% of bamboos as building materials (h), from pole to support, flooring, walls, doors and windows are made of bamboo materials.

4.3.1.5. Marriage Ceremony

Bamboo products hold a special place during the marriage ceremonies in Naga society. Bamboo containers (a & b)and basket (c) was carried by bride to the groom's place in earlier days after their wedding as the most prized possessions with rice, salt and cloths in different baskets. This was a popular tradition of Ao tribe in the marriage ceremony. Bamboos were also used as a stage decorations items during marriage party (d).

Figure 4.e. Bamboo items used in marriage ceremonies.

(a& b). Basket container for rice and salt, (c). Basket used as wardrobe and (d). Stage decoration made of bamboo.

4.3.1.6. Traditional musical instruments

Nagaland is known for love of music and have deep connections with it. The musical instruments made of bamboo generate fabulous tunes which add to its melody. Unique traditional musical instruments are used by each tribe which is mainly influenced by customs.

Figure 4.f. Musical instrument of bamboo

(a).Tati, (b). Trumpet, (c). Flute, (d) Mouth organ and (e) Cup violin.

Popular bamboo made musical instruments include, '*tati'*, trumpet, flute, and mouth organ. *Tati* (a) one of the local musical instruments is used by Chakesang and Angami tribe. It is

a single stringed traditional musical instrument which is made out of bamboo pole. '*Atutu'* is an indigenous bamboo trumpet usually played by male members of Pochury tribe (b). The trumpet serves as a warning signal to ward off birds and animals in the paddy fields, to alert the collective habitat when enemies attack and also to signal the declaration of war.

A special type of flute known as '*Dungdung'*(c) was used by Yimchunger tribe of Naga. It can be played by both men and women. It is one of the simplest and easy to make musical instruments. It was made of special type of bamboo called '*ani*' which is a thin bamboo.

One of the oldest musical instruments of *Nagas* is the bamboo mouth organ (d) which is called the 'Midnight musical instrument'. It is very simple yet effective in making enchanting musical sound which can be played by both men and women. The length of the flute is 6 inches and wide is half an inch. Traditionally, it was generally played inside the dormitory '*Zuki'* and '*Arju'.* Four different sounds is produced simultaneously while playing the instrument, which is created due to the movement of fingers pulling the strings, use of lips, control of breathing and movement of the tongue.

The cup violent is popularly used by the Ao tribe and is called 'Midnight Violin' because it is played mainly at mid night. It is made of good quality of hard and thin bamboo, or sometimes a shell of bitter gourd is used. To play the violin, a bow is required which is made of a thin bamboo half an inch in width and about a foot long and a thin bamboo fiber.

As per oral tradition, it is said that the man learnt the method of playing this instrument from the movement of crab's finger. This instrument can be played by both men and women.

4.3.1.7. Agricultural implements

Agriculture being the main occupation of the *Nagas*, lot of bamboo made tools and products were used for agriculture purpose. Some of the items popularly used in agricultural practices are such as umbrella to protect from heat and rain, spades and spade handles, storage basket to store paddy, basket to carry paddy and vegetables, protection wall for plants. Bamboo barriers are erected horizontally along the slope of jhum field to protect from soil erosion.

Figure 4.g. Bamboo products used in farming.

(a). Umbrella, (b). Spades and hoe, (c). Storage basket to store paddy in grainary, (d). Baskets to carry grains, (e). Basket to carry firewood, water and vegetables etc (f). Rope used as handle and (g). Protection wall for sapling plants, (h) bamboo trellis.

Beautiful designs of umbrella made of bamboo were used in field to get protection from heat and rain (a). Grasses and weeds in the field were cleaned using bamboo spade (b). Once harvesting gets over, the usual practice by the farmers were to store the grains in large bamboo

basket (c). It acted as storage for food grains. Bamboo baskets were made use for mainly two purposes; one is for storage and the other to be carried on the back for day-to-day use. Different design of basket is made for different purpose. Carefully woven baskets were used for carrying rice from the fields (d) and loosely woven baskets to carry firewood or water in a bamboo container (e). Even the rope or handle of those baskets were made of finely made bamboo rope (f). Protection walls/fences are made of bamboo (g). It was also used as support for the creeping plants to grow and bear fruits (h).

4.3.1.8. Weaving tools

In Nagaland, weaving is the domain of the female folk. All women were expected to know weaving among the *Nagas* and traditional art for all the Naga tribes. They design beautiful pattern which is colorful and attractive. Each tribe has their unique design of traditional attire and has deep meaning. This reflects the rich artistic skills and creative imagination of the weaver. In ancient times, it was practiced according to social customs; the wife of a particular man who had gone for hunting was not allowed to weave. This custom is no longer in practice today. Beautiful traditional skirts and shawl were weaved using tools made of bamboos.

Figure 4.h. Bamboo weaving tools

(a). Weaving tool set, (b). Yarn basket and (c) Back strap.

The whole set of weaving tool were made of bamboo (a). The small bamboo sticks in the right hand corner are used for creating different design. Yarn basket used in weaving is made of bamboo (b). Back strap to hold the posture while weaving were also made of bamboo (c).

4.3.1.9. Hunting and Fishing

Traditionally, the *Nagas* were hunters and exhibited hunting skills with great pride and honour. Hunting equipment like bow and arrow, shield, different kinds of fish traps and basket to store fish and crab were made of Bamboo.

Figure 4.i. Hunting and fishing tools

(a) Shield to protect from animals, (b & c). Basket to store fish and crap, (d).Fishing net (e). Fishing trap and (f) Bow and arrow.

Bamboo shield was used as protection while going for hunting (a). Different types of bamboo basket were used for storing fish and crap (b & c). Fishing nets made of bamboo were

mostly used by Kachari tribe (d). Community fishing was commonly practiced by Ao tribe for which bamboo walls were erected across the river for fishing purpose (e). Bamboo beams were used to make bow and arrows of different shapes and sizes.

4.3.1.10. Food and medicinal products

Bamboo has many nutrients, especially nitrogen (N), phosphorus (P) and potassium (K) in content orders as N > O > K (Mohamed et al., 2007)[17]. Bamboo shoot being low in fat, high in dietary fiber and rich in mineral content, like an ideal vegetable has been used traditionally by tribal for decades, world over. (Satya et al., 2010)[18]. Bamboo shoot is considered as the staple food for the *Nagas* and has been consumed for centuries. The young edible bamboo plants that have just emerged from the ground generally 20-30 cm long tapering at one end and weighing almost to a pound is consumed in the form of canned bamboo shoots and fermented. It is also used in the form of bamboo water (vinegar), fermented bamboos, fresh bamboo shoots, and in its dry form. *Dendrocalamushamiltoni, D. latiflorus, Bambusa pallid* and *Bambusatulda* are edible species found in the state. *D. hamiltoni* bamboo shoot is reported to be the best among the clump forming bamboo in terms of taste and nutritive value (Anon., 2005)[19]. Modern research on bamboo shoot revealed that consuming bamboo shoots increase appetite & good digestion, controls obesity, diabetes, and treatment of heart disease and breast cancer (Panee, 2009)[20]. Although bamboo shoot is an important constituent of traditional food items, not many were aware of its health benefits that the bamboo shoots come loaded with.

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[17]Mohamed, A. H., Hall, J. B., Sulaiman, O., & Wahab, R. (2007). Quality management of the bamboo resource and its contribution to environmental conservation in Malaysia. *Management of Environmental Quality: An International Journal*, 18(6), 643-656. https://doi.org/10.1108/14777830710826685.

[18]Satya, S., Bal, L. M., Singhal, P., & Naik, S. N. (2010). Bamboo shoot processing: food quality and safety aspect (a review). *Trends in Food Science & Technology*, 21(4), 181-189.

[19]Anon. (2005). TAMBAC Times (Tamenlong Bamboo and Cane Development Centre) Quarterly Newsletter.

[20]Panee, J. (2009). Bamboo extract in the prevention of diabetes and breast cancer. In *Complementary and Alternative Therapies and the Aging Population* (pp. 159-177). Academic Press.

Figure 4.j. Bamboo as food items

(a). Bamboo vinegar, (b). Fermented bamboo, (c). Fresh bamboo and (d). Dried shoots

Consumption of bamboo shoot in Nagaland in fresh form is seasonal, generally found during the month of August and September as new shoots sprout at the base of the tree and fermented bamboo shoot, bamboo shoot juice and dried shoots are consumed throughout the year.

Each part of bamboo is beneficial right from its rhizome to its leaves (Nirala et al., 2017)[21]. The leaves of bamboo tree are stimulant, aromatic and tonic. It is beneficial for treating stomach troubles, menstrual disorder and killing intestinal worms. Medicine made from the leaves of *Pleioblastusamarus* bamboo species is used in treating fever, fidgeting and lung inflammation (Dharmananda, 2006)[22]. Stems and leaves of *Bambusabambos* are used in Ayurveda system of medicine as blood purifier, burnt roots are applied to control ringworm, bleeding gums and to painful joints (Tripathi et al., 2002)[23].

[21]Nirala, D. P., Ambasta, N., Kumari, P., & Kumari, P. (2017). A review on uses of bamboo including ethno-botanical importance. *International Journal of Pure & Applied Bioscience*, *5*(5), 515-523.
[22]Dharmananda, S. (2OO6). Bamboo as medicine. http://www.itmonline.org/arts/bamboo.htm
[23]Tripathi, Y. C., Singh, H. P., Pandey, B. K., & Kaushik, P. (2002). Prospects of bamboo flowering and resource management: An industrial perspective. *Proc. Exper t Consultation on strategies for sustainable utilization of bamboo resource s subsequent to gregarious flowering in the North East*, *12.*

4.3.1.11. Bamboo as fodder and house for livestock

Bamboo leaves are an alternative source of fodder for cattle in dry season (Scurlock et al., 2000)[24]. The most preferred bamboo species in the state for fodder to cattle and goats is *Dendrocalamushamiltonii*, which is also the species of choice from bamboo shoot production. Bamboo has proven to be an excellent cattle fodder. Fresh bamboo leaves can be collected throughout the year owing to its 'evergreen' characteristic. House of livestock was usually made of bamboo.

Figure 4.k. Bamboo house for livestock

(a)Chicken coop (b) pig sty and (c) portable basket to carry livestock

4.3.2. Present conventional use of bamboos

Bamboo has gained importance as a resource capable of providing ecological security and nurturing economic benefits to the people. From a 'poor man's timber' (Sagwal, 1982)[25] to 'the miracle plant' as addressed by the then Prime Minister of India Atal Bihari Vajpayee, bamboo is regarded for its high economic value. The Prime Minister had in the Seventh World

[24]Scurlock et al., (2000).op. cit. p. 1
[25]Sagwal, S.S., 1982. Bamboo--a poor man's timber. *Farmer and parliament.* 7(2), 15-16.

Bamboo Congress[26] way back in 2004 had tagged bamboo as a vehicle to boost rural economy. It is considered as fast emerging super material of the 21st century. Products of bamboos are used everywhere and bamboo industries are now thriving in Asia and are quickly expanding across the continents of Africa and America (FAO, 2007)[27].

In the modern day, bamboo made products is common, which makes part of a regular set up in a Naga society that its use ranges from household to market. Bamboos have made a mark even in beauty industries. Various items have bamboo as one of the key elements such as perfume, face masks, face cream, face wash, toothpaste, and face wipes. Bamboo is being used as both packaging and an ingredient in cosmetic products. It is an eco-friendly and sustainable product that is increasingly being used in natural cosmetic.

Some other common uses of bamboo in Nagaland are as follows:

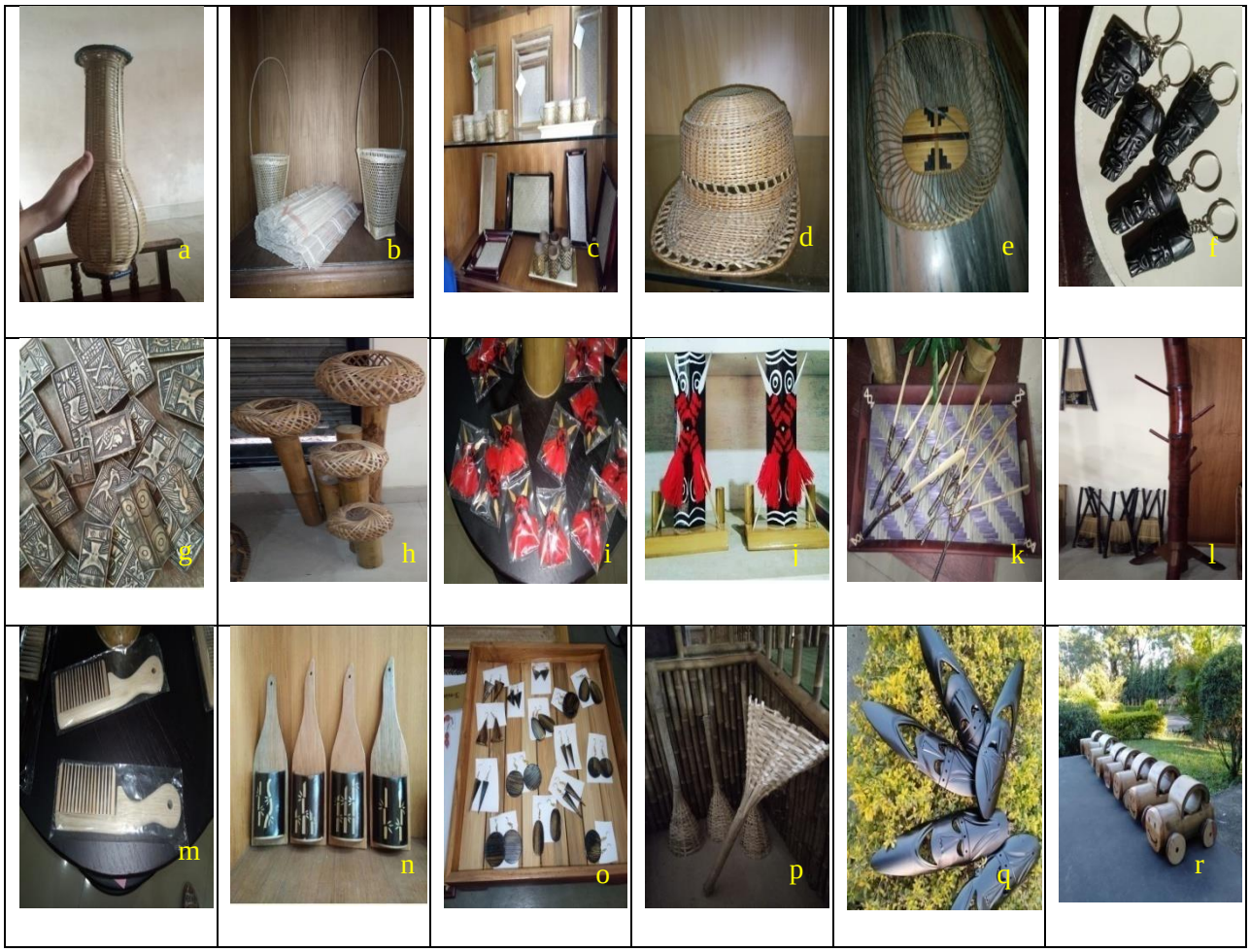
4.3.2.1. Bamboo handicrafts

The Naga artisans and craftsmen are good in transforming the extremely adaptable bamboo into a variety of utilizations, decorative and also ritualistic objects. There is a legacy of traditional knowledge and skills in bamboo craft and use. Bamboo crafts can be used to replace plastic to a large extend as bamboo is eco-friendly. Artisan communities depend on bamboo crafts for their livelihoods. Bamboo handicrafts have now gain national and international recognition.

[26]Rediff news, February 27, 2004 Bamboo associated with my name: Vajpayee, viewed 20 March 2019,https://www.m.rediff.com.

[27]FAO, World Bamboo Resources (2007). A thematic study prepared in the framework of the Global Forest Resources Assessment, Non-wood forest products, Food and Agriculture Organization of the United Nations, Rome.

Figure 4.l. Handicrafts



(a) flower pot, (b) blinds and baskets (c) trays (d) hat (e) fruit tray (f) key holder (g) fridge magnet (h) pot stand, (i) badge (j)) logo stand (k) thongs (l) bag stand (m) comp (n) brush stand (o) earrings (p) waste bin (q) face mask (r) toys.

4.3.2.2. Modern bamboo furniture

Furniture made of bamboo have been in use for centuries. As bamboo is known for strong, sustainable and durable it plays an integral part in everyday life. The use of a combination of contemporary and traditional method by the Naga artisan, bamboo furniture looks sophisticated and is comfortable to use. With the advancement in technology, bamboo is

now used to make high end product like bamboo furniture which is long lasting, attractive, versatile and multifunctional having high market demand.

Figure 4.m. Bamboo furniture

4.4.2.3. Others

Bamboo has established traditions for being used as construction materials such as, for the element structure, roof, walls, floors, scaffolding and support. It is one of the best sustainable resources for construction industry (von Seidlein et al., 2017)[28]. It is used for making structure and support in constructions of houses. Today, the modern tourist resort in the world is made of bamboo. Bamboo species like *Bambusabalcooa, B. tulda, B. nutans, B. pallida, B.polymorpha, Dendrocalamushamiltonii*and *Melocannabaccifera* are suitable for construction (Borah et al., 2008)[29].

Bamboo charcoal serve as an antibacterial agent, which is capable of absorbing unpleasant odour and toxic substances as its absorption capacity is six times more than that of

[28]VonSeidlein, L., Ikonomidis, K., Mshamu, S., Nkya, T. E., Mukaka, M., Pell, C., ...& Knudsen, J. B. (2017). Affordable house designs to improve health in rural Africa: a field study from northeastern Tanzania. *The Lancet Planetary Health*, *1*(5), e188-e199.
[29]Borah, E. D., Pathak, K. C., Deka, B., Neog, D., & Borah, K. (2008). Utilization aspects of Bamboo and its market value. *Indian Forester*, *134*(3), 423-427.

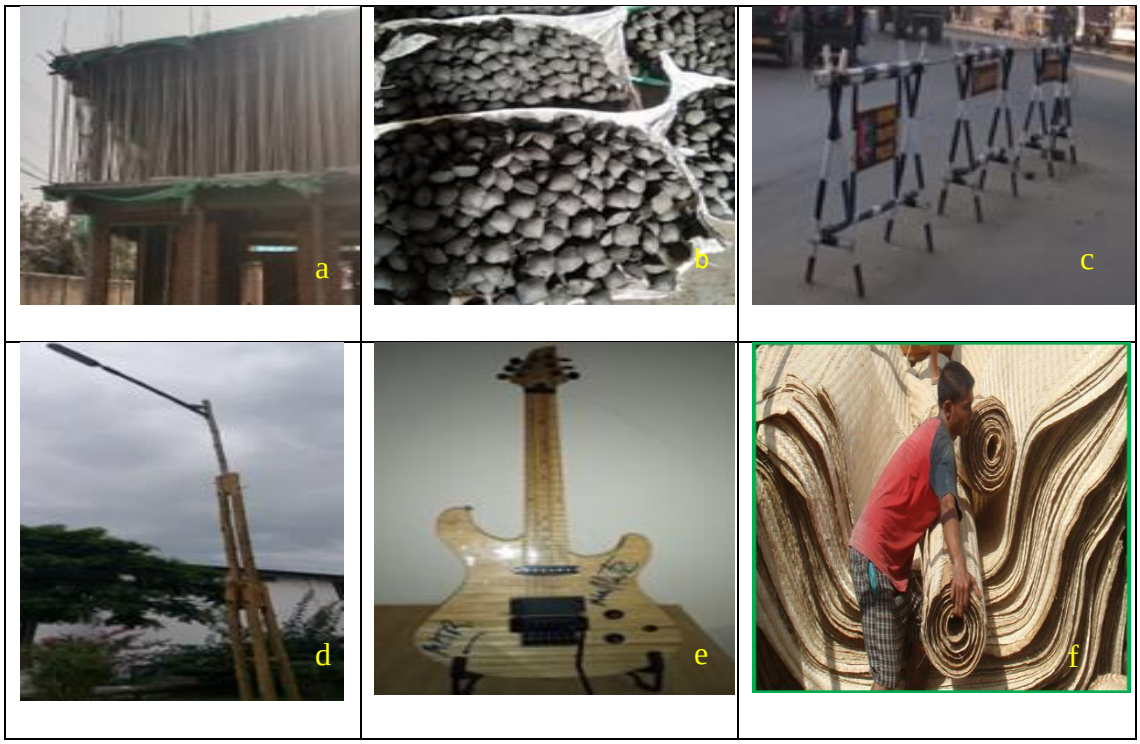
wood charcoal (Dwivedi et al., 2014)[30]. It has huge potentials for economic up-liftmen where large resources of wild bamboo are available in the state. Bamboo charcoal is made of bamboo by means of Pyrolysis process. It not only provides a new way to utilize bamboo, but also benefits environment protection by reducing pollutant residue. It is an environmentally functional material that has excellent absorption properties.

To promote Atmanirbhar Bharat Adhiyan Programme encouraging 'vocal for local' Dimapur police promoted using bamboo barricades as traffic assistance tools and road safety. Street light post is made of bamboo which is durable. A bamboo guitar promoted by NBDA, the first of its kind in India, was launched in 2012.

The first commercial production of bamboo mats is supposed to have started in 1940 which was supplied to British army to build their camps and to Tea estates in Assam at the rate of ₹1 per 16 mats and mat supply chain as cluster activity started in March 2006 (Infomag, 2015)[31]. Bamboo mats is produced by weaving thin bamboo slivers, using simple tools. The raw material is usually sourced from either the individual's forest land or community forest. There is an increasing demand of bamboo mats which is also used as curtains. With the inherent skill of Naga villager in the art of weaving mats, it has created the potentials of mat production as a viable micro bamboo enterprise which can enhance the rural economy.

[30]Dwivedi, A., Jain, N., Patel, P., & Sharma, P. (2014). The versatile bamboo charcoal. *Int. J. Res. Sci. Innov. I*, 129-131.
[31]Infomag (2015).op. cit. p. 85

Figure 4. n. Other uses of bamboo



(a) Pole, (b) Charcoal, (c) Barricades (d) Street light stand, (e) Guitar and (f) Mats

4.4. CONCLUSION

Bamboo being one of the most valuable and abundant forest resources, it occupies central place in the lives of the Naga society. The multiple use of Bamboo in the day to day lives of people in Naga society is evident with its rich tradition and knowledge related to utilization of bamboo is reflected by the fact that bamboo products were used in the kitchen as utensils, water carrier and storage and also as food products. It was used to make beds, chairs, fences, bridge as infrastructure material. Bamboos were used in the constructions of houses as roof, floor, walls and ropes. It has been an integral part of Naga family and a way of life.

Over the years, bamboos have moved from traditional uses to rapid commercialization of its products in various parts of the country. The initial understanding about bamboo that was

associated with the culture has now gaining momentum as commercial product for variant purposes. However, its benefits are yet to be fully understood and realized by the larger community of professionals and end users. Bamboo as a material can be made as an integral part in architectural and engineering studies. It provides lot of scope for innovations in design because of its qualities like strength, flexibility and usability. The knowledge, art and creativity use of bamboo can be clearly seen thus bamboo is a marker of indigenous identity and will continue to be so, as long as the resources sustain.

CHAPTER 5

BAMBOO PRODUCTION AND ITS DETERMINANTS

5.1. INTRODUCTION

This chapter deals with the bamboo production and its determinants. It is important to know the status of bamboo production and those factors determining it. Bamboo is regarded as the major resource which meets the requirements of common people and also a poverty alleviator (IFAD, 2014)[1]. It is estimated that about 8.6 million people depend on bamboo for their livelihood around the world (FSI, 2019)[2].

A review of bamboo resource statistics shows that the information available is scarce, fragmented and contradictory and cannot be compared within or between regions of the world (Lobovikov, M et al., 2007)[3].

5.2. BAMBOO RESOURCE OF THE WORLD.

The extent of bamboo resource is mainly indicated by the growing stock. Information regarding the bamboo growing stock and resource of Asian and African countries are presented in table 5.1. Data for the rest of the countries was not presented as no proper records were available.

There were eight Asian countries namely Bangladesh, China, India, Indonesia, Malaysia, Myanmar, Pakistan and Philippines and five African countries namely Ethiopia, Kenya, Nigeria, Uganda and United republic of Tanzania have provided information on area and stock of bamboo resource. Bamboo stock in Asian countries increased from 251 million

[1]IFAD. 2014. Annual Report 2013. International Food and Agriculture Department, Rome.
[2]FSI. 2019. India State of Forest Report 2019, Volume 1. Forest Survey of India, Dehradun.
[3]Lobovikov, M., Paudel, S., Ball, L., Piazza, M., Guardia, M., Ren, H., ...& Wu, J. (2007). *World bamboo resources: a thematic study prepared in the framework of the global forest resources assessment 2005* (No.18). Food & Agriculture Org.

tonnes in 1990 to 332 million tonnes in 2005. Over 80 per cent of the growing stock was contributed by China and India alone.

In African countries, bamboo stock remained the same from 1990 to 2005 that is 57 million tonnes. Ethiopia and Nigeria contributed 80 per cent of the total growing stock African countries.

Table 5.1. Growing stock of bamboo resources.

Country	1990			2000			2005		
	Area (1000 ha)	Stock Million tonnes	Average (tonnes per ha)	Area (1000 ha)	Stock Million tonnes	Average (tonnes per ha	Area(1000 ha)	Stock Million tonnes	Average (tonnes per ha)
Bangladesh	90	1	11	86	1	12	83	1	12
China	3856	96	25	4869	144	30	5444	164	30
India	10711	115	11	10863	117	11	11361	122	11
Indonesia	2151	13	6	2104	11	5	2081	10	5
Malaysia	422	7	17	592	10	17	677	11	17
Myanmar	963	18	19	895	18	21	859	18	21
Pakistan	9	0.09	10	14	0.14	10	20	0.21	11
Philippines	127	6	48	156	6	39	172	6	35
Total Asia	18329	251	14	19579	307	15	20697	332	16
Ethiopia	842	21	25	849	21	25	849	21	25
Kenya	124	1	5	124	1	5	124	1	5
Nigeria	1590	27	17	1590	27	17	1590	27	17
Uganda	67	3	37	67	3	37	67	3	37
United republic of Tanzania	128	5	35	128	5	35	128	5	35
Total Africa	2758	57	21	2758	57	21	2758	57	21
Total	21087	314	15	22337	364	16	23455	389	17

Source: World bamboo resources: a thematic study prepared in the framework of the global forest resources assessment 2005 (No.18). Food & Agriculture Org.

**Note: The systematic data beyond 2005 were not available*

The table 5.1 depicts that in 1990, India had the largest bamboo area of 10711 hectares which is followed by China and Indonesia. India still continue to have largest bamboo area in the world as per 2005 with the land area of 11361 hectares. Despite of having largest area of bamboo resource in India, China has the highest stock of bamboo in 2005 with 164 million tonnes as against 122 million tonnes in India.

Table 5.2. Compounded Annual Growth Rate (CAGR) of Area, production and productivity of bamboo in world from 1990 to 2005.

Country	Area	Stock	Average
Total Asia	0.008	0.019	0.009
Total Africa	0	0	0
Over all	0.007	0.014	0.008

Source: Table 5.1

The compounded annual growth rate which is the representative growth rate of area, production and productivity is 0.007 per cent, 0.014 per cent and 0.008 per cent, respectively. During the observed period the area and stock of bamboo resources in Asian countries have increased at marginal rates but for Africa, it remained stagnant.

5.3. BAMBOO RESOURCE OF INDIA.

According to FSI Report 2019, there are about 125 indigenous and 11 exotic species from 23 genera of bamboo. It is found in deciduous and semi-evergreen forest of North-Eastern region and tropical moist deciduous forest of North and South India. In spite of having rich resource base and a wide spread living tradition of bamboo use, the tremendous potential of bamboo lies dormant and largely untapped in comparison with countries like

China, Japan and Taiwan (Sastry. 2001)[4]. The area, production and productivity of bamboo resource in India is presented in table 5.3.

Table 5.3. State-wise Area, production and productivity of Bamboo in of India (2019)

States	Area (000'hectacres)	Production (million tonnes)	Productivity (MT/ hectare)
Andra Pradesh	7003 (5)	1820 (4.82)	0.26
Arunachal Pradesh	14,981(9.81)	5769 (15.29)	0.39
Assam	10,525 (6.89)	3829 (10.15)	0.36
Bihar	1,136 (0.74)	247 (0.65)	0.22
Chhattisgarh	11,255 (7.37)	2114 (5.60)	0.19
Goa	418 (0.27)	30 (0.08)	0.07
Gujarat	3,393 (2.22)	677 (1.79)	0.20
Himachal Pradesh	650 (0.43)	485 (1.26)	0.75
Jharkhand	4,123 (2.70)	876 (2.32)	0.21
Karnataka	10,181(6.67)	1910 (5.06)	0.19
Kerala	2,849 (1.87)	1030 (2.73)	0.36
Madya Pradesh	20,867 (13.66)	3595 (9.53)	0.17
Maharashtra	15,408 (10.09)	2971 (7.88)	0.19
Manipur	9,903 (6.48)	1126 (2.98)	0.11
Meghalaya	5,410 (3.54)	1521 (4.03)	0.28
Mizoram	3,476 (2.28)	1074 (2.85)	0.31
Nagaland	4,284 (2.81)	2544 (6.74)	0.59
Orissa	11,827 (7.74)	2291 (6.07)	0.19
Punjab	255 (0.17)	11 (0.03)	0.04
Rajasthan	1,874 (1.23)	527 (1.40)	0.28
Sikkim	1,176 (0.77)	218 (0.58)	0.19
Tamil Nadu	4,357 (2.85)	946 (2.51)	0.22
Tripura	3,783 (2.48)	1110 (2.94)	0.29
Uttar Pradesh	1,235 (0.81)	236 (0.63)	0.19
Uttarakhand	1,489 (0.98)	384 (1.02)	0.26
West Bengal	855 (0.56)	384 (1.02)	0.45
Total	152713 (100)	37725 (100)	0.29

Source: ISFR, 2019.

Note: Figures in the parentheses are percentage to the country's total.

Information for A & N Island, Chandigarh, Delhi, Daman & Diu, Lakshadweep, J&K, Puducherry, Telangana, Haryana and Dadra & Nagar Haveli is not given due to inadequate data.

The area, production and productivity as per India State of Forest Report shows that in 2019 total area of bamboo cultivation in India was 15271300 hectares. Madhya Pradesh

[4]Sastry, C. B. (2001). Bamboo: Timber for 21st century. *Draft paper for International Network for bamboo and Rattan (INBAR), China.*

(13.66 %) and Maharashtra (10.09 %) have the highest area under the cultivation. Production is highest in Arunachal Pradesh with 15.29 per cent, which is followed by Assam with 10.15 per cent of the total production in India. Productivity is highest in Himachal Pradesh having 0.75 per hectare which is followed by Nagaland with 0.59 per hectare.

Table 5.4. Compound annual growth rate of area, production and productivity of bamboo in India (2011 to 2019).

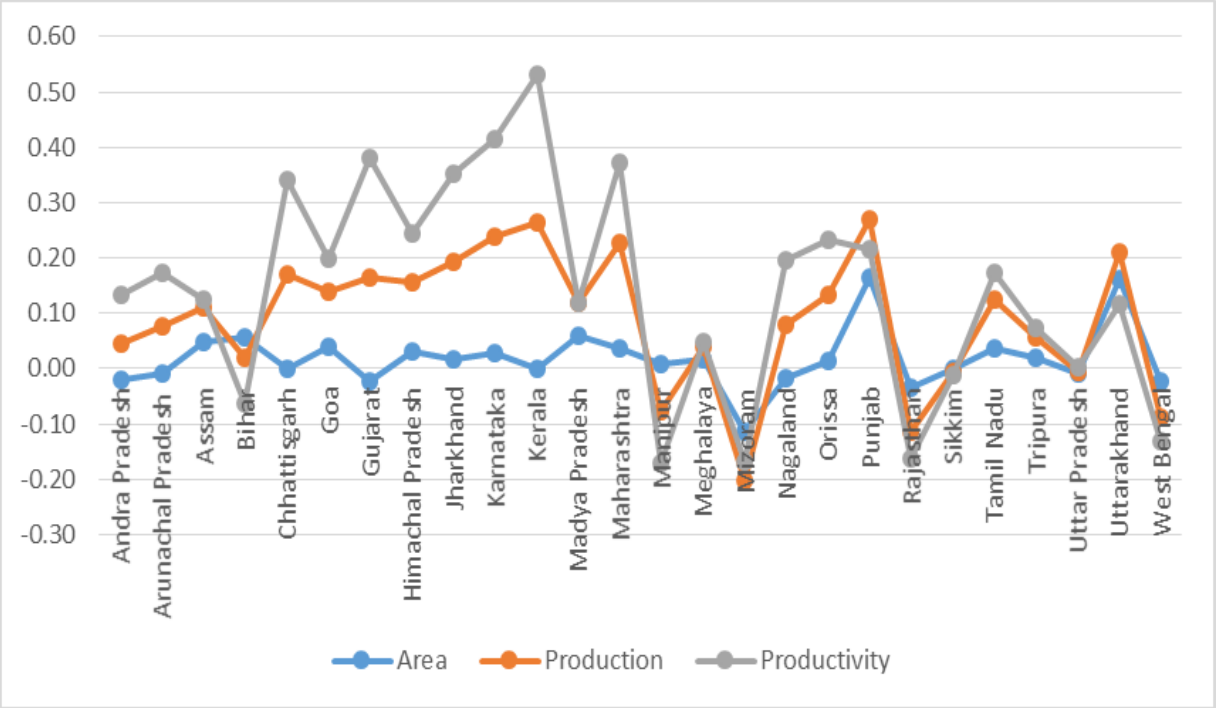
States	Area	Production	Productivity
Andra Pradesh	-0.02	0.07	0.09
Arunachal Pradesh	-0.01	0.09	0.10
Assam	0.05	0.06	0.01
Bihar	0.06	-0.03	-0.08
Chhattisgarh	0.00	0.17	0.17
Goa	0.04	0.10	0.06
Gujarat	-0.02	0.19	0.22
Himachal Pradesh	0.03	0.12	0.09
Jharkhand	0.02	0.18	0.16
Karnataka	0.03	0.21	0.18
Kerala	0.00	0.27	0.27
Madya Pradesh	0.06	0.06	0.00
Maharashtra	0.04	0.19	0.15
Manipur	0.01	-0.09	-0.09
Meghalaya	0.02	0.02	0.01
Mizoram	-0.12	-0.09	0.03
Nagaland	-0.02	0.10	0.12
Orissa	0.01	0.12	0.10
Punjab	0.17	0.10	-0.05
Rajasthan	-0.03	-0.08	-0.05
Sikkim	0.00	-0.01	-0.01
Tamil Nadu	0.04	0.09	0.05
Tripura	0.02	0.04	0.02
Uttar Pradesh	-0.01	0.00	0.01
Uttarakhand	0.16	0.05	-0.10
West Bengal	-0.02	-0.07	-0.04
Total	0.01	0.06	-0.32

Source: Source: ISFR, 2011 & 2019.

The compound annual growth rate of area was 0.01, production was 0.06 and productivity was -0.32 in India. Among the states, Punjab has experienced highest growth in area (0.17), followed by Uttarakhand (0.16). The growth in production was highest in Kerala

(0.27), followed by Karnataka (0.21). While in respect of productivity, it was highest in Kerala (0.27 %), followed by Gujarat (0.22).

Figure 5.a. Compound annual growth rate of different states in India (2011-2019)



Source: Table 5.4

5.4. BAMBOO RESOURCE IN NAGALAND

Bamboo plays an important role in *Naga* society as it provide food, shelter and livelihood. It is an abundant resource found growing extensively all over the state and is one of the most important forest resource, which is rapidly renewable. The bamboo bearing area in Nagaland is shown in table 5.5.

Table 5.5. Bamboo bearing area under different classes in recorded forest area in Nagaland.

Bamboo bearing area (in sq. km)	2011	2017	2019
Recorded Forest Area	13318	12489	12486
Bamboo Area	4902	6025	4284
Percentage in total forest area	36.81	48.24	34.31
Pure Bamboo	101	57	227
Dense Bamboo	3064	1669	1137
Scattered Bamboo	1644	4196	2730
Culms hacked	65	30	75
Bamboo regeneration	28	73	115

Source: FSI 2011, 2017 & 2019

As one of the states in the North East region, Nagaland has rich biodiversity and a home to many species of flora and fauna. The State's total geographical area is 16,579 sq. km. with a forest cover of 12,489 sq. km., which comprised of 75.33% (FSI, 2019) of total area. Percentage of bamboo to forest area is found to be highest in 2017 (48.24%). According to the ISFR-2019, in Nagaland, 4284 sq.km is bamboo bearing area (constituted 34.31% of its forest area). The data also shows that bamboo area increased from 4902 sq. km in 2011 to 6025 sq. km in 2017. However, the state has witnessed was a decline in bamboo area in 2019 to 4284 sq. km. There is increased in pure bamboo from 101 in 2011 to 227 in 2019, culms hacked increased from 60 sq.km in 2011 to 75 sq.km in 2019 and bamboo generation was 28 sq.km in 2011 and 115 sq.km in 2019.

Table 5.6. Number of estimated culms by soundness and green weight

1	Number of culms by soundness (in millions)	2011	2017	2019
	Green Culms	1077 (88.57)	985(75.71)	2,289(89.98)
	Dry Culms	102 (8.39)	188(14.45)	98 (3.85)
	Decayed	37 (3.04)	128(9.84)	157 (6.17)

	Total	1216 (100)	1301 (100)	2544 (100)
2	**Equivalent Green Weight (in 000' tones)**			
	Green Culms	6150 (84.55)	8037(71.32)	18,678(90.90)
	Dry Culms	1124 (15.45)	3232(28.68)	1869(9.10)
	Total	7274(100)	11269(100)	20,547(100)

Source: FSI 2011, 2017 & 2019.

Note: Figures in the parentheses are percentage to the total

Nagaland holds third place in maximum increase in number of culms by soundness and also in equivalent green weight among the different states of India. There is an increase of 1243 million culms by soundness in 2019 as compared to 2017. In equivalent green weight, there is an increase of 9278 million tonnes in 2019 with reference to 2017. This indicate that even though the bamboo area is declining, the number of culms is increasing, which means the productivity has been increased.

Bamboo plantation is practised in all the districts of Nagaland. At micro-level, bamboo farming is an activity taken up by individuals, especially for income generation which is mostly in homesteads and also for catering domestic demand. At small and medium level, farming activity is taken up by groups, societies and SHGs, especially to provide raw material to small scale industries. At the large or community level, farming activity is taken up by the communities as a whole, which is targeted to provide raw materials to large scale users and industries.

Bamboo is planted from seeds or through vegetative propagation. Propagation through rhizome, culms and branch cutting is predominantly practiced in the state. The table 5.7 below present the area, production and productivity of bamboo in the districts of Nagaland.

Table 5.7. District wise Area, Production and Productivity of Bamboo in Nagaland (2016-17)

District	Area(ha)	Production(MT)	Productivity(MT/ha)
Kohima	200 (8)	143 (6.84)	0.72
Dimapur	300 (12)	287 (13.73)	0.96
Mokokchung	300 (12)	326 (15.59)	1.09
Wokha	200 (8)	152 (7.27)	0.76
Zunheboto	200 (8)	134 (6.41)	0.67
Phek	200(8)	154 (7.36)	0.77
Tuensang	200(8)	168 (8.03)	0.84
Mon	200 (8)	152 (7.27)	0.76
Kiphire	200(8)	143 (6.84)	0.72
Longleng	200 (8)	163 (7.80)	0.82
Peren	300 (12)	269 (12.86)	0.90
Total/Average	2500	2091	0.82

Source: NBDA office record, 2019.

Note: Figures in the parentheses are percentage to the total

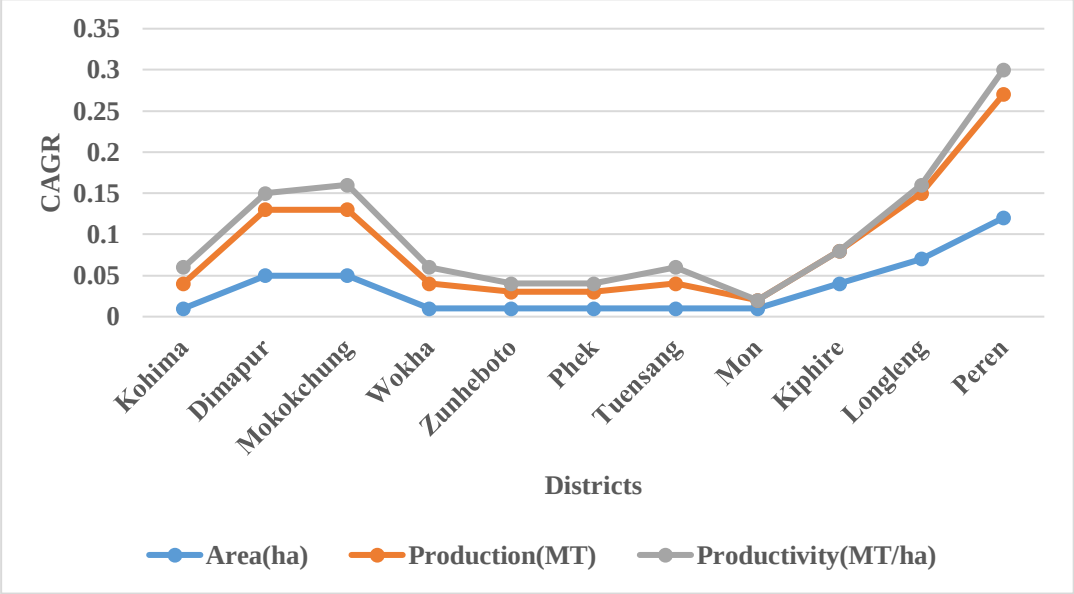
The area, production and productivity as per NBDA record shows that in 2016-17 total area of bamboo cultivation in Nagaland was 2500 hectare where Dimapur, Mokokchung and Peren has the highest area under the cultivation having 300 hectares each. As a result, the production is highest in Mokokchung with 15.59 per cent which is followed by Dimapur with 13.73 per cent of the total production in Nagaland. Productivity is highest in Mokokchung with 1.09 MT/ha. and it is followed by Dimapur with productivity of 0.96 MT/ha and Peren with 0.90 MT/ha. The average productivity for the state is estimated at 0.82 MT/ ha.

Table 5.8. Compound annual growth rate of area, production and productivity of bamboo in Nagaland (2005-06 to 2016-17)

District	Area(ha)	Production(MT)	Productivity(MT/ha)
Kohima	0.01	0.03	0.02
Dimapur	0.05	0.08	0.02
Mokokchung	0.05	0.08	0.03
Wokha	0.01	0.03	0.02
Zunheboto	0.01	0.02	0.01
Phek	0.01	0.02	0.01
Tuensang	0.01	0.03	0.02
Mon	0.01	0.01	0
Kiphire	0.04	0.04	0
Longleng	0.07	0.08	0.01
Peren	0.12	0.15	0.03
Overall	0.04	0.07	0.03

Source: Table 5.7

Figure 5.b. Compound annual growth rate of Bamboo in Nagaland (2005-06 to 2016-17)



Source: Table 5.8

The compound annual growth rate of area, production and productivity is found to be insignificant with 0.04, 0.07 and 0.03 respectively, during 2005-06 to 2016-17. Similarly, the district wise growth rates are also insignificant for area, production and productivity.

5.5. FACTORS INFLUENCING INCOME AND PRODUCTION

5.5.1. Factors influencing income

A multiple regression analysis was carried out to investigate whether the socio-economic independent variables such as gender, age, educational qualification, family size, experiences in cultivation, area under cultivation, motive and occupation could significantly predict income per month of the bamboo farmers.

$$y = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \varepsilon$$

Where, y = Income per month

βi= Parameter

ε = Error

x_1 = Gender (Male = 1, Female = 2)

x_2 = Age (in years)

x_3 = Educational qualification (Primary=1, Secondary = 2, Graduate = 3)

x_4 = Family size (in numbers)

x_5 = Experiences (in years)

x_6 = Area under cultivation (in hectare)

x_7 = Motives (Domestic need =1, Main source of income =2, Supplement income =3)

x_8 = Occupation (Farming =1, Own business =2, Service =3)

Table 5.9. Regression Analysis: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.836[a]	.698	.688	.548

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	167.594	8	20.949	69.725	.000
Residual	72.410	242	.300		
Total	240.004	250			

a. Predictors: (Constant), Age, Gender, Occupation, Motive, Experience, Farm size, Education, Area

b. Dependent Variable: Annual Income

Coefficients

Variables	Un-standardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.501	.295		3.697	.000
Gender	.282	.119	.085	2.374	.058**
Age	.028	.062	.018	.457	.648
Educational Qualification	.056	.053	.040	1.057	.292
Family size	.079	.088	.033	.897	.371
Experience	.297	.060	.183	4.912	.001*
Area under cultivation	.339	.035	.377	9.664	.001*
Motives	.054	.042	.047	1.270	.205
Occupation	.726	.050	.569	14.379	.001*

*Significant at 1% and **at 5% levels.

The result of multiple regression analysis in table 5.9 shows dependent variable is found to be statistically a good fit as R^2 is .698, thus, about 70% of the variation in monthly income of the bamboo farmer is explained by independent variables like gender, age, educational qualification, family size, experience, area under cultivation, motives and occupation. The regression analysis seems to be appropriate for making useful predictions since the value of R Square is closer to 1.

The independent variables significantly predicts the dependent variable, F = 69.725, p<.001. From the data analysis, it can infer that the F-test is highly significant. This indicates that the model explains a significant amount of the variance in income.

The regression coefficient provides the significance level, beta coefficient and the t-values. The result indicates that years of experience, area of cultivation and occupation are statistically significant at p< .001 level and significant predictors of monthly income of the farmers. The years of experience in bamboo cultivation (B =.297, P = .001) is significant and its coefficient is positive indicating that monthly income increases by 29.7 % for each 1 year increase in experience. This is because with experience, a person becomes more efficient if continuously engaged in same activities. Area of cultivation (B =.339, p=.001) is significant and predicted income increases by 33.9 per cent for each 1 hectare increase in area of cultivation. As area is increased more plantations can be carried out leading to more number of bamboo production and thus increasing the level of income. The occupation (B=.726, p=.001) is significant and its coefficient is positive indicating that income increases by 72.6 per cent as the respondents' occupation shifts from agriculture to secondary and tertiary activities.

5.5.2. The determinant of Production

A multiple regression analysis was carried out to examine whether the predictors like area under bamboo cultivation, number of years of farmer's experience in bamboo cultivation, annual profits and annual total investment (cost) are significant predictors of annual production of bamboo. The following regression model is set to carry out this analysis.

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon$$

Where, y = Annual Production (MT)

β_i= Parameter

ε = Error

X_1 = Experience in bamboo cultivation (in years)

X_2 = Area of cultivation (in hectare)

X_3 = Total cost per year (in Rs.)

X_4= Profits (in Rs)

Table 5.10. Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.998[a]	.995	.987	1402.669

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.

Regression	9.679	4	2.420	1.230	.000[a]
Residual	4.820	246	1967480.46		
Total	9.727	250			

a. Predictors: (Constant), Profit, area of cultivation, Number of years in cultivation, Total cost

b. Dependent Variable: Annual production of bamboo (MT)

Coefficients

Variables	**Un-standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	Std. Error	Beta		
(Constant)	608.112	366.737		1.658	.000
Experience (in years)	88.157	35.387	.015	2.491**	.013
Area (in ha)	.172	93.382	.145	11.921*	.001
Total cost (in ₹)	.282	.009	.692	33.129*	.001
Profit (in ₹)	.112	.004	.430	29.485*	.001

a. Dependent Variable: Annual production

* significant at 1% and ** at 5% levels.

The correlation coefficient R is 0.998, seems to indicate close positive relationship of the variables (dependent and predictors). The coefficient of determination R^2 is 0.995, thus, about 99.50% of the variation in production is explained by experience, area of cultivation, total cost and profits. The regression analysis seems to be appropriate for making useful predictions since the value of R Square is close to 1.

The table 5.10 shows that the independent variables significantly predicts the dependent variable, $F(4, 246) = 1.230$, $p < .001$. From the data analysis, we can infer that the F-test is significant. This indicates that the model explains a significant amount of the variance in production.

The regression coefficient in table 5.10 indicate that area, total cost and profits are statistically significant as p<.001 level and significant predictors of annual production.

The area under bamboo cultivation (B=.172, p=.001) is significant, where t =11.92 and its coefficient is positive indicating that predicted annual production of bamboo in clump increases by 17.52% for each 1 hectare increase in area. Total cost (B=.282, p=.001) is significant with t = 33.12 and predicted annual production of bamboo increases by 28.2% for each 1 percent increase in total cost. Profit (B=.122, p=.001) is significant with t= 29.49 and predicted that annual production of bamboo will increases by 12.2% for each percent increase in profit.

5.6. CONCLUSION

Even though bamboo is known to human for long, it was not considered as a valuable resource. As such, there is no proper documentation on the bamboo resource of the world. Data on bamboo resource was found to be scare and inconsistent. A thematic study was conducted by FAO in 2015 and the result showed that China have the major bamboo resource of the world.

India is a home to several type of bamboo and most of them are found in North-Eastern part of India. According to IFSR 2019, the total land area of bamboo was 151713 hectares with 37725 million of estimated bamboo culms. In Nagaland, forest area was 12,486 hectares and the total bamboo area was 4284 hectares.

Multiple regression analysis reveals that the predictors like occupation, area and experience are significant predictors of income of the bamboo farmers. Moreover, area of cultivation, number of years in cultivation, profits and total cost are significant predictors of total annual production of bamboo, which are positively related. The study shows that

increase in area of cultivation and investment (cost) results in higher production of bamboo, thus the vast degraded land area in the State may be brought under managed bamboo cultivation, with increased investment and thus create a sustainable resource base. Bamboo plantation for productive and protective utilization of uncultivable land is not only profitable for the local stakeholders but also an economically viable policy option for the funding agencies and government as it will generate additional employment and income that sustain and secured the livelihood of the people.

ANNEXTURE 5.1: Area, production and productivity of Bamboo of India (2011, 2017 & 2019)

State/ UT	2011			2017			2019		
	Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
Andra Pradesh	8,184	1098	0.13	7,578	1076	0.14	7003	1820	0.26
Arunachal Pradesh	16,083	2980	0.19	15,125	4048	0.27	14,981	5769	0.39
Assam	7,238	2341	0.32	8,955	2452	0.27	10,525	3829	0.36
Bihar	739	327	0.44	1,004	353	0.35	1,136	247	0.22
Chhattisgarh	11,368	601	0.05	11,060	1075	0.10	11,255	2114	0.19
Goa	308	14	0.05	382	26	0.07	418	30	0.07
Gujarat	4,091	171	0.04	3,544	485	0.14	3,393	677	0.20
Himachal Pradesh	508	191	0.38	540	321	0.59	650	485	0.75
Jharkhand	3,603	238	0.07	4,470	666	0.15	4,123	876	0.21
Karnataka	8,186	417	0.05	10,442	1166	0.11	10,181	1910	0.19
Kerala	2,882	157	0.05	3,484	834	0.24	2,849	1030	0.36
Madya Pradesh	13,058	2270	0.17	18,167	2406	0.13	20,867	3595	0.17
Maharashtra	11,465	748	0.07	15,927	1816	0.11	15,408	2971	0.19
Manipur	9,303	2297	0.25	10,687	2340	0.22	9,903	1126	0.11
Meghalaya	4,793	1251	0.26	5,943	1323	0.22	5,410	1521	0.28
Mizoram	9,245	2205	0.24	3,267	716	0.22	3,476	1074	0.31
Nagaland	4,902	1216	0.25	6,025	1301	0.22	4,284	2544	0.59
Orissa	10,518	944	0.09	12,109	1585	0.13	11,827	2291	0.19
Punjab	75	5	0.07	44	6	0.14	255	11	0.04
Rajasthan	2,455	1026	0.42	1,976	831	0.42	1,874	527	0.28
Sikkim	1,181	228	0.19	553	135	0.24	1,176	218	0.19
Tamil Nadu	3,265	485	0.15	4,154	777	0.19	4,357	946	0.22
Tripura	3,246	830	0.26	3,617	797	0.22	3,783	1110	0.29
Uttar Pradesh	1,313	235	0.18	936	175	0.19	1,235	236	0.19
Uttarakhand	451	259	0.57	1,078	267	0.25	1,489	384	0.26
West Bengal	1,042	660	0.63	942	464	0.49	855	384	0.45
Total	1,39,502	23194	5.56	1,52,009	27441	0.18	152713	37725	0.25

ANNEXTURE 5.2: Area, production and productivity of Bamboo of Nagaland (2015-2017).

District	Kohima			Dimapur			Mokokchung			Wokha		
	Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
2005-06	180	105	0.58	180	135	0.75	180	145	0.81	180	112	0.62
2006-07	300	124	0.41	350	223	0.64	1000	725	0.73	250	175	0.70
2007-08	600	421	0.70	600	475	0.79	1091	802	0.74	450	311	0.69
2008-09	215	109	0.51	210	104	0.50	650	461	0.71	210	162	0.77
2009-10	150	92	0.61	240	161	0.67	1050	912	0.87	270	194	0.72
2010-11	430	204	0.47	510	384	0.75	1114	1007	0.90	400	371	0.93
2011-12	340	145	0.43	440	312	0.71	924	649	0.70	370	162	0.44
20012-13	700	649	0.93	600	474	0.79	1000	928	0.93	350	146	0.42
2013-14	930	721	0.78	600	430	0.72	1150	1032	0.90	600	385	0.64
2014-15	132	98	0.74	100	53	0.53	144	102	0.71	78	54	0.69
2016-17	200	143	0.72	300	287	0.96	300	326	1.09	200	152	0.76
CAGR	**0.01**	**0.03**	**0.02**	**0.05**	**0.08**	**0.02**	**0.05**	**0.08**	**0.03**	**0.01**	**0.03**	**0.02**

Zunheboto			Phek			Tuensang			Mon		
Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
180	114	0.63	180	126	0.70	180	122	0.68	180	142	0.79
250	137	0.55	350	283	0.81	350	210	0.60	262	119	0.45
450	314	0.70	620	486	0.78	500	423	0.85	550	426	0.77
210	98	0.47	210	164	0.78	180	133	0.74	80	47	0.59
150	92	0.61	150	93	0.62	150	94	0.63	250	137	0.55
400	283	0.71	480	285	0.59	470	328	0.70	430	326	0.76
350	231	0.66	360	264	0.73	340	147	0.43	360	294	0.82
350	236	0.67	600	456	0.76	350	182	0.52	550	368	0.67
300	176	0.59	600	462	0.77	300	142	0.47	300	183	0.61
78	42	0.54	78	778	9.97	78	51	0.65	78	110	1.41
200	134	0.67	200	154	0.77	200	168	0.84	200	152	0.76
0.01	**0.02**	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**	**0.03**	**0.02**	**0.01**	**0.01**	**0.00**

Kiphire			Longleng			Peren			NAGALAND		
Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
130	95	0.73	100	76	0.76	100	79	0.79	1770	143	0.08
250	184	0.74	280	184	0.66	250	217	0.87	3892	287	0.07
400	316	0.79	400	380	0.95	400	371	0.93	6061	326	0.05
210	175	0.83	180	136	0.76	210	185	0.88	2565	152	0.06
150	98	0.65	270	165	0.61	150	118	0.79	2980	134	0.04
400	261	0.65	440	317	0.72	430	368	0.86	5504	154	0.03
350	236	0.67	350	214	0.61	340	216	0.64	4524	168	0.04
432	247	0.57	350	195	0.56	650	624	0.96	5932	152	0.03
370	169	0.46	300	163	0.54	300	176	0.59	5750	143	0.02
78	62	0.79	78	51	0.65	78	65	0.83	1000	163	0.16
200	143	0.72	200	163	0.82	300	269	0.90	2500	269	0.11
0.04	**0.04**	**0.00**	**0.07**	**0.08**	**0.01**	**0.12**	**0.13**	**0.01**	**0.04**	**0.07**	**0.03**

CHAPTER 6

COST- RETURNS ANALYSIS IN BAMBOO PRODUCTION

6.1. INTRODUCTION

To study the economics of business, cost-benefit analysis is one of the ideal parameters, so is important for the study of bamboo cultivation. This measurement leads to the findings of the costs and return structure of a business activity. The analysis also helps to understand the gaps in the investments and output of a business. In this section an attempt is made to estimate the expenditure incurred by the bamboo farmers for plantation and maintaining of the bamboo farm and its returns.

The duration for maturity of a bamboo plant for harvesting is between 3-5 years from the time of plantation, which is quite short span as compare to that of softwood or hardwood which takes 50-100 years (ABS, 2002)[1]. The data on cost of production and return are of special interest to farmers as it reveals the input output relationship of their enterprises and bring out the differences in unit cost between the less and most efficient farm enterprises (Roy, 2007)[2]. The present value is calculated with the method of compound interest using discount rate (CASA, 2007)[3]. Present value estimates of income are based on market and discount rates (Groom and Palmer, 2012)[4]. The analysis of bamboo cultivation for the current study was carried out using Benefit-Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR).

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[1]American Bamboo Society (ABS), (2002). General bamboo information. www.bamboo.org/GeneralInfo.htmI.

[2]Roy,P. (2007). Stevia: The herbal non-caloric sugar substitute. *Satsa Mukhapatra*, 11, 55-68.

[3]CASA, (2007), Cost Benefit Analysis Methodology Procedures Manual. Australia: Civil Aviation Safety Authority, Australian Government.

[4]Groom, B., & Palmer, C. (2012). REDD and rural livelihoods. *Biological Conservation*, 154, 42-52.

In the study, the economic viability of bamboo cultivation in Dimapur and Mokokchung districts is analyzed by studying the investment incurred and yield of bamboo (in Rupees). This Benefit-Cost analysis holds importance from the economic viewpoint to the farmers who wish to undertake commercial bamboo cultivation, the central and the state governments while formulating and evaluating the economic policies and also to the financial institutions those are willing to render support to bamboo cultivators.

Benefit Cost Ratio (BCR):

BCR is the proportion between the discounted cash inflows and out flows and for an investment to be considered economically efficient in terms of resource use, where the ratio must be unity or more. It can be expressed as

$$BCR= \sum_{i=1}^{n} \frac{Bn}{(1+i)^n} / \sum_{i=1}^{n} \frac{Cn}{(1+i)^n}$$

Net Present Value (NPV):

NPV is the discounted sum of cash flows during the project life. For a project to be economically feasible NPV must be positive.

$$NPV=\sum_{i=1}^{n} \frac{Bn-Cn}{(1+i)^n}$$

Where, Bn = Benefit in the n^{th} year

Cn = Cost in the n^{th} year

n = number of n years

i = Discounted rate.

Internal Rate of Return (IRR):

IRR is the rate of return which compares the discounted benefits with the discounted costs. IRR ranks different projects and the highest value of IRR indicates the first choice of

preference. The IRR should be greater than the discount rate for any project to be profitable. It is represented as below:

$$IRR = \sum_{t=1}^{n} \frac{Bt-Ct}{(1+i)^n} = 0$$

Where, Bt = Benefit in the nth year

Ct = Cost in the nth year

n = number of n years

i = Discounted rate.

6.2. COST INCURRED IN BAMBOO CULTIVATION

The total costs on bamboo plantation in Dimapur and Mokokchung districts were mainly accounted for land preparation, plantation and maintenance during the initial years. In the latter years, the cost for transportation of bamboo to urban markets and labour cost for its handling become considerably higher than the costs of other activities.

The basic data used for estimating costs of cultivation of bamboo in two districts per hectare are presented in table 6.1.

Table 6.1. Basic data for cultivation of bamboo

Descriptions	Dimapur	Mokokchung	Nagaland (average)
Spacing (m×m)	5×5	5×5	5×5
No. of plants / ha	400	380	390
Mortality replacement (%)	20	25	22.5
Seedling price (Rs/seedling)	20	30	25
Labour wages (Rs/mandays)	300	350	325
Sale price per bamboo pole (Rs)	60	50	55

Source: Field Survey, 2017-18.

Bamboo is planted at 5m×5m spacing as it is a perennial plant which propagates with cutting or from shoots. The spacing provides good space for bamboo clump to grow in the following years and the number of plants planted per hectare is 390 on average. The field study indicated 20 per cent mortality replacement in Dimapur and 25 per cent in Mokokchung which difference is due to local management. Seedling cost per sapling is ₹ 20 in Dimapur and ₹ 30 in Mokokchung. The average daily wage of Labour in Dimapur is ₹ 300 and ₹ 350 in Mokokchung. Bamboo per pole is sold at ₹ 60 in Dimapur and ₹ 50 in Mokokchung. On sample average, the cost per seedling is ₹ 25, labour wages per day is ₹ 325 and the average sale price per bamboo pole is estimated at ₹ 55.

Among the two sample districts, Dimapur exhibits a lower cost (price of seedling and labour cost) and higher selling price (per bamboo pole) as compared to that of Mokokchung. The reasons being, Dimapur is connected by rail road and having better road connectivity, and cheap and easy availability of labour in the district as it is more densely populated than the other districts and also its close proximity to Assam state, which is a source of cheap labours. Moreover, Nagaland Bamboo Development Agency is located at Dimapur that provides technical support to the bamboo farmers.

The costs incurred by the bamboo cultivators on the major heads are as following:

i) Jungle clearing: To set up bamboo plantation, clearing of jungle is done which involve human labour. No machines are used. It is purely labour intensive and people use traditional machetes and axes to clear the jungle.

ii) Pit digging: To plant the bamboo saplings, digging of pit is required and is an important activity. Planting is usually done during the rainy season. The pit size of 60×60 is required for planting the saplings, which is done exclusively with human labour. Usually, labours are paid approximately ₹15 per pit.

iii) Planting per sapling: Once digging of pit is completed, planting of sapling takes place. Labours are paid in terms of planting per saplings which cost around ₹10-₹15.

iv) Seedling Price: Bamboo**,** unlike tree or other vegetative species, the span of flowering cycle is very long, varying from 25-120 years and /or more, depending from species to species. Vegetative propagation is undertaken for plantation. The cultivators procure bamboo saplings from sources like own nurseries, nurseries in market place or nurseries sponsored by Nagaland Bamboo Development Agencies. There are bamboo nurseries found in all the districts of the state which is sponsored by NBDA. The price of bamboo saplings ranges from ₹20 to ₹30.

v) Transportation: Huge amount of expenditure is incurred for transportation purpose as most areas do not have proper road access. Moreover, it is difficult to get transportation facilities, which make it expensive. The transportation service is required to bring the saplings from main town or where nurseries are located. Again, after harvesting the bamboo, heavy transportation cost is incurred to take the raw bamboo to market places.

vi) Weeding or tending: Weeding or tending is required especially during the initial stage of plantation which involves the activity of removal of weeds. This activity is undertaken twice a year so that it does not hinder the growth of bamboo.

vii) Monitoring: To look after the farm, people are employed and paid a lump sum amount for his service.

viii) Cutting and sizing: Harvesting of bamboo is labor intensive. Bamboo cultivators are encouraged to plant in systematic order having equal-distance from each other so that during the time of harvesting cutting and sizing becomes easier. High labour cost is incurred for cutting the bamboo.

ix) Loading and unloading (handling): Generally large scale production of bamboo takes place in remote areas. Labours are required to load and unload the produce for transportation to urban towns mainly for marketing. Thus, huge cost is incurred for payment to laborers. Further, additional cost is incurred for the maintenance.

6.2.1. Cost Components:

The cost of bamboo cultivation is estimated in Dimapur and Mokokchung districts separately. The details of various costs incurred in 10 years period are presented in table 6.2, 6.3 and 6.4.

Table 6.2. Unit cost of cultivating 1 hectare under bamboo plantation in Dimapur district (2017-18 prices).

Particulars	Years									
	1	2	3	4	5	6	7	8	9	10
Jungle clearance	6000	-	-	-	-	-	-	-	-	-
Pit digging and planting per sapling	8000	-	-	-	-	-	-	-	-	-
Seedling price	6000	-	-	-	-	-	-	-	-	-
Transportation cost	2000	-	-	-	6000	6000	9000	9000	9000	12000
Maintenance cost	4500	-	-	-	-	-	-	-	-	-
Weeding/Tending (2 times)	-	3000	3000	-	-	-	-	-	-	-
Casualty replacement 20%	-	1800	-	-	-	-	-	-	-	-
Maintenance and mounting(LS)	-	4800	-	-	-	-	-	-	-	-
Thinning	-	-	4800	4800	4800	4800	4800	4800	4800	3600
Monitoring (LS)	-	-	5000	5000	5000	5000	5000	5000	5000	5000
Cutting and sizing	-	-	-	-	3000	3000	3600	3600	3600	4800
Loading & Unloading	-	-	-	-	900	900	1200	1200	1200	1500
Total	26500	9600	12800	9800	19700	19700	23600	23600	23600	26900

**LS-Lump sum (expenditure incurred for the year)*

Source: Field survey, 2017-18.

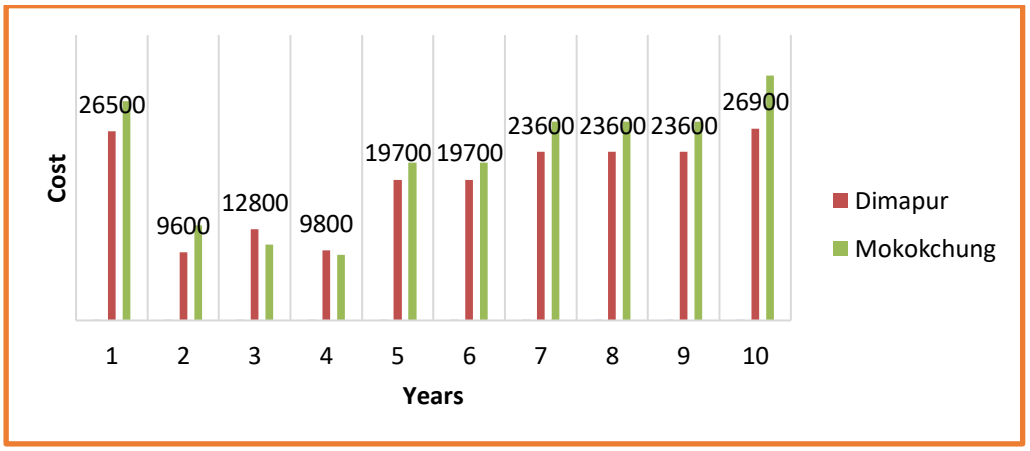
Table 6.3. Unit cost of cultivating 1 hectare bamboo plantation in Mokokchung district (2017-18 prices).

Particulars	Years									
	1	2	3	4	5	6	7	8	9	10
Jungle clearance	7000	-	-	-	-	-	-	-	-	-
Pit digging and planting per sapling	8000	-	-	-	-	-	-	-	-	-
Seedling price	8000	-	-	-	-	-	-	-	-	-
Transportation cost	3500	-	-	-	8000	8000	12000	12000	12000	16000
Maintenance cost	4200	-	-	-	-	-	-	-	-	-
Weeding/Tending (2 times)	-	5600	2800	-	-	-	-	-	-	-
Casualty replacement 20%	-	2100	-	-	-	-	-	-	-	-
Maintenance and mounting(LS)	-	5600	-	-	-	-	-	-	-	-
Thinning	-	-	2800	4200	4200	4200	3500	3500	3500	2800
Monitoring (LS)	-	-	5000	5000	5000	5000	5000	5000	5000	5000
Cutting and sizing	-	-	-	-	3500	3500	5600	5600	5600	8400
Loading & Unloading	-	-	-	-	1400	1400	1750	1750	1750	2100
Total	30700	13300	10600	9200	22100	22100	27850	27850	27850	34300

Source: Field Survey, 2017-18.

**LS-Lump sum (expenditure incurred for the year)*

Figure 6.a. Total Cost per hectare incurred in different years in Dimapur and Mokokchung districts.



Source: Table 6.2 & 6.3

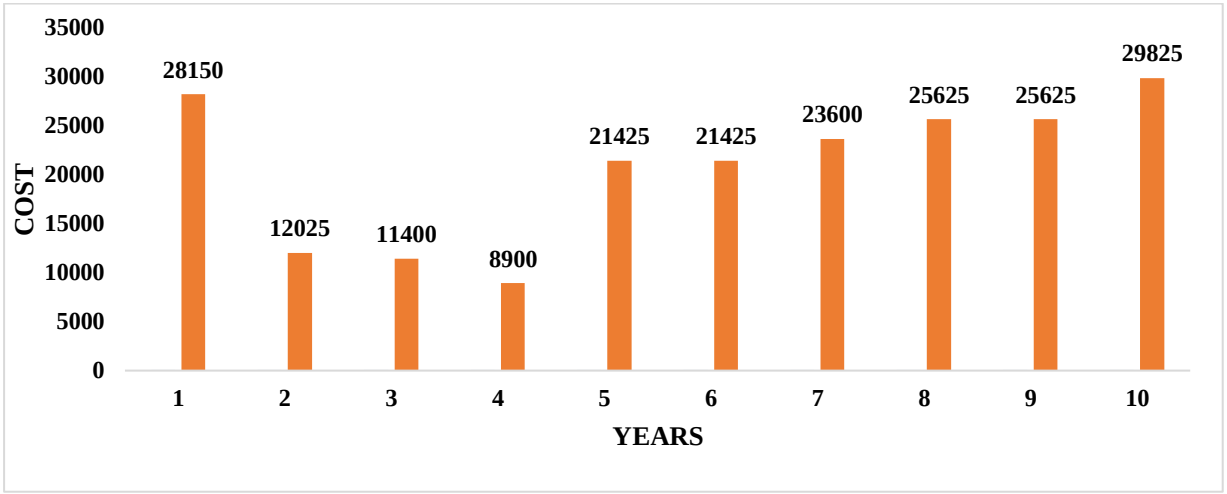
Table 6.4. Average Unit cost of cultivating 1 hectare bamboo plantation in Nagaland (2017-18 prices).

Particulars	Years									
	1	2	3	4	5	6	7	8	9	10
Jungle clearance	6500	-	-	-	-	-	-	-	-	-
Pit digging and planting per sapling	8000	-	-	-	-	-	-	-	-	-
Seedling price	7000	-	-	-	-	-	-	-	-	-
Transportation cost	2750	-	-	-	7000	7000	10500	10500	10500	14000
Maintenance cost	3900	-	-	-	-	-	-	-	-	-
Weeding/Tending (2 times)	-	4875	2600	-	-	-	-	-	-	-
Casualty replacement 20%	-	1950	-	-	-	-	-	-	-	-
Maintenance and mounting(LS)	-	5200	-	-	-	-	-	-	-	-
Thinning	-	-	3800	3900	5200	5200	3900	3900	3900	2600
Monitoring (LS)	-	-	5000	5000	5000	5000	5000	5000	5000	5000
Cutting and sizing	-	-	-	-	3250	3250	3600	3600	3600	6600
Loading & Unloading	-	-	-	-	975	975	1625	1625	1625	1625
Total	**28150**	**12025**	**11400**	**8900**	**21425**	**21425**	**23600**	**25625**	**25625**	**29825**

Source: Field survey, 2017-18.

**LS-Lump sum (expenditure incurred for the year)*

Figure 6.b Average Cost per hectare in different years in Nagaland (in Rupees)



Source: Table 6.4

The table no 6.2, 6.3 and 6.4 show that the maximum expenditure is incurred in the first and the tenth year of cultivation. The maximum expenses is made on labour activities such as, for jungle clearing, pit digging and planting the saplings, which cost is incurred during the first year of cultivation of the farm. The farmers use traditional method of cultivation, for entire operation whereby, use *dao* and spade. This makes the farming method highly labour intensive.

The labour cost (wages) is found to be relatively higher in Mokokchung than Dimapur (table 6.1). One of the reasons for higher wage rate in Mokokchung district is due to shortage of labourers in the area as most labours migrate to towns and cities for better opportunities. In Dimapur, cheap labour is available, especially those seasonal labours coming from neighboring state of Assam.

From the fifth year, the expenditure starts to increase because intense cultivation starts from that year when more laborers are required. In the 10^{th} year maximum expenditure is incurred on transportation cost to the urban market, raising its cost. More so, transportation cost is higher in Mokokchung district as it is predominantly hilly where vehicle hiring charge is more expensive as compared to Dimapur district.

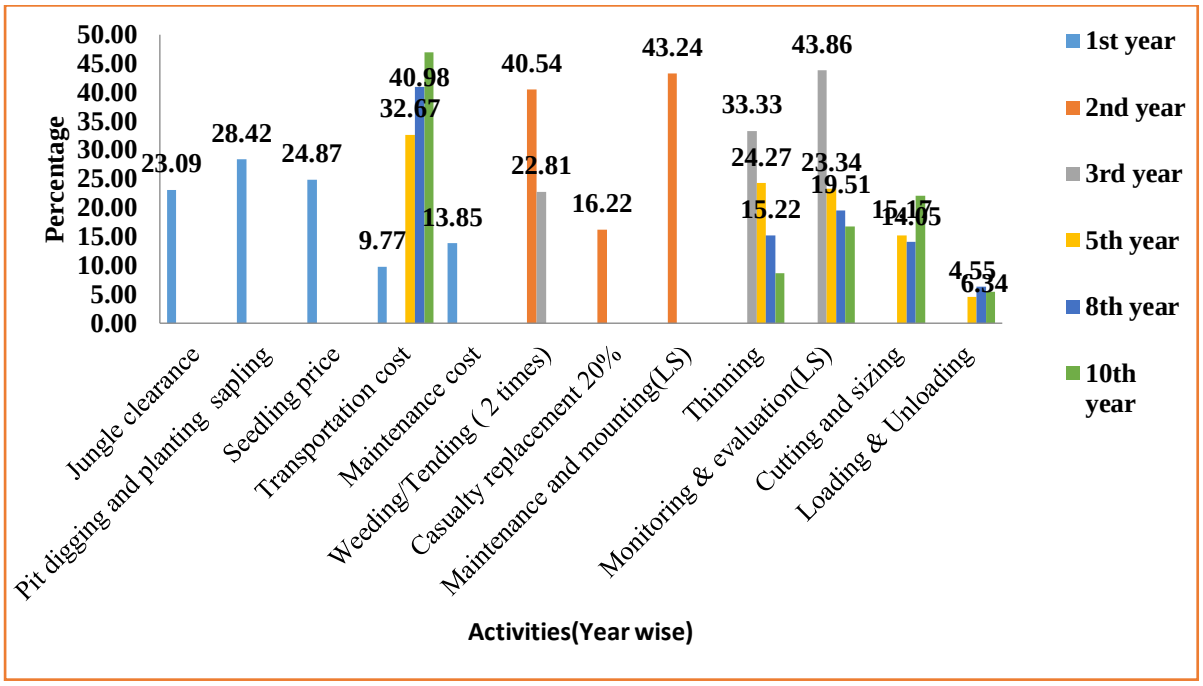
Table 6.2 shows that in Dimapur district, the initial investment of ₹6000 for jungle clearing, ₹8000 for pit digging and planting, ₹ 6000 for seedling cost, ₹2000 for transportation cost and ₹4500 for maintenance cost are incurred, which total round up to ₹ 26500 as investment cost per hectare in the first year of cultivation. There is not much expenditure once it is planted as it requires less maintenance to look after the plantation. Thus, expenditure from 2^{nd} to 4^{th} declines. An amount of ₹3000 is spend on weeding or tending which is done twice a year, ₹1800 for casualty replacement and ₹4800 for maintenance and mounting. Total expenditure in the second year is ₹9600, ₹ 12800 in the

third year and ₹ 9800 in forth year, mostly spend for weeding, thinning and monitoring. Expenditure increased from the fifth year as from the year intense cultivation starts. Major expenditure is made under different activities like thinning (₹4800), monitoring and evaluation (₹5000), transportation cost (₹ 6000), cutting and sizing (₹ 3000) and loading and unloading (₹900). Highest expenditure is made in the tenth year of ₹ 26900. This is because more bamboo poles are harvested and thus spent more on transportation and labour cost for cutting.

Table 6.3 depicts the cost incurred in Mokokchung district. An initial investment of ₹30700 is required per hectare for clearing jungle, pit digging and planting sapling, seedling price, transportation cost and maintenance cost per hectare of bamboo farm. From the second to forth year an amount of ₹ 13300, ₹ 10600 and ₹ 9200 respectively is invested for weeding, thinning and monitoring. An amount of ₹ 34300 is spent in the tenth year where maximum amount is spent on transportation (₹ 16000).

According to the table 6.4, for Nagaland (average of the two sample districts) in the first year an amount of ₹ 28150 is incurred in bamboo plantation and from the second year to forth year expenditure starts to decline from ₹ 12025 to ₹ 11400 to ₹ 8900, respectively as not much investment is required for maintenance of bamboo plantation. From the fifth year onwards, expenditure starts to increase from ₹ 21,425 and maximum expenditure is incurred in the tenth year with ₹ 29,825. Most of the expenditure is made in transportation and labour costs as plantation is usually done in the remote forest area and to bring them to urban place become expensive due to poor road connectivity and where the transportation cost is very high.

Figure 6.c. Percentage of Cost per hectare in Nagaland (activity and year-wise)



Source: Field Survey, 2017-18.

The figure no. 6.c indicates that on an average, in the first year of bamboo plantation, the maximum expenditure is incurred on digging pit for planting bamboo (28 %), followed by purchasing seedlings (25%) and jungle clearing (23%). Other expenses are made on maintenance and transportation (14% and 10%, respectively). In the Second year, the cost for maintenance (43%) and weeding (41%) is higher, followed by replacement of mortality. In the third year, the cost is highest for monitoring& evaluation (44%) follows thinning (33%) and weeding (23%). From the fifth year onwards, the maximum cost is incurred on transportation of bamboo to markets. Cost incurred on cutting and loading and unloading (labour cost) become relatively high.

6.2.2. Yield and Income from Bamboo Cultivation:

The yield and income from bamboo plantation in both the districts are shown in the table 6.5.

Table 6.5. Yield and Income of bamboo plantations in Dimapur and Mokokchung Districts and Nagaland.

Year	Yield (poles/ha)			Gross Income(Rs/ha)		
	Dimapur	Mokokchung	Nagaland	Dimapur	Mokokchung	Nagaland
V & VI	960	940	950	57600	47000	52300
VII to IX	1600	1500	1550	96000	75000	85500
X	3200	3000	3100	192000	150000	171000

Source: Field Survey, 2017-18.

(Average of Dimapur and Mokokchung data represents Nagaland)

The harvest of bamboo starts from the fifth year onwards, where the average selling price per pole is estimated at ₹55 for Nagaland, while it is ₹60 and ₹50 for Dimapur and Mokokchung districts, respectively. From the fifth and sixth year three good poles per clump can be harvested every year on an average, and five mature poles every year from the seventh to ninth year and 10 mature poles in the tenth year. A gross income of ₹52300/ha could be realized in 5th and 6th year in Nagaland and ₹57600/ha in Dimapur and ₹47000/ha in Mokokchung, respectively. This increased to ₹ 85500/ha in 7th, 8th and 9th year in Nagaland and ₹96000/ha in Dimapur and ₹75000/ha in Mokokchung. Further increased to ₹171000 in the 10th year in Nagaland with ₹192000 /ha in Dimapur and ₹150000 /ha in Mokokchung.

6.3. COST-BENEFIT ANALYSIS

The cost and benefits have been estimated at 2017-18 prices (local) in the two districts. Even though the productive cycle of bamboo is very long, yet the analysis has been conducted for a period of 10 years only as most of the respondents were engaged in cultivating bamboo for 10 years. A discounted rate of 6 per cent was adopted to estimate the

financial analysis of plantation, as this was the bank interest rate during the period of the survey.

Table 6.6. Cost Benefit Analysis of bamboo plantation per hectare in Dimapur

Year	Costs	Benefits	Net Benefits	Discounted cost	Discounted benefits	Net Present Value (6%)
1	26500	-	-26500	25000.00	-	-25000.00
2	9600	-	-9600	8543.97	-	-8543.97
3	12800	-	-12800	10747.13	-	-10747.13
4	9800	-	-9800	7762.52	-	-7762.52
5	19700	57600	37900	14720.99	43042.07	28321.08
6	19700	57600	37900	13887.72	40605.73	26718.00
7	23600	96000	72400	15695.35	63845.48	48150.14
8	23600	96000	72400	14806.93	60231.59	45424.66
9	23600	96000	72400	13968.80	56822.25	42853.45
10	26900	192000	165100	15020.82	107211.8	92190.98
Total			399400	140154.22	371758.9	231604.70

Source: Field survey, 2017-18.

Table 6.7. Cost Benefit analysis of bamboo plantation per hectare in Mokokchung

Year	Costs	Benefits	Net Benefits	Discounted costs	Discounted Benefits	Net Present Value (6%)
1	30,700	-	-30,700	28962.26	-	-28962.26
2	13,300	-	-13,300	11836.95	-	-11836.95
3	10,600	-	-10,600	8899.964	-	-8899.96
4	9,200	-	-9,200	7287.26	-	-7287.26
5	22,100	47,000	24,900	16514.40	35121.13	18606.73
6	22,100	47,000	24,900	15579.62	33133.14	17553.52
7	27,850	75,000	47,150	18521.84	49879.28	31357.44
8	27,850	75,000	47,150	17473.43	47055.92	29582.49
9	27,850	75,000	47,150	16484.37	44392.38	27908.01
10	34,300	1,50,000	1,15,700	19152.94	83759.21	64606.28
Total			2,43,150	160713.06	293341.09	132628.03

Source: Field survey, 2017-18.

Table 6. 8. Cost Benefit Analysis of bamboo plantation per hectare in Nagaland (Average)

Year	Costs	Benefits	Net Benefits	Discounted cost	Discounted benefits	Net Present Value (6%)
1	28600	-	-28600	26981.13	-	-26981.1
2	11450	-	-11450	10190.46	-	-10190.5
3	11700	-	-11700	9823.546	-	-9823.55
4	9500	-	-9500	7524.89	-	-7524.89
5	20900	52300	31400	15617.7	39081.6	23463.91
6	20900	52300	31400	14733.68	36869.44	22135.76
7	25725	85500	59775	17108.59	56862.38	39753.79
8	25725	85500	59775	16140.18	53643.76	37503.57
9	25725	85500	59775	15226.59	50607.32	35380.73
10	30600	123000	140400	17086.88	68682.56	78398.63
total			321275	150433.6	305747.1	182116.4

Source: Field Survey, 2017-18.

The feasibility of bamboo cultivation was analyzed using Benefit-Cost Ratio (BCR), Net Present value (NPV) and Internal Rate of Return (IRR). The analysis was conducted per hectare at a discount rate of 6 percent in both the districts. The result is shown in table 6.9.

Table 6.9. Cost Benefit Analysis of bamboo plantation in Dimapur and Mokokchung districts of Nagaland.

Sl. No.	Parameters	Dimapur	Mokokchung	Nagaland
1	Benefit-Cost Ratio	2.65	1.83	2.03
2	Net Present Value(Rs/ha/year)	231604.70	132628.03	182116.36
3	Internal Rate of Return(IRR)	42%	29%	36%

Source: calculated from tables 6.6, 6.7 and 6.8.

6.3.1. Benefit-Cost Ratio:

According to the free dictionary by Farlex (2011)[5], benefit cost ratio is "A ratio representing the benefits of a project or investment compared to its cost. The BCR may be a strictly financial ratio, comparing the expected return to the cost of investment, or it may account for approximations of qualitative measurements". The benefit cost analysis of bamboo plantation in Dimapur and Mokokchung Districts and Nagaland is given in table 6. 9. The data reveals that Bamboo plantation is viable as the BCR is greater than 1 in both the sample districts with 2.65 for Dimapur and 1.83for Mokokchung districts and the average of the two districts represented for Nagaland is 2.03. BCR is somewhat greater in Dimapur as compared to Mokokchung, which means that bamboo cultivation is more profitable in Dimapur. Capital investment revels that the ratio of net profit to capital employed is very remarkable (Sudhakar & Sarkar, 2013)[6], which is also true in case of bamboo farmers in Nagaland.

6.3.2. Net Present Value (NPV):

The difference between present value of cash inflows and cash outflows over a period of time is called NPV. Acceptance rule of NPV is that if NPV is positive (NPV> 0) than it is encouraged to accept the project, if NPV is negative (NPV< 0) than reject the project and may accept the project if NPV is equal to zero (NPV=0). The Net Present Value of bamboo cultivation per hectare is discounted at 6 percent and it is estimated to be ₹ 2, 31,604 /ha/year in Dimapur and ₹132628.03/ha/year in Mokokchung with an average NPV of ₹182116.36 for Nagaland. There is positive NPV (Gondalia & Patel, 2007) [7]in bamboo cultivation, hence it is

[5]Farlex (2011) Cost-benefit ratio. *Financial Glossary*. Retrieved April 12 2021. https://financial-dictionary.thefreedictionary.com/Cost-benefit+ratio

[6]Sudhakar, L., & Sarker, S. C. (2013). Cost and return analysis of Mandarin Orange-a case study in Darjeeling District of West Bengal. *Agricultural Situation in India*, 70(7), 17-23.

[7]Gondalia, V. K., & Patel, G. N. (2007). An Economic evaluation of investment on aonla (Emblica officinalis G.) in Gujarat. *Agricultural Economics Research Review*, 20(2), 385-394.

economically viableand financiallysounds to undertake bamboo cultivation in the state. NPV is higher in Dimapur as compared to Mokokchung, which shows that it is more profitable in Dimapur.

6.3.3 Internal Rate of Return (IRR):

The Internal Rate of Return measures the rate of return that can be realized by investment in bamboo cultivation and is more appealing compared to other discounted cash flow analysis. The internal rate of return (IRR) is the annual rate of growth that an investment is expected to generate. Generally, the higher an internal rate of return, the more desirable an investment is to undertake (Fernando, 2021)[8]. ADB's newly adopted minimum required IRR is 9% (ABD, 2017)[9]. The table shows that IRR in bamboo plantation is found to be 36% in Nagaland and that in Dimapur gave best rate of return (42%) as compared to Mokokchung (29%). The IRR was greater than the opportunity cost of capital (Karegaonkar et al., 2011)[10] which indicates a higher marginal efficiency of capital per unit.

6.4. FUNCTIONAL ANALYSIS

The Cost-Benefit analysis showed that bamboo cultivation was profitable in the study area. The Cobb-Douglas type of production function is fitted to test the relationship between the yield of Bamboo per hectare (the dependent variable) and the inputs labour and capital investments (on five inputs) are included as independent variables. The function in log form is:

$$\text{Log } Y = \log b_0 + b_1 \log X_1 + b_2 \log X_2 + \ldots + b_5 \log X_5$$

[8]Jason Fernando (2021), Internal Rate of Return (IRR), **https://www.investopedia.com/terms/i/irr.asp**, accessed on 03.09.2021

[9]ABD (2017). Guidelines for the Economic Analysis of Projects. http://dx.doi.org/10.22617/TIM178607-2.

[10]Karegaonkar, S. S., Patel, V. M., Sanap, D. J., & Babar, A. P. (2011). Economic analysis of production and physibility of sweet orange garden in Jalna district of Maharastra. *Agriculture update*, 6(1), 70-74.

Where,

Y = Annual yield of bamboo (pole/ha)

X_1 = Human labour (₹ in man-days/hectare/year)

X_2 = Transportation cost (in ₹/ hectare/year)

X_3 = Seedling cost (in ₹/ hectare/year)

X_4 = Maintenance cost (in ₹ /hectare/year)

X_5 = Monitoring cost (in ₹ /hectare/year)

b_0, b_1, …, b_5 are the parameters to be estimated.

b_0 = Regression constant

b_1, b_2, …, b_5 = Partial elasticity of yield with respect to the factors

X_1, X_2, …, X_5 respectively.

In order to test the significance of the estimated parameters b_1, b_2, …, b_5, the t – test of the following formula was used.

$$t = \frac{b1}{SEbi}$$

SEbi = Standard Error of bi

The sum of all production elasticities of the factor inputs indicates returns to scale. i.e. $\sum bi$, i = 1, 2, …, 5

If $\sum bi > 1$ increasing returns to scale

< 1 decreasing returns to scale

= 1 constant returns to scale.

6.4.1 Determinants of Bamboo Yield in Dimapur district

The Cobb-Douglas type of production function is fitted to test the relationship between the yield of Bamboo and the independent variables for Dimapur cultivators. The result is presented in table 6.10.

Table 6.10. Estimated Cobb-Douglas Type Production for Dimapur cultivators

Variables	Notation	Elasticity co-efficient (bi)	Standard Error	't' value	'p' value
Yield (pole per ha)	Y	-	-	-	-
Constant	b_0	3.399	.724	4.695	.000
Labour in rupees (Man days/ha)	X_1	.298	.161	1.849	.000*
Transport cost (in ₹)	X_2	.237	.183	1.291	.199
Seedling cost (in ₹)	X_3	.257	.141	1.816	.000*
Maintenance cost (in ₹)	X_4	- .073	.175	-.418	.676
Monitoring cost (in ₹)	X_5	.015	.175	.088	.930
R = .655	R^2 = .429		F- Value = 19.262		

Source: Field study 2017-18, computed data

**significant at 1%.*

It is observed from Table 6.10 that the correlation coefficient is R=.655, indicating strong positive correlation among variables. The coefficient of determination, R^2 = .429, thus, about 43% of the variation in yield of bamboo is explained by the variance of the independent variables labour cost, transport cost, seedling cost, maintenance cost and monitoring cost.

Further, it is shown that the independent variables significantly predicts the dependent variable, F = 19.262, p< .001. From the data analysis, we can infer that the F-test is highly significant. This indicates that the model explains a significant amount of the variance in yield.

The Cobb Douglas multiple regression analysis results indicate that labour cost and seedling cost are statistically significant at p<.001 level. The labour cost (B=.298, p=.000) is significant and its coefficient is positive indicating that predicted yield increases by 29.8 % for 1 percent increase in labour cost. Seedling cost (B=.257, p=.000) is also significant and predicted yield increases by 25.7% for 1 percent increase in seedling cost.

This is because the method of cultivation is highly labour intensive. Thus more saplings are planted costing more and engaging more labour, there will be higher yields of bamboo culms and thus increase production.

6.4.2 Determinants of Bamboo Yield in Mokokchung district

The Cobb-Douglas type of production function is fitted to test the relationship between the yield of Bamboo and the independent variables for Mokokchung cultivators. The result is presented in table 6.11.

Table 6.11. Estimated Cobb-Douglas Type Production for Mokokchung cultivators

Variables	Notation	Elasticity co-efficient (bi)	Standard Error	't' value	'p' value
Yield (pole per ha)	Y	-	-	-	-
Constant	b_0	2.223	.682	3.260	.001
Labour in rupees (Man days/ha)	X_1	.328	.132	2.482	.000*
Transport cost (in ₹)	X_2	.310	.152	2.044	.043**
Seedling cost (in ₹)	X_3	.013	.105	.121	.904
Maintenance cost (in ₹)	X_4	.218	.131	1.658	.100
Monitoring cost (in ₹)	X_5	.234	.142	1.652	.101
R = .596	R^2 = .355		F- Value = 12.133		

Source: Field Study 2017-18.

**significant at 1% level and **significant at 5% level*

Table 6.11 shows that the correlation coefficient is R=0.596, indicating positive correlation among variables. The coefficient of determination, R^2 = .355, thus, about 35% of the variation in yield of bamboo is explained by independent variables labour cost, transport cost, seedling cost, maintenance cost and monitoring cost in Mokokchung district or in other words, the results of the regression indicated that the model explained 35% of the variance in yield of the bamboo. That the model is a significant predictor of bamboo yield, F (5, 111) = 12.133 p< .001.

The above Cobb Douglas regression coefficient indicates that labour cost is statistically significant at p<.001 level (with B=.328, p=.000) and its coefficient is positive indicating that predicted yield increases by 32% for each 1 percent increase in labour cost. As more labour is employed it contributes positivity to the production of bamboo as the technique of production is highly labour intensive.

6.4.3 Determinants of Bamboo Yield by Nagaland Cultivators

It is assumed that the yield of bamboo is influenced by various factors such as labour cost, transport cost, seedling cost, maintenance cost and monitoring cost. The Cobb-Douglas type of production function is fitted to test the relationship between the yield of Bamboo and the independent variables for Nagaland cultivators, taking the average data of the two sample districts. The result is presented in table 6.12.

Table 6.12. Estimated Cobb-Douglas Type Production for Nagaland cultivators

Variables	Notation	Elasticity co-efficient (bi)	Standard Error	't' value	'p' value
Yield (pole per ha)	Y	-	-	-	-
Constant	b_0	3.377	.491	6.875	.000
Labour in rupees (Man days/ha)	X_1	.383	.106	3.595	.000*
Transport cost (in ₹)	X_2	.154	.114	1.349	.179

Seedling cost (in ₹)	X_3	.130	.089	1.472	.142
Maintenance cost (in ₹)	X_4	.202	.102	1.972	.050
Monitoring cost (in ₹)	X_5	.140	.100	1.404	.162
R = .641	R^2 = .410		F- Value = 33.960		

Source: Field study 2017-18, computed data

The result shows that the correlation coefficient R= 0.641, indicating strong positive correlation among variables. The value of coefficient of determination, R^2 = .410 reveals that 41 per cent of the variance in yield of bamboo is explained by predictors. It reveals that the independent variables significantly predicts the dependent variable, F = 33.960, p< .001.

The labour cost (B=.383, p=.000) is significant and its coefficient is positive indicating that predicted yield increases by 38 per cent for each 1 per cent increase in labour cost. This is due to the fact that labour is one of the major inputs in bamboo cultivation, apart from land, making the method of cultivation highly labour intensive and thus accepts the hypothesis that labour cost is a major input that enhance yield of bamboo.

6.5 CONCLUSION

The accomplishment of bamboo cultivation will depend upon their relative cost and benefits. This chapter highlighted the various components of cost of production of bamboo. The prospective of bamboo plantation can be realized as it is economically viable, require less labour and low maintenance cost, drought tolerant and has future market potential.

The unique land ownership and management system in the state is different from the rest of the states in the country. It is the local customary law that governs the land ownership where a larger proportion of land is owned by the community and private individuals. This gives due advantage to the farmers to take up bamboo plantation as it will generate more income. The analysis which was performed under the framework of cost-benefit analysis shows that BCR, NPV and IRR have shown that bamboo cultivation is economically efficient

in terms of resource use. The BCR was 2. 65 in Dimapur and 1.83 in Mokokchung district. NPV stood at 231604.70 and 132628.03 in Dimapur and Mokokchung respectively and IRR was 42 per cent in Dimapur and 29 per cent in Mokokchung districts. Thus, bamboo cultivation creates an opportunity for income generation and serves as job creation to those who engage in associated activities as well as employment for the people in the State. The study also shows that farmers spend more on labour and transportation costs. The first year of plantation has higher expenditure as compared to the other years. Till the fourth year there is only expenditure and no return as harvesting starts from the fifth year only. Even though expenditure on the 10^{th} year is high yet benefit incur is more than the expenditure on that year.

The Cobb Douglas regression analysis reveals that labour cost and seedling cost are significant predictors of bamboo yield in Dimapur, while labour cost is significant predictor of bamboo yield in Mokokchung as well as in Nagaland in general.

Development in bamboo based activities will help in improving the livelihood of those engaged in bamboo cultivation as it can be grown or harvested in forest area or even in agro forestry area. With the passing of a bill in the parliament on 20^{th} December 2017, which exclude bamboo from the definition of tree under the Indian Forest Act, it can be seen as a motivation for Bamboo grower, which will encourage the farmer to expand bamboo cultivation on commercial scale, so that the produce from the State can feed the market demands of the other parts of the country. This will help not only in generation of income and employment but also contribute towards solving environmental problems.

CHAPTER 7

PROBLEMS IN BAMBOO PRODUCTION AND NAGALAND BAMBOO POLICY

7.1. INTRODUCTION

There are various problems associated with the cultivation of bamboo which affect the production as well as its profitability. The effects of different problems may not be uniformly the same, however all these problems are of considerable importance and cannot be ignored. An attempt has been made to identify the problems faced by the growers of Bamboo in Nagaland and ranked them by making use of Garrett's Ranking Technique.

Further, an overview of the policy adopted by the Government of Nagaland in order to boost the bamboo production and the economy of the state is presented in this chapter.

7.2 Application of Garret's Ranking Technique

In order to identify the significant problems which have affected them the most, based on the Garret's Ranking technique, the study ranked the different problems based on the respondents preferential ordering of the problems, thereby convert into score values and ranks with the help of the following formula:

$$\text{Percent position} = \frac{100(Rij - 0.5)}{Nj}$$

Where,

Rij = Rank given for the i^{th} variable by j^{th} respondents

Nj = Number of variable ranked by j^{th} respondents

The estimated percentage position is converted into score by referring to the table given by Garret and Woodworth (1969)[1]. With the help of Garret ranking, the outcome of the percentage position is converted into Garret Values as shown in table 7.1. Then determine total Garret score, which is calculated by the value of Rij multiplied by the Garrett Value. To find the average Garret Score, total Garret Score is divided by the number of problem listed, then based on highest average value, the alternative ranking is made. For each factor, the scores of each individual are added and total the value of scores from which, the mean values of score are calculated. The factors having highest mean value is considered to be the most important factor. The representation of the problems faced by the bamboo farmers in Dimapur and Mokokchung districts is in the section that follows. The tables 7.2 and 7.3 are categorizations of the problems found during personal interview with the help of questionnaires, showing the preferences and ranking of problems faced by cultivators engaged in bamboo cultivations, which may, in turn, throw light on the decision making perspectives by the government for development of bamboo cultivation.

7.2.1. The Percentage Position and Garret Value

Based on the Garret ranks, calculation of the garret value was done. The Garret tables and scores of each problem is given in the table no. 7.1 and multiplied to record scores in next table, finally by adding each row, the total Garret score were obtained.

$$\text{Percent position} = \frac{100(Rij - 0.5)}{Nj}$$

The result is provided in the following table.

[1]Garrett, H. E., & Woodworth, R. S. (1969). Statistics in psychology and education. Vakils, feffer and simons pvt. *Ltd*., Bombay, *329*.

Table 7.1. Percent position and Garret Value

Sl.No	100(Rij-0.5)/ Nj	Calculated Value	Garret Value
1	100(1-0.5)/ 8	6.25	80
2	100(2-0.5) /8	18.75	68
3	100(3-0.5) /8	31.25	60
4	100(4-0.5)/ 8	48.75	51
5	100(5-0.5) /8	56.25	47
6	100(6-0.5) /8	68.75	40
7	100(7-0.5) /8	81.25	32
8	100(8-0.5)/8	93.75	20

Source: Annexure 7.1

The percent position for each rank from 1 to 8 is calculated. The percentage score obtained from 8 ranks is converted into scale values using scale conversion table of Henry Garret. The scale value of first to eight ranks is 80, 68, 60, 51, 47, 40, 32 and 20.

7.2.2. Problems of Bamboo farmers in Dimapur district.

The analysis of the problems faced by bamboo cultivator in Dimapur district is indicated in Table 7.2.

Table 7.2. Problems faced by the Bamboo farmers in Dimapur District

Description	Ranks given by the Respondents							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Infrastructure Problems								
Lack of transportation facility	12	27	5	19	42	14	5	10
Poor machinery and inadequate tools	16	18	38	20	7	15	8	12
Lack of good storage facility	28	22	30	9	26	11	3	5
Man power problems								
Shortage of labour	13	7	2	10	8	36	39	19
Lack of work culture	7	9	2	15	19	17	30	35
Service related problems								
Marketing problems	34	20	26	29	11	4	7	3
Absence of grading service	2	3	0	5	8	32	36	48
Inadequate farm credit	22	28	31	27	13	5	6	2

Source: Field Survey, 2017-18.

Among the problems stated by the farmers, marketing related problems ranked the highest for a larger proportion of farmers (34 farmers) in Dimapur, while for 28 farmers 'lack of storage facility was ranked first followed by 'inadequate farm credit' by 22 farmers. While in the 2nd rank, 28 farmer expressed they suffer from 'inadequate farm credit', whereas, 22 suffered from 'lack of storage facilities', followed by 'transport problem' (27 farmers.

In the third rank, 38 farmers suffers due to 'inadequate tools and machineries', the next is 'inadequate farm credit' for 31 farmers and 'storage facility' for 30 farmers.

From the data in the table no 7.2, the Garret value and ranking of the problems were calculated as follows:

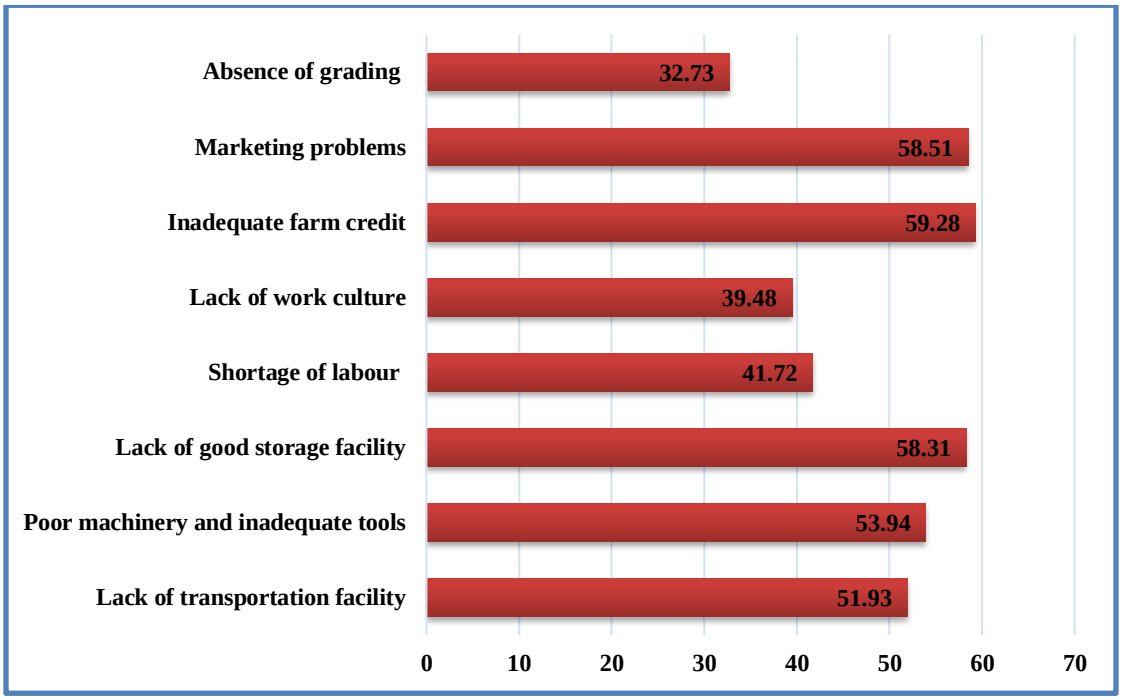
Table 7.3. Garret value and ranking of problems faced by bamboo farmers in Dimapur District

Description	Ranks given by the Respondents								Total	Average Score	Rank
	1st	2nd	3rd	4th	5th	6th	7th	8th			
Infrastructure Problems											
Lack of transportation facility	960	1836	300	969	1974	560	160	200	6959	51.93	**V**
Poor machinery and inadequate tools	1280	1224	2280	1020	329	600	256	240	7229	53.94	**IV**
Lack of good storage facility	2240	1496	1800	459	1222	400	96	100	7813	58.31	**III**
Man-power Problems											
Shortage of labour	1040	476	120	510	376	1440	1248	380	5590	41.72	**VI**
Lack of work culture	560	612	120	765	893	680	960	700	5290	39.48	**VII**
Service related Problems											
Inadequate farm credit	1760	1904	1860	1377	611	200	192	40	7944	59.28	**I**
Marketing problems	2720	1360	1560	1479	517	160	224	60	7840	58.51	**II**
Absence of grading	160	204	-	255	376	1280	1152	960	4387	32.73	**VIII**

Source: Calculated from Table 7.2

The result from table no 7.3 indicates the various problems experienced by the bamboo farmers in Dimapur. The study shows that the major challenges faced by bamboo farmers in Dimapur are 'inadequate farm credit' followed by 'marketing problems' and 'lack of good storage facility' respectively. Inadequate farm credit has the highest average score of 59.28, marketing problems holds the second highest rank with an average score of 58. 51, which is followed by 'lack of good storage facilities' with an average score of 58.31. On the other hand, grading (32.72), work culture (39.48) and shortage of labour (41.72) scored least in the ranking. The figure below shows the scores of problems faced by farmers at Dimapur district.

Figure 7.a. Problems of bamboo cultivators in Dimapur District



Source: Calculated from Table 7.3

7.2.3. Problems of Bamboo farmers in Mokokchung district.

The severity of problems faced by farmers in Mokokchung district differs from that of farmers in Dimapur district, may be, due to difference in geographical location, market system and environment. The table 7.4 highlights the problems faced by Mokokchung farmers in cultivating Bamboo.

Table 7.4. Problems faced by the Bamboo farmers in Mokokchung District

Description	Ranks given by the Respondents							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Infrastructure Problems								
Lack of transportation facility	14	24	20	23	18	12	5	0
Poor machinery and inadequate tools	24	4	7	29	14	10	23	5
Lack of good storage facility	12	6	10	5	36	22	18	7
Man power Problems								
Shortage of labour	29	25	14	12	9	15	8	4
Lack of work culture	2	0	4	6	11	17	20	56
Service Problems								
Inadequate farm credit	13	20	29	19	8	12	13	2
Marketing problems	15	33	23	16	14	10	4	1
Absence of grading	7	4	9	6	6	18	25	41

Source: Field survey, 2017-18.

The table 7.4 shows the ranking of problems faced by cultivators engaged in Bamboo production in Mokokchung district. It is observed from the table 7.4 that 29 respondents ranked shortage of labour as the main problem and rank at top, which for 24 farmers the top most problem is poor machinery and inadequate tools. At the 2nd rank, 33 farmers expressed that marketing problems are the second top most problem. Shortage of labour (25) and inadequate credit (20) were also significant. On the other hand, Lack of work culture and grading were found to be the least significant problems.

7.2.4. Calculation of Garret Value and Ranking

Information on the problems were collected and presented in table no. 7.4. From these data, Garret value and ranking of the problems are calculated and presented in table 7.5.

Table 7.5. Garret value and ranking of problems faced by bamboo farmers in Mokokchung District

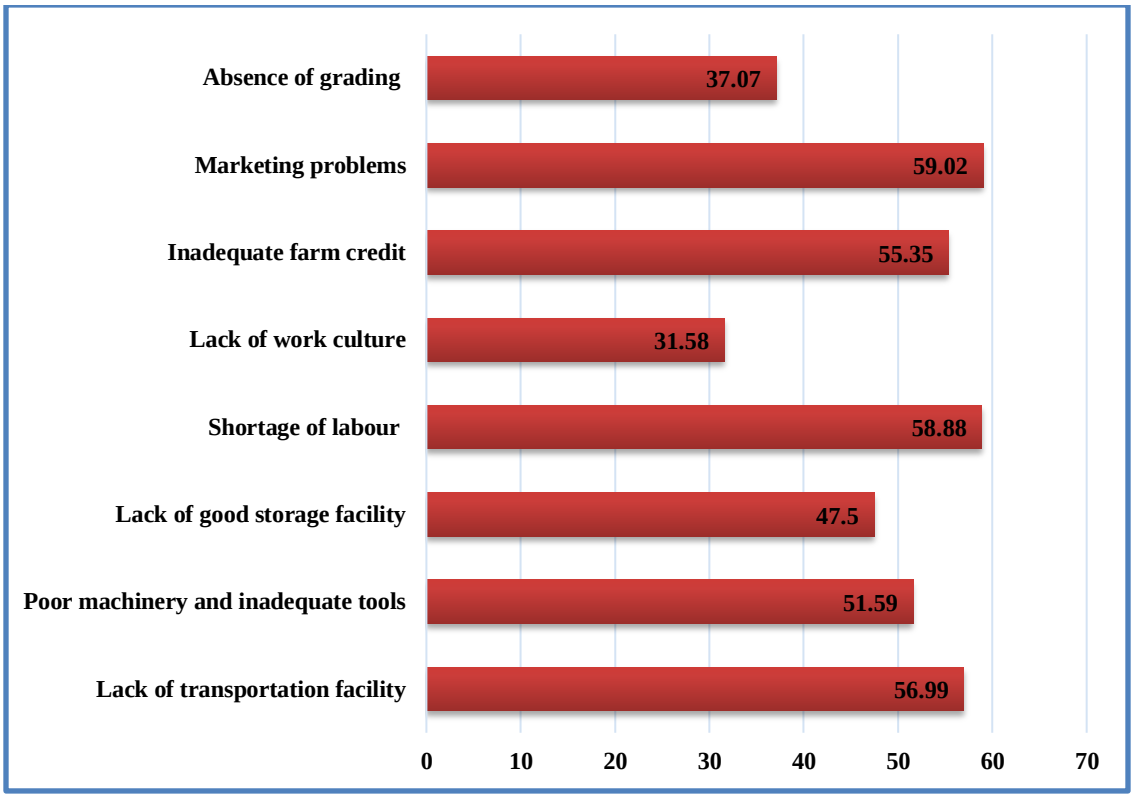
Description	Ranks given by the Respondents								Total	Average Score	Rank
	1st	2nd	3rd	4th	5th	6th	7th	8th			
Infrastructure Problems											
Lack of transportation facility	1120	1632	1200	1173	846	480	160	0	6611	56.99	**III**
Poor machinery and inadequate tools	1920	272	420	1479	658	400	736	100	5985	51.59	**V**
Lack of good storage facility	960	408	600	255	1692	880	576	140	5511	47.50	**VI**
Man-power Problems											
Shortage of labour	2320	1700	840	612	423	600	256	80	6831	58.88	**II**
Lack of work culture	160	-	240	306	517	680	640	1120	3663	31.58	**VIII**
Service related Problems											
Inadequate farm credit	1040	1360	1740	969	376	480	416	40	6421	55.35	**IV**
Marketing problems	1200	2244	1380	816	658	400	128	20	6846	59.02	**I**
Absence of grading	560	272	540	306	282	720	800	820	4300	37.07	**VII**

Source: Calculated from Table 7.4

Based on the Garret's Ranking Technique it was revealed that 'Marketing problem' is the top most problem faced by bamboo cultivators in Mokokchung district with highest Garret score of 6846 and an average score of 59.02. Accordingly, 'Shortage of labour' with Garret scores of 58.88 is represented the second most problem. 'Lack of transportation facility' ranks third with an average score of 56.99. This is followed by 'inadequate credit' which ranked forth with an average score of 55.35. On the other hand, 'Lack of work culture' ranked least with an average score of 31.58.

The problems faced by bamboo cultivators in Mokokchung district with their average score in ranking is shown in the figure 7.b.

Figure 7.b. Problems of bamboo cultivators in Mokokchung District.



Source: Table 7.5

7.2.5. Problems faced by bamboo cultivators in Nagaland

The average analysis of the sample districts is considered as the representative of the state. As such, an overall analysis of problems faced by the bamboo cultivators in Nagaland is discussed below.

Table 7.6. Problems faced by the Bamboo farmers in Nagaland.

Description	Ranks given by the Respondents							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Infrastructure Problems								
Lack of transportation facility	26	51	25	42	60	26	10	10
Poor machinery and inadequate tools	40	22	45	49	21	25	31	17
Lack of good storage facility	40	28	40	14	62	33	21	12
Man power problems								
Shortage of labour	42	32	16	22	17	51	47	23
Lack of work culture	9	9	6	21	30	34	50	91
Service related problems								
Marketing problems	49	53	49	45	25	14	11	4
Absence of grading	9	7	9	11	14	50	61	89
Inadequate farm credit	35	48	60	46	21	17	19	4

Source: Field Survey, 2017-18.

The table 7.6 shows the combine ranking of Dimapur and Mokokchung bamboo cultivators, which average may be taken as representative of the State as a whole. The responses of the farmers are presented in ranks. In the first rank, out of the total 250 respondents, 49 of them ranked marketing problem as the most severe one. This is followed by shortage of labour

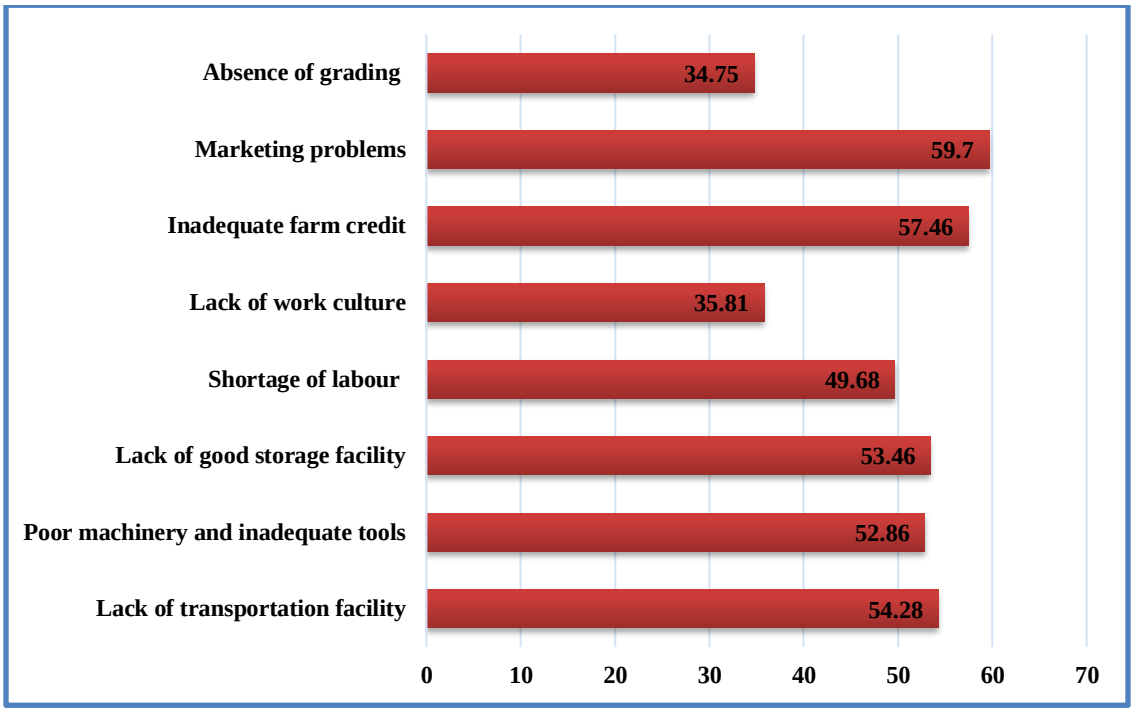
where 42 respondents ranked first, poor machinery and tools and shortage were also ranked for most problems for 40 farmers (each). Lack of work culture and absence of grading were least concern for the farmers.

Table 7.7. Garret value and ranking of problems faced by bamboo farmers in Nagaland

Description	**Ranks given by the Respondents**								**Total**	**Average Score**	**Rank**
	1st	2nd	3rd	4th	5th	6th	7th	8th			
Infrastructure Problems											
Lack of transportation facility	2080	3468	1500	2142	2820	1040	320	200	13570	54.28	**III**
Poor machinery and inadequate tools	3200	1496	2700	2499	987	1000	992	340	13214	52.86	**V**
Lack of good storage facility	3200	1904	2400	714	2914	1320	672	240	13364	53.46	**IV**
Man-power Problems											
Shortage of labour	3360	2176	960	1122	799	2040	1504	460	12421	49.68	**VI**
Lack of work culture	720	612	360	1071	1410	1360	1600	1820	8953	35.81	**VII**
Service related Problems											
Inadequate farm credit	2800	3264	3600	2346	987	680	608	80	14365	57.46	**II**
Marketing problems	3920	3604	2940	2295	1175	560	352	80	14926	59.70	**I**
Absence of grading	720	476	540	561	658	2000	1952	1780	8687	34.75	**VIII**

Source: Calculated from Table 7.6

Figure 7.c. Problems of bamboo cultivators in Nagaland



Source: Table 7.7

From the figure 7.c and table 7.7, it is revealed that 'Marketing problem' is the major problem faced by cultivators in Nagaland with the highest Garret score of 14926 and an average score of 59.7. Accordingly 'Inadequate farm credit' with Garret scores of 14365 and an average score of 57.46 is represented the second rank. With an average score of 54.28 for 'Lack of transportation facility' ranked the third. On the other hand, 'Absence of grading' with average score of 34.75 is the least in the rank.

By individual ordering of preferences (problems), the data show that marketing, credit, transportation, storage and proper machinery and tools, respectively were the major problems for bamboo farmers. Other problems like lack of work culture and grading were least concerns for the bamboo farmers in Nagaland.

Table 7.8. Category description of problems of Nagaland Bamboo farmer

Description	Total	Average	Rank
Infrastructure Problems	40148	53.53	**I**
Man-power Problems	21374	42.7	**III**
Service related Problems	37978	50.63	**II**

Source: Table 7.7

By averaging the scores of problems by broad categories, the findings in table 7.8 shows that Infrastructure and service related problems were the major challenges faced by bamboo cultivators in Nagaland. Therefore, the hypothesis that lack of infrastructure is the major obstacle for bamboo cultivators in Nagaland is accepted.

Lack of Transportation Facility

Poor road conditions and connectivity is one of the major hindrances to bamboo cultivators. Farmers find it difficult to send the product to various places. Inclement weathers have also been disadvantageous to the business. The density of good roads in the state of Nagaland is weak and has been a drawback for entrepreneurs dealing with bamboo business. The mode of transportation is limited to trucks. Challenging topography and geography of the destinations have not been encouraging for transport business to collaborate much with the entrepreneurs dealing with bamboo business.

Poor machinery and inadequate tools

People still use the traditional method for cultivation and plantation of bamboos. They use simple tools like machete (Dao), iron rods and spade for clearing jungles and planting

bamboo saplings. The farmers use human labour and *dao* for the whole plantation process which consumes time and energy. Machines like the incense sticks making machine if available to the farmers, the farmers can make use of the abundant raw bamboo resources to make the same instead of waiting for the people to buy bamboo pole. Absences of industrial tools have been a major setback for the cultivators; otherwise the farmers can process the raw resources into semi or finish products, adding value to their output and can earn a higher income.

Lack of good storage facility

Most of the cultivators keep the harvested bamboo in open spaces. This has lead to natural damages of the bamboos. There is no proper storage place and as such farmers directly sell the produce for whatever the negotiable amount they get. In worst cases, the bamboos when degraded are used to set fires for cooking.

Shortage of Labour

People's preference for white collar job and wanting to stay in urban centers has lead to the difficulty in finding labours in rural areas. Not many venture into the business that requires long term commitment, unsure of the future market returns. For those who have taken up bamboo cultivation as serious business venture faces difficulty in getting the right number of labours on time. The investment and effort is a long term as such farmers are required for returns. Rural migration is the reason why cultivation that started during the forefather days has taken a back seat.

Lack of work culture

Bamboo cultivation requires a lot of effort and the returns are not instant. The attitude and outlook of the people has also hampered the growth of bamboo production. Along with effort, Bamboo cultivation is time consuming and lack of commitment to the business has often resulted in the slow progress of the cultivation trend and practice.

Inadequate Farm Credit

Poor financial assistance stands as an obstacle for promoting bamboo cultivation. Huge initial investment is needed to start the cultivation which the poor farmers cannot afford. There is also lack of awareness among the cultivators regarding various schemes or credit facilities offered by the center and state.

Marketing problems

According to the study, marketing problem is identified as the most significant problems faced by the Bamboo cultivators. Due to lack of proper marketing linkages and topographical challenges, the Bamboo produces do not reach the buyers, leaving the farmers discouraged in taking it as a full time job. Exposure to other states and strengthening of inter-state market relation can address the issue. A common market for all the Bamboo cultivators of the state and region needs to be encouraged. Taking part in trade expo has helped some of the farmers to get connected with potential buyers.It has been noted that there is need of aggressive marketing policy for promoting bamboo resources in the form of products.

Absence of grading

There is no grading system practiced in Nagaland with regard to bamboo products. It solely depends on the market demand and supply. Prices vary from place to place and person to person. There also exist syndicate markets which discourage the farmer to take up bamboo cultivation in large scale. Appropriate grading can add market value to the produce. Grading system is also important to identify the quality of the produce and regularize the purchase.

7.3. NAGALAND BAMBOO POLICY

A brief review of Bamboo policy of Nagaland Government highlights the intensions and initiatives of the government towards development of bamboo as resource to uplift the economic conditions of the rural people. Bamboo is an important resource in the socio-economic-ecological-climatic-functional context for Nagaland and the State has now taken a step in the initiative to harness the potential of bamboo and its benefits. The State announced its bamboo policy on 15th March 2004 and with it the Nagaland Bamboo Development Agency (NBDA) was established to undertake the programs and activities of bamboo with the objective to foster in ecological security and economic growth through development and utilization of the bamboo resource. The Nagaland Bamboo Policy (2004)[2] is discussed in brief as follows:

7.3.1. Goals of Nagaland Bamboo Policy

The Nagaland Bamboo Policy adopted the following goals:

i) Disruption of ecological balance leading to adverse impact on the quality of life of the rural people who constitute 80% of the population of the state.

[2]https://www.nbm.nic.in

ii) Tribal people, particularly the *Nagas*, continue to depend on bamboo for their existence and sustenance.

iii) It plays an important role in maintaining environment by maintaining balance of Oxygen and Carbon dioxide and also capable of generating Oxygen.

iv) It is versatile species, which is adaptable to a wide range of soil and climate.

v) Technology inputs to the qualities of versatility and resilience has given wider scope of bamboo uses in the form of pulping, boards, ply furniture, handicraft and many other uses including energy alternatives in the form of bamboo charcoal and biomass electric generating resource.

vi) Bamboo shoot has been identified as food with a large commercial market. Bamboo leaves can promote various forms of medicine, apart from being a rich fodder for domesticated animals.

vii) Mass propagation of bamboo by active involvement of the people for plantation on private and public jhum land is feasible as the plantation is well known to the rural people.

viii) A planned and scientific approach to the cultivation and management of bamboos in the state will greatly contribute to the economic development of the state.

7.3.2. Aims and Objectives

The Nagaland Bamboo Policy is envisaged to achieve the following aims and objectives:

1. Protection and conservation of rich bio-diversity associated with bamboo forest and bamboo areas in the state.

2. Sustainable development and utilization of bamboo resource through scientific management.
3. Promotion of bamboo plantation (by Government, Individuals and communities) as a key thrust area for future economy of the state.
4. Promotion of bamboo based industries for utilizing the available resources for generating income.
5. Revitalization and promotion of local traditional bamboo craft and art with improved technology and design, and value addition for export through industrialized mode of production.
6. Promotion of bamboo as an essential wood substitute by increasing bamboo production and promotion of bamboo based enterprise in the state in order to reduce pressure on forests.
7. Promotion of awareness and understanding of bamboo as " Green Gold" among farmers, traders, industry and the people in the state with a view to utilizing its full potential and to galvanize the rural and industrial economy in the state.
8. Effective exploitation of existing mature bamboos before the impending gregarious flowering.

7.3.3. Strategy

The Development of Bamboo in Nagaland is approached in a Missionmode, which is categorised as namely:

a) Development of Bamboo as a Resource
b) Development of Bamboo as Enterprise

7.3.3.1. Development of Bamboo as a Resource

Strategy for cultivation and management of bamboo resources in the state focus on activities like inventorization of bamboo resource, assessment of scope and potential of bamboo growth and regeneration, evolve scientific management practices, creating massive and consistent awareness of the value of bamboo, prepare suitable policy to deal with gregarious flowering, setting up appropriate institutes for research and development of bamboo and evolve suitable techniques of multiplication, develop infrastructure for mass production of planting materials and development of communication network for development of bamboo as an industry in Nagaland.

The action plan for development of bamboo resources covers:

1. **Development of Natural Bamboo forest:**
    - i) Identify, demarcate and quantify the extent of natural bamboo area.
    - ii) Evolve management practice and harvesting techniques for natural bamboos.
    - iii) Increase area of natural bamboos through aided natural regeneration in the immediate vicinities of the bamboo forests.
    - iv) Improve communication network to access the existing bamboos for harvesting and transportation.
    - v) Protection of native bamboo species and preservation of germplasm through the mechanism of bamboo setum, in-situ and ex-situ preservation.

2. **Bamboo plantation development:**

i) Promotion of bamboo cultivation by individuals and communities on private and community lands which forms 89% of the total area of the state through the active participation of the Village Councils, VDBs and VFCs.

ii) Introduction of bamboos having commercial superior and desirable attributes for large-scale cultivation to augment the existing local varieties of bamboo in the state.

iii) Development of bamboo nurseries and distribution networks in both the Government and the private sector to ensure adequate and timely supply of high quality planting materials.

iv) Encouraging the participation of private sector wherever Government private and community land can be made available by way of land lease.

v) Development of research infrastructures for introduction and adoption of technological innovations.

vi) Development of mechanism for technology transfer, extension and awareness education.

vii) Streamlining of finance and credit facilities for bamboo plantation, management and harvesting.

viii) Promotion of Co-operatives Self Help Groups for the plantation and management of Bamboo.

ix) Bamboo cultivation to synchronize with existing farming practices, such as jhuming to maximize interim benefits.

x) Structural changes within the Government machinery to provide people oriented bamboo development programme.

3. Regulation of bamboo harvest:

Transplantation of unprocessed bamboo requires transit pass through the payment of forest royalty. To do away with the present systems of transit pass for transportation of bamboo through appropriate administrative decision and alternate means of realizing forest royalty evolved.

4. Bamboo flowering and strategy to utilize surplus bamboo:

i) Encouraging scientific harvesting of bamboo inside and outside the Government forests and Jhum land.

ii) Construction of extraction road/path network to reduce extraction cost.

iii) Increase the use of improved products from bamboo for infrastructure development works. Obtain improved design and technology from National and International Institute to support and maintain such initiatives.

iv) Promotion of conversion of Bamboo to other mass scale uses such as Bamboo Charcoal and Biomass energy plants for generation of power.

v) Replenishment of depleted bamboo growing stock through artificial regeneration using modern scientific technology of micro-propagation protocols developed for important bamboo species.

5. Bamboo Trade:

i) Endeavour of the State to promote trade in bamboo and bamboo products among the people. Organization of bamboo traders into trade association with linkages

with bamboo growers and the bamboo processing industries and bamboo exporters to rationalize the bamboo trade practices.

ii) A study to organize movement of the products from primary producing point or the cultivation areas to other industrial location. This will ascertain the cost of raw material, taking into account the difficult terrain and from where the bamboo is to be extracted the shortage of manpower in the labour. Such study will be undertaken with the aim to contain the cost of raw material required for promoting the Bamboo industry. This exercise will ensure that the Bamboo products of Nagaland become commercially viable with competitive pricing.

7.3.3.2. Development of Bamboo as an Enterprise

Development of 'Bamboo as enterprise' shall evolve policies and action plans that will focus on the following aspects:

1. Promote Bamboo based Industries like food products, medicinal, Chemical Products and Alcohol Beverages, craft, handicraft and Art Products and Value added products and wood substitutes such as ply, flooring tiles, shuttering etc.
2. Create awareness of the uses and value of Bamboo by imparting Training, Seminar, and Workshop etc.
3. Promote and develop traditional usage of Bamboo.

7.4. GOVERNMENT INITIATIVES

With a view to achieve the goals set in its bamboo policy, the state government has undertaken various initiatives through by the NBDA, listed as follows:

7.4.1. Plantation

The agency has implemented National Bamboo Mission's programme in development of bamboo resources. Bamboo plantation is been promoted in all districts of Nagaland in a commercial basis with intensive management to get maximum yield per hectare. Certain bamboo species with potentials are been promoted as plantation of too many species may lead to complicacies in future while processing for more value added products. Species-to-site matching has been given special importance because depending on the genetic characters, species vary in growth and development pattern and in their response to environment conditions. Out of 46 species in the state only 10 species in the state are recommended by NBM for commercial point of view for which the agency is promoting 4 species with commercial potential which are endemic to the state. They are *Bambusatulda, Bambusabalcooa, Dendrocalamusgiganteus and D. hamiltonii.*

7.4.2. Nurseries

To promote bamboo as a resource and enterprise development, the agency with the financial support from the NBM has set up Central Private &Kisan/ Mahila nurseries in all the districts of the state with the capacity of 50000 and 5000 nos of saplings respectively and 7 Central Public nursery at NBRC Dimapur with 5-7 lacs saplings.

7.4.3. Adoption of cluster concept and formation of VBDC

The integrated cluster development approach has been adopted to meet its objectives. The agency has established 34 bamboo clusters comprising of 280 villages in the state. The Village Bamboo Development Committees has been set up in the villages and all the bamboo development activities in the rural areas are being taken up through VBDCs.

7.4.4. Enterprise development

Keeping in view that the economic potential of bamboo can be realized only by creating bamboo enterprise development augmented by availability of sufficient quality raw material, the agency with the support of Nagaland Mission on Bamboo Application (NMBA) has initiated distribution of Micro Primary Processing units. Some of the activities undertaken to promote enterprise are providing mechanization of tools and implements like crosscutter, manual slivering machine, internal node and outer skin removing machine, pole flattening machine, thin slicing machine etc to the young and enterprising craftsman. Only 19 per cent of the households from the study area have benefitted.

7.4.5. Bamboo mat production

The Bamboo Mat production as a community enterprise was launched by NBDA in 2007 with a target of 3,000 bamboo mats per month priced at ₹43 per mat. The cluster development approach, with one cluster having one product, was adopted for the activity with individual households as the production units. Six villages in the Mokokchung districts, comprising of 1208 households were identified and clustered to form Anaki Bamboo Mat production cluster. It was link with the Arunachal Ply Industry Pvt. Ltd for tapping its production. The agency facilitated the establishment of two additional bamboo mat production clusters in Aboi and Tamlu area, linking them with two new bamboo mat manufacturing companies (M/S TimpackPvt Ltd, Banihart and M/S Nano Steels Pvt Ltd, Guwahati).

As bamboo mat production is taken up in Mokokchung district, there were 64 per cent of the household respondents who were benefited through the mat production and market linkages taken up by the agency.

7.4.5. Bamboo Charcoal Production

NBDA has set up 49 nos. of bamboo charcoal production kilns with capacity to produce 300 kgs per cycle set in Dimapur and Peren districts in view of the bamboo flowering occurring in these areas, while 3 units have been set up in Wokha, Tuensang and Kiphire districts respectively as pilot demonstrative production units. So far 148 persons covering 28 villages have been trained in bamboo charcoal production. There were around 23 per cent of the household who received training on charcoal production in Dimapur and Mokokchung district combine together.

7.4.6. Conduct of trainings, tours and events

Training on Bamboo Resource management, Management of Revolving Funds and Book-keeping, Organization of Self-Help Groups were imparted to all the VBDCs and bamboo farmers across the districts in Nagaland. The agency conducted capacity building and skill up gradation in bamboo toy making, training on mat making, training on Primary processing Bamboo shoot for SHGs, training cum workshop on vegetative propagation of Bamboo, training on bamboo furniture making, training on traditional pit method of bamboo charcoal production, training on engineered bamboo structural application, training on bamboo shoot pickle making and training on bamboo structural application.

7.5. CONCLUSION

The Garret Ranking Technique in the case of Bamboo cultivation and problems associated to it deems fit. This is significantly because of the ranking method that puts up the highest mean value indicating it as an important factor in studying the problem. The respondents

had given their preferential ordering of the unranked problems at the initial stage. These problems were ranked on preferential order, which reveal the primary concerns of the farmers.

In Dimapur, inadequate farm credit followed by marketing problems and lack of good storage facility were the major problems faced by the cultivators. In Mokokchung, farmers ranked Marketing problem, shortage of labour and lack of transportation facility as the major problems. The average of the sample districts which may be taken as the overall problems faced by bamboo cultivators in Nagaland, shows that marketing problem ranked the first. Even though cultivation of bamboo has great potential in Nagaland, farmers are not able to sell their produce as there is no proper linkage that connects different markets and value chains. This discourages the cultivators to take up bamboo cultivation as full time job and at business/scale. Inadequate farm credit is ranked second. Cultivators are often faced with problems related to credit facilities. There is lack of infrastructure like transport and storage which makes it expensive for the cultivators in villages to bring and sell their produce in the market.

The Nagaland Bamboo Policy taken up by the NBDA covers bamboo resource and enterprise development. Many activities are conducted to give boost to the bamboo sector, however the state have not yet achieved the desired level. Trainings conducted for bamboo cultivators have not reached to majority of the farmers. The various tools and machines provided by the agency were limited and many of the respondents in the current study have not accessed to the benefits provided by the agency.

The outcome of the study can be used by policy makers and government to formulate policies to mitigate the problems so as to enhancing the productivity of bamboo cultivation and the possibilities of adding commercial values to it to help the farmers.

ANNEXURE 7.1. GARRET'S RANKING CONVERSION TABLE

Percentage	Score	Percentage	Score	Percentage	Score
0.09	99	20.93	66	80.61	33
0.2	98	22.32	65	81.99	32
0.32	97	23.88	64	83.31	31
0.45	96	25.48	63	84.56	30
0.61	95	27.15	62	85.75	29
0.78	94	28.86	61	86.89	28
0.97	93	30.61	60	87.96	27
1.18	92	32.42	59	88.97	26
1.42	91	34.25	58	89.94	25
1.68	90	36.15	57	90.83	24
1.96	89	38.06	56	91.67	23
2.28	88	40.01	55	92.45	22
2.63	87	41.97	54	93.19	21
3.01	86	43.97	53	93.86	20
3.43	85	45.97	52	94.49	19
3.89	84	47.98	51	95.08	18
4.38	83	50	50	95.62	17
4.92	82	52.02	49	96.11	16
5.51	81	54.03	48	96.57	15
6.14	80	56.03	47	96.99	14
6.81	79	58.03	46	97.37	13
7.55	78	59.99	45	98.72	12
8.33	77	61.94	44	98.04	11
9.17	76	63.85	43	98.32	10
10.16	75	65.75	42	98.58	9
11.03	74	67.48	41	98.82	8
12.04	73	69.39	40	99.03	7
13.11	72	71.14	39	99.22	6
14.25	71	72.85	38	99.39	5
15.44	70	74.52	37	99.55	4
16.69	69	76.12	36	99.68	3
18.01	68	77.68	35	99.80	2
19.39	67	79.12	34	99.91	1
				100	0

Source: Garrett, H. E. (1969). *Statistics in Psychology & Education*. Central Book Company.

CHAPTER 8

CONCLUSION

8.1. INTRODUCTION

Economic uses of bamboo are well documented in economic literatures at international, national and regional levels. However, relevant estimates on cost and return on bamboo cultivation is not available for the state of Nagaland. Thus, in the present study, estimated the cost–benefit analysis based on data collected through filed survey conducted during 2017-18 in the State. Further, it accessed production and productivity, the problems faced by the cultivators and the State's Bamboo policy. The important findings and observations made in the study are summarized and presented below, followed by suggestions.

8.2. SOCIO-ECONOMIC PROFILE

The summary of the socio-economic profile of Nagaland and the bamboo farmers in the survey are as follows:

8.2.1. Geography and demographic features

The total geographical area of Nagaland is 16,579 Sq. km and is the 16th State of India. The state has twelve districts and English is the official language. The temperature ranges from 21°C to 40°C, which drops below 4°C during winter.

According to Census report (2011), the total population of Nagaland is recorded about 19, 78,502 people, of which, 51.8 per cent are male and 48.2 per cent are female. The sex ratio was 931 female per 1000 male, and the density of population was just about 119 per sq. km. The

State literacy rate is 79.6 per cent, whereby, males (82.8%) are more literate than the females (76.1%). Total work participation rate was 49.2 per cent, which is comparatively higher than the national average (39.1%). A higher proportion of working population was cultivators (55.2%), followed by other workers (36%). Agricultural labours constituted only 6.5 per cent and household industrial workers were only 2.3 per cent.

8.2.2. Economy

The GSDP at current prices is estimated to increase from ₹24,095 crores in 2017-19 ₹.26,637 crores in 2018-19, achieving a growth rate of 10.55 per cent. At constant price, the GSDP is estimated to increase from ₹16,182 crores to ₹17,147 crores, with a growth rate of 5.97 per cent.

The sector wise contributions to Gross State Value Added (GSVA) at constant prices, the share of primary sector is estimated to fall from 32.465 per cent in 2013-14 to 29.39 per cent in 2018-19. Correspondingly, the secondary sector has shown a marginal increase from 8.98 per cent to 12.25 per cent, while the tertiary sector contributed the highest, with more than 58 per cent to the State economy.

8.2.3. Forest Land Use

Nagaland has a total forest area of 12,486.40 sq km that accounted about 75 per cent of the total geographical area. The legal forest status of the state represents that government owned forest holds only 5.99 per cent and the largest portion of forest land is village and individual owned which holds 88.4 per cent.

8.2.4. Profile of sample districts

As per Census report of 2011, the total population of Dimapur district is recorded about 3,78,811, of which, 52.11 per cent are male and 47.89 per cent are female. The sex ratio was 919 female per 1000 male. The district has the highest density of population in the state with 409 per sq km.

The total population of Mokokchung district is recorded about 1,94,622, of which, 51.94 per cent are male and 48.06 per cent are female. The sex ratio was 925 female per 1000 male, and the density of population was 121 per sq km.

8.2.4. Profile of the sample population

The general characteristics found amongst the sample population are summarized as follows:

1. Age profile

The sample data indicated that majority of the cultivators are in the middle age group (56.8 per cent were in between 35-55 years), followed by older age group (33.6 per cent with above 55 years) and the younger age group (9.6 per cent who were below 35 years), respectively.

2. Gender

The bamboo cultivators in the survey are overwhelmingly of male, who constituted 82.8 per cent of the total respondents and the remaining 17. 2 per cent are female. One reason is that the *Nagas* being a patriarchal society, hence most of the respondents during the survey were male, who represented their family.

3. Education attainment

A larger section of the farmers have completed only primary level of education (67.2 per cent), followed by secondary level (23.6 per cent) and only 11.6 per cent were found to be with graduate and above degree of education.

4. Access to training

It was evident that most of the respondents never received any training on bamboo cultivation (63.2 %), this depicts the low level of information on production among the farmers. Only 36.8% had undertaken training on bamboo plantation. This may imply that the government's initiative for development of bamboo through imparting trainings has not been reached to the masses of bamboo growers.

5. Family size

On an average, 86 per cent of the farmers have family size of 4-8 people, whereas, 12 per cent were of larger family size with 8-12 members and only 2 per cent of smaller size with less than 4 members.

6. Motive of bamboo cultivation

The aggregate sample data reveals that 50.8 per cent of the respondents started cultivating bamboo to meet domestic needs. There were 28.4 per cent who cultivated bamboo to supplement income and only 20.8 per cent cultivated bamboo as a main source of income.

7. Experience in Bamboo Cultivation

It is observed that 62 per cent of the farmers are engaged in bamboo cultivation for shorter period (6 to 12 years), followed by 18.8 per cent of farmers with 12 to 18 years of experience. Only 8.8 per cent have longer years of experience (18 to 24 years) and 10.4 per cent with very short period (below 6 years). Thus majority are with shorter years of experience in bamboo cultivation in the survey.

8. Area under Bamboo Cultivation

On an average, a larger proportion of bamboo cultivators were of small and small-medium farmers (with 34.8 per cent and 26.8 per cent, respectively). Marginal farmers comprised of 24 per cent and medium and large farmers were very few (with 9.6 per cent and 4.8 per cent, respectively).

9. Occupation

Agriculture is found to be the main occupation (61.2 per cent) for the sample population, while own business and services accounted for 21.6 per cent and 17.2 per cent, respectively.

10. Monthly income distribution

The sample aggregate shows that majority of respondents' income ranges between ₹10000-₹25000 and very few were at the higher income range of ₹50000 and above per month.

8.3. SOCIO-CULTURAL AND ECONOMIC IMPORTANCE OF BAMBOO IN NAGALAND

Naga society continues to depend on bamboo. The different uses of bamboo as kitchen utensils, infrastructure materials, agriculture implements, weaving tools, musical instruments, traditional ornaments, hunting tools, food, household, in marriage ceremony pictures, handicrafts and furniture are depicted through pictures.

8.4. BAMBOO PRODUCTION AND ITS DETERMINANTS

8.4.1. CAGR

The Compounded Annual Growth Rate (CAGR) of area, production and productivity from 1990-2005 is 0.007, 0.014 and 0.008, respectively in the world. In India, the CAGR of area from 2011-2019 was 0.01, production was 0.06 and productivity was -0.32. In Nagaland from 2005-2017, the CAGR of area, production and productivity is 0.04, 0.07 and 0.03, respectively, which rates are relatively higher than that of national rates.

1.4.2. Regression Analysis Result on Income and Production

(i) Income

Results of multiple regression analysis reveals that the economic factors like years of experience, area under cultivation and occupation are significant predictors of income of the bamboo farmers. The years of experience in bamboo cultivation (B =.297, P = .001) is significant and its coefficient is positive indicating that monthly income increases by 29.7 per cent for each 1 year increase in experience. This is because with experience, a person becomes more efficient if continuously engaged in the same activities. Area of cultivation (B =.339,

p=.001) is significant and predicted income increases by 33.9 per cent for each 1 hectare increase in area of cultivation. As the area is increased, more plantations can be carried out leading to more number of clumps and thus increasing the level of income. The principal occupation of the bamboo cultivators (B=.726, p=.001) is significant and its coefficient is positive indicating that income increases by 72.6 per cent as the respondents shifts from agriculture to secondary and tertiary activities.

(ii) Production

Multiple regression analysis reveals that area, total cost and profit are significant predictors of annual bamboo production. The area under bamboo cultivation (B=.172, p=.001) is significant, where t =11.92 and its coefficient is positive indicating that predicted annual production increases by 17.2 per cent for each 1 hectare increase in area. Total cost (B=.282, p=.001) is significant with t = 33.12 and predicted annual production increases by 28.2 per cent for each 1 per cent increase in total cost. Profit (B=.122, p=.001) is also significant with t= 29.49 and predicted that annual production will increases by 12.2% for each 1 per cent increase in profit.

Thus, the first hypothesis that income and annual production of bamboo are positively influenced by socio-economic factors in Nagaland is accepted.

8.5. COST-BENEFIT ANALYSIS

8.5.1. BCR

The data reveals that Bamboo plantation is economically viable as the BCR is greater than 1 in both the sample districts with 2.65 for Dimapur and 1.83 for Mokokchung districts and

for Nagaland it is 2.03. Capital investment reveals that the ratio of net profit to capital employed is very remarkable which is in compliance with Sudhakar & Sarkar (2013)[1] result and applicable in case of bamboo farmers in Nagaland.

8.5.2. NPV

The Net Present Value of bamboo cultivation per hectare which is discounted at 6 percent is estimated to be ₹ 2, 31,604 /ha/year in Dimapur and ₹132628.03/ha/year in Mokokchung with an average NPV of ₹182116.36. This result is in compliance with Gondalia & Patel (2007)[2] as NPV is positive, hence it is economically viability and financially sounds to start bamboo cultivation.

8.5.3. IRR

IRR in bamboo plantation is found to be 36% in average which may represent for Nagaland state. Among sample districts, Dimapur gave best rate of return (42%) as compared to Mokokchung (29%). This result is in compliance with Karegaonkar et al., (2011)[3]as IRR was greater than the opportunity cost of capital which indicates a higher marginal efficiency of capital per unit.

Thus, the second hypothesis stating that bamboo cultivation is a profitable venture in Nagaland is accepted.

[1]Sudhakar & Sarkar (2013). *Op.cit*. p. 168
[2]Gondalia & Patel (2007).*Op.cit*. p. 169
[3]Karegaonkar et al., (2011). *Op.cit*. p. 169

8.5.4. Cobb-Douglas Production Function

It indicates that labour and seedling costs are statistically significant at p<.001 level in Dimapur. The results indicated that the model explained 43% of the variance in dependent variable and that the model was a significant predictor of bamboo yield, F (5, 128) = 19.262, p< .001. The labour cost (B=.298, p=.000) is significant and its coefficient is positive indicating that predicted yield increases by 29.8 % for each 1 per cent increase in labour cost. Seedling cost (B=.257, p=.000) is also significant and predicted yield increases by 25.7% for each 1 per cent increase in seedling cost. This is because as more saplings are planted costing more, it will yield more bamboo culms and thus increase production.

The results indicate that only labour cost is statistically significant at p<.001 level at Mokokchung, with the labour cost (B=.328, p=.000) is significant and its coefficient is positive indicating that predicted yield increases by 32% for each 1 percent increase in labour cost. Keeping other things constant, as more labours are employed it contributes to increase in productivity of bamboo.

On average, the labour cost (B=.383, p=.000) is significant and its coefficient is positive, indicating that bamboo yield increases by 38 per cent for each 1 per cent increase in labour cost in Nagaland. This is due to the fact that labour is one of the major inputs in bamboo cultivation, apart from land, and accepts the hypothesis that labour cost is a major input that enhance yield of bamboo. Thus, the third hypothesis that labour cost significantly determines the yield of bamboo in Nagaland is accepted.

8.6. PROBLEMS

The foremost challenges faced by bamboo farmers in Dimapur were found to be 'inadequate farm credit' with the highest average score of 59.28 followed by 'marketing problems' with average score of 58.51 and 'lack of good storage facility' with average score of 58.31, respectively. 'Marketing problem' was the top most problem faced by bamboo cultivators in Mokokchung district with highest Garret score of 6846 and an average score of 59.02. Accordingly, 'Shortage of labour' with Garret scores of 58.88 is represented the second most problem. 'Lack of transportation facility' ranks third with an average score of 56.99. 'Marketing problem' was the major problem faced by cultivators in Nagaland with an average score of 59.7 which is followed by 'Inadequate farm credit' with an average score of 57.46 and an average score of 54.28 for 'Lack of transportation facility' ranked the third.

By averaging the scores of problems by broad categories, the finding shows that "Infrastructure problem' is the major problem faced by bamboo cultivators in Nagaland. Therefore, the hypothesis that lack of infrastructure is the major obstacle for bamboo cultivators in Nagaland is accepted.

8.7. GOVERNMENT INITIATIVES

The State announced its bamboo policy on 15th March 2004 and with it the Nagaland Bamboo Development Agency (NBDA) was established to undertake the programs and activities of bamboo with the objective to foster in ecological security and economic growth through development and utilization of the bamboo resource. Various initiatives like promotion of bamboo plantation, giving financial support for setting up Central, Private & Kisan/ Mahila nurseries in all the districts of the state, establishing 34 bamboo cluster comprising of 280

villages in the state, distribution of Micro Primary Processing units, establishing bamboo mat production linking with the Arunachal Ply Industry Pvt Ltd for tapping its production, setting up 49 bamboo charcoal production kilns with capacity to produce 300 kgs per cycle set up in Dimapur and Peren districts and conduct trainings, tours and events. However, not many of the farmers have benefited from the various initiatives taken up by the agency.

8.8. SUGGESTIONS

Nagaland is blessed with abundant resources of bamboo with suitable agro climatic conditions for propagation of bamboo. Moreover, the local farmers have the skills for bamboo plantation. In spite of all these advantages, bamboo production in the state has not gain its due momentum. Basing on the study, the following recommendations are suggested.

1. Proper documentation of bamboo resource of the State is needed as very little information on the same have been documented and made available.

2. There is no reliable database on the nature, volume, and location of products that would serve as a good linkage of value added chains, which can bring improvement in production and marketing sector. Therefore government takes initiative for timely update and maintain database.

3. The NBDA as a nodal agency for bamboo development in the state needs strengthening. As of now, most of the employees are working on deputation. This hampers the proper functioning and continuity of the agency. Thus, the agency necessitates having permanent employees.

4. Keeping tracks and records of the people trained by the NBDA and also beneficiaries from the agency, will help is accessing the success rate of the trainers and also outcome of the beneficiaries.

5. Identifying right species for commercial production and encouraging and disseminating the information to the farmers to grow the species which is in demanded in the market, this will lead to creating more revenues.

6. Conduct trainings for the farmers to better manage and adopt improved production techniques. Disseminate information on how to control fungal attacks and such problems, and using improved chemical treatment for longevity and elasticity.

7. Houses, furniture, decorative items and food made from bamboo are part and parcel of the *Naga* society, and recently it is becoming fashionable with the use of advance technology and innovative ideas. Preservation of indigenous and traditional knowledge and incorporating with latest design and use can boost its value thus changing the mindset of the people from handicraft to modern products.

8. In order to inculcate the right work culture and skill, Naga youth can be given opportunity to work abroad or outside the state on exchange program or trainings.

9. Lack of awareness is one of the main challenges that stand in the way for development of bamboo based activities. Creating awareness at grassroots level by encouraging farmers to attend various exposure programs like trade expo, exhibition, workshop and trainings in other parts of the country and abroad can help the farmers and entrepreneurs to widen their outlook on bamboo base enterprise. Awareness programmes are needed to influence the bankers, traders and investors about the potential of bamboo.

10. The quality of raw bamboo can be improved and new improvised technologies can be devised and value addition products of bamboo so that it rose to international standards.

11. Encourage investors for setting up mini plants and small scale industries for processing bamboo within the state, instead of sending raw materials outside the state. This will enhance bamboo production in the state and the region as a whole, which will also address the unemployment issue in the state and improve the economy. Rural economy can be built at the edifice of available local resources which is sustainable.

12. Reviving paper and pulp industry at Tuli can create huge demand for raw bamboo in the state and can generate employment and income.

13. Bamboo combines the best of forestry and agriculture as it can easily be adopted to become annually farmed resources while remaining perennial. The land ownership and management systems of the *Nagas* are unique and different from the rest of the country, where the customary laws gives land rights to the people. This gives due advantage to take up bamboo plantation by individuals, as it will generate more income for the people. The degraded land area may be put into use for bamboo plantation. As a result, bamboo cultivation creates an opportunity for income generation and profitable job opportunities.

14. Proper infrastructure like transportation and road connectivity, and also adequate farm credit, marketing facilities and subsidy can help in boosting the bamboo sector in the state.

15. The Ministry of Commerce has placed import of incense stick (raw Agarbatti) under “Restricted category”. Thus the local farmers can take advantage of this and become a major supplier to other parts of the country.

16. With the amendment of Indian Forest Act, 1927 in 2017, bamboo is not listed as a tree. This act can help the bamboo grower to export to other states and thus expanding its market.

17. Bamboo production can be a link between farm and industry, making commodities of high value ready for market use.

18. Making aware to the cultivators and entrepreneurs about online mode of marketing which can promote sales.

8.9. CONCLUSION

As the world considers for green options and solutions to meet global challenges, bamboo has now been recognized as the major resource to reckon with in many fields. Bamboo can be seen as a potential means to solve agro-climatic challenges, contribute towards poverty alleviation, improve scope of bio-fuels and used in medicine and industry. Its natural form and numerous species have given the world to adopt a green lifestyle. Its versatility and other properties have resulted in its numerous application, and thereby, have the potential to replace other material like wood, steel and plastic. Bamboo cultivation creates an opportunity for income generation activities and job creation. By engaging in commercial production, it gives maximum economic benefits.

Bamboo mostly considered as ‘poor man’s timber’ because it is readily available for poor people at often very low costs is gaining popularity for some time, mostly in many developing countries and especially in India, where it is easily available. Bamboo groves can be managed by individual farmers, who need only basic tools for cultivation and harvesting. With processing plants for shoots, culm for flooring, paneling and many more products for domestic and export markets, bamboo has provided much needed revenues.

By considering the benefits of each step, from planting and harvesting of bamboo, to its processing in industries and finally in construction, the income generation opportunities for each socio-economic strata of society can be included in development project of bamboo. Traditional construction technology was handed down from generation to generation, so it became a part of the socio-cultural structure of the people. Reviving such technology, further developing the technology and transferring it to the people who are already familiar with use of bamboo can strengthen the economy.

Bamboo is one of the amazing raw materials which can be explored in various ways and means for all kinds of applications for day today uses. It has the capacity to make buildings cost-effective, time efficient, disaster resistant and must be leveraged universally, to create affordable housing for millions of houseless or slum dwellers, to have a living space. Initially bamboo was used in agriculture purposes to house wares. With traditional and technical knowledge and cultural ideas it leads to mass production of bamboo craft arts. Because of material exploration, cultural symbol and trends it pave the way from traditional to new bamboo design and ideas. Later with experience, sustainability and attractions, bamboo was change from personal objects to public art. Currently bamboo has become a quality material, industrialized process and of global value with new perspectives and innovations. Bamboo can become a global language.

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Bambusa Balcooa	Bambusa Tulda	Dendrocalamus Hamiltonii
		
Melocanna Baccifera	**Schizostachyum Pergracile**	**Pleioblastus Fortunie**