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Diversity of Bamboo Species and its Utilization in the North-Eastern Region of India

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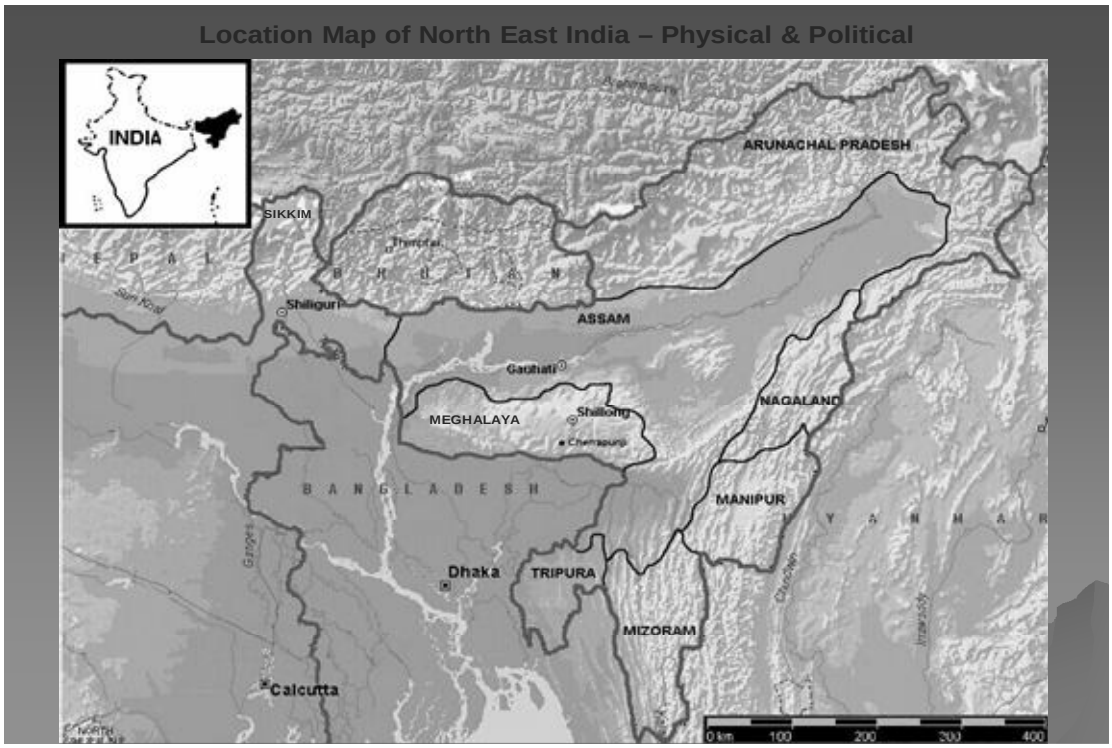
Abstract: ***Bamboos are distributed throughout the Himalayas with a variety of different genera adapted to different ecological zones. At the eastern end of the Himalayas heavy monsoon rains coupled with low level of evapo-transpiration during the pre and post monsoonal periods lead to minimal water stress, thus providing conditions that are well suited to bamboo growth. Geographical location and physiographical features contribute to bamboo diversity and its distribution in the different bio-climatic zones of the region. This paper presents a general survey of the diversity of bamboo species and its utilisation in the northeastern region of India. About 125 bamboo plant species belonging to 23 genera occur in India (Tewari, 1992; Varmah and Bahadur 1980). Similarly, about 78 species belonging to 19 genera occur only in northeastern region itself (Biswas, 1988; Hore, 1998). The regions accounts to about 50 percent of bamboo species of the total species in India. This region can be referred as the centre and genetic diversity for the genera, Arundinaria, Bambusa, Cephalostachyum and Dendrocalamus. The variety of interpretation of structural forms of different bamboo species results in a utilisation pattern that has geographical and cultural implications. Yang et al. (2004) reveals that traditional bamboo uses are very important for the cultural diversity of the ethnic minorities. Their lives are closely related with bamboo having a strong influence on their history, art, handicrafts, music, religion, customs, architecture, and agricultural production. There is an increasing importance of studying diverse utilisation of bamboo in different cultures and geographic regions. Such differentiation in its utilisation forms an interesting and important study to discover the interrelationship between geographic and cultural forces and the biodiversity of bamboo species. Out of the 78 species and 23 genera prevalent in the northeastern region of India, 6 species belonging to 2 genera namely, Bambusa balcooa, B. tulda, B. vulgaris, Dendrocalamus giganteus, D.hamiltonii and D. strictus have been found to be most widely used in the region. The most commonly used species in all the northeastern states of India has been observed to be D.hamiltonii.***
Keywords: genera bio-climatic zones structural forms cultural ethnic

I. INTRODUCTION

Bamboos are distributed throughout the Himalayas, with a variety of different genera adapted to different ecological zones and are often limited in distribution to a narrow geographic area. Geographical location and physiographical features contribute to bamboo diversity and its distribution in the different bio-climatic regions of north-eastern Himalayan region (Biswas, 1988). About 125 bamboo plant species belonging to 23 genera occur in India (Tewari, 1992; Varmah and Bahadur 1980) whereas, about 78 species belonging to 19 genera occur in northeastern region (Biswas, 1988; Hore, 1998).

Studies conducted by Yang *et al*. (2004) in the Yunnan province of China reveal that traditional bamboo uses are very important for cultural diversity of the ethnic minorities. Their lives are closely related with bamboo that has a strong influence on their history, art, handicrafts, music, religion, customs, architecture and agricultural production. This understanding has helped to preserve traditional cultural knowledge systems in this mountainous province of China. Yang *et al*. (2008) have surfaced interesting facts on the cultural value of bamboo in south-eastern China. The importance of studying diverse structural utilisation of bamboos in different cultures and geographic regions has been asserted by Ranjan (1995), as various cultures have interpreted the same species of bamboo in subtle ways that reflect and preserve their unique identity. According to Bystriakova *et al*. (2004), bamboos have many uses which exemplify the connection between biodiversity and livelihoods very clearly. Thus, conserving genetic resources of bamboo is an essential step towards solving the problems of poverty alleviation, pursuing sustainable development and is also necessary in preserving culture. Intensification of management has led to loss of bamboo biodiversity (Buckingham, 2009) and that bamboo has no doubt been certified globally yet it lacks culturally embedded enabling environments for protection of bamboo. The variety of interpretation of structural forms of bamboo results in cultural differentiation. Such differentiation can form an interesting and important study to discover the interrelationship between cultural forces and biodiversity of bamboo species. In this paper an attempt has been made to provide a comprehensive account on the diversity of bamboo and its utilization pattern in the states of north-eastern India.

II. STUDY AREA AND METHODS



The northeastern region of India comprises of eight states, viz. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, which is collectively considered as a major 'Hotspot of Biodiversity' (Rao, 1999). According to Biswas (1988), the north eastern region of India has over 50 percent of bamboo species of the total species in India and this region can be referred as the centre and genetic diversity for the genera, *Arundinaria, Bambusa, Cephalostachyum* and *Dendrocalamus*. The high diversity of bamboo resource plays a significant role in the food and nutritional security of the tribal population of north eastern Himalayan region. Sharma and Borthakur (2008) have conducted research on ethno-botanical knowledge of utilization of bamboo resource among the *Adi* tribe of Arunachal Pradesh. It seems such studies have been carried out only in a few tribes, thus immense cultural diversity is yet unexplored.

Broadly bamboo diversity in north eastern region of India occurs in bio-climatic regions such as, i) tropical ii) sub-tropical iii) temperate and iv) alpine type. The zone of tropical type of vegetation occurs from 0 to 300m and comprises of evergreen, semi-evergreen and grasslands. The bamboo species in this zone are found naturally as well as cultivated. The sub-tropical vegetation zone is found from 300 to 1700m and comprises of moist deciduous, savannah type and broad leaved hill forests. The temperate vegetation zone is found at elevations ranging from 1700 to 3000m while alpine type is found at higher altitudes of 3000 to 4500m. Bamboo dwindles into under shrubs in temperate regions and at greater altitudes, some species look almost like grasses.

Data on diversity of bamboo species in northeastern region of India have been collected from secondary sources such as articles from journals, books and National Mission on Bamboo Applications (NMBA) website. An inventory on the popular uses of bamboo species in the north eastern states of India was prepared in a tabular form with numerical codes assigned to the various uses. After screening a list of diverse bamboo species available along with their uses for each state, a table was prepared where the species having immense utility were identified and sorted in a descending order for each state. The species that were dominantly utilized in all the states were selected and a table was constructed showing their various uses in each north eastern state of India.

III. ANALYSIS

A. *Diversity of bamboo species in north-east India*

Diversity at generic and specific levels at the elevation between 1000-3000m is found to be higher i.e. 16 species distributed among 8 genera than at lower altitude between 30-300m with 10-12 species of 4 genera (Biswas, 1988). Further investigations have established that distribution of genera, based on species diversity in the north eastern region shows that, Arundinaria and Chimonobambusa are dominant in higher altitude and Bambusa and Dendrocalamus at lower elevations.

Table No.1: Various species available in the north eastern region of India

Sl.no.	Scientific name	Distribution	Bio-climatic zone (m)	Local name
1	Arundinaria callosa	Manipur	Temperate,alpine	Laiwa(Manipur)
2	Arundinaria clarkei	Manipur, Sikkim	Temperate,alpine	Wa(Manipur)
3	Arundinaria falconeri	Manipur	Temperate,alpine	
4	Arundinaria gracillis	Arunachal Pradesh, Sikkim	Temperate,alpine	
5	Arundinaria hirsute	Nagaland, Meghalaya	Temperate,alpine	
6	Arundinaria kurzii	Nagaland, Manipur	Temperate,alpine	Tenwa manbi(Manipur)
7	Arundinaria mailing	Arunachal Pradesh, Sikkim	Temperate,alpine	Mailing(Sikkim)
8	Arundinaria mannii	Meghalaya	Temperate,alpine	
9	Arundinaria microphylla	Meghalaya	Temperate,alpine	
10	Arundinaria racemosa	Arunachal Pradesh, Sikkim	Temperate,alpine	Mailing(Sikkim)
11	Arundinaria rolloana	Manipur,Nagaland	Temperate,alpine	Tenwa(Manipur)
12	Arundinaria suberecta	Meghalaya, Sikkim	Temperate,alpine	Sanu mailing(Sikkim)
13	Bambusa arundinacea	Arunachal Pradesh, Assam, Mizoram, Meghalaya, Sikkim Tripura	Tropicalsubtropical	
14	Bambusa auriculata	Assam	Tropical,subtropical	Kalia bans(Assam)
15	Bambusa balcooa	Arunachal Pradesh, Assam, Manipur, Meghalaya, Tripura	Tropical	Mulukang(Arunachal Pradesh),Bhaluka(Assam), Saneibi(Manipur), Bom(Tripura)
16	Bambusa cacharensis	Assam,Tripura	Tropical,subtropical	Mal/Makhla(Tripura)
17	Bambusa glauscescens	Assam, Meghalaya, Sikkim	Tropical,subtropical	
18	Bambusa jaintiana	Meghalaya	Tropical,subtropical	Thning/Kolongki/U skhen(Meghalaya)
19	Bambusa khasiana	Assam, Nagaland, Manipur, Meghalaya, Sikkim	Tropical,subtropical	Khok(Manipur)
20	Bambusa kingiana	Manipur	Tropical,subtropical	Watangkhoi(Manipur)
21	Bambusa longispiculata	Meghalaya	Tropical,subtropical	
22	Bambusa mastersii	Assam	Tropical,subtropical	
23	Bambusa nutans	Arunachal Pradesh, Assam, Nagaland, Meghalaya, Tripura	Tropical,subtropical	Beti bans(Assam)
24	Bambusa oliveriana	Mizoram	Tropical,subtropical	Talan(Mizoram)
25	Bambusa pallida	Arunachal Pradesh, Assam, Manipur, Meghalaya, Tripura	Tropical,subtropical	Deo bans(Assam),Paura(Tripura),Utang(Manipur)

26	Bambusa polymorpha	Arunachal Pradesh, Assam, Tripura	Tropical,subtropical	Betua(Assam),Mirtinga(Tripura)
27	Bambusa teres	Arunachal Pradesh, Assam	Tropical,subtropical	Nangal bans(Assam)
28	Bambusa tulda	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram Nagaland, Sikkim, Tripura	Tropical,subtropical, temperate	Dibang/Ejo(ArunachalPradesh),Bhaluki makal(Assam),Saneibi(Manipur), Wat/Rnai(Meghalaya),Rawthing (Mizoram),Karanti bans(Sikkim),Bari(Tripura)
29	Bambusa vulgaris	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Tripura	Tropical,subtropical	Tela bans(Assam), Lam saneibi(Manipur), Baruba(Meghalaya),Vairua(Mizoram), Rupai(Tripura)
30	Cephalostachyum capitatum	Arunachal Pradesh, Meghalaya, Mizoram Nagaland, Sikkim	Sub-tropical	Cope bans(Sikkim)
31	Cephalostachyum fuchsianum	Arunachal Pradesh, Manipur, Nagaland	Temperate	
32	Cephalostachyum latifolium	Arunachal Pradesh, Sikkim	Temperate	Palom(Sikkim),
34	Cephalostachyum pallidum	Arunachal Pradesh, Manipur, Meghalaya	Temperate	
35	Cephalostachyum peregracile	Arunachal Pradesh, Assam, Manipur, Nagaland	Temperate	Pongshang(Manipur)
36	Chimonobambusa callosa	Arunachal Pradesh, Meghalaya, Nagaland,	Subtropical,temperate	Tao(Arunachal Pradesh),Phar(Mizoram)
37	Chimonobambusa griffithiana	Arunachal Pradesh, Meghalaya, Nagaland	Subtropical,temperate	U skong(Meghalaya)
38	Chimonobambusa hookeriana	Arunachal Pradesh, Meghalaya, Sikkim	Subtropical,temperate	
39	Chimonobambusa intermedia	Arunachal Pradesh, Sikkim	Subtropical,temperate	
40	Chimonobambusa khasiana	Manipur, Meghalaya, Sikkim	Subtropical,temperate	
41	Chimonobambusa polystachya	Meghalaya, Sikkim,	Subtropical,temperate	
42	Dendrocalamus callostachys	Meghalaya, Nagaland,	tropicalsubtropical	
43	Dendrocalamus compactiflora	Assam, Meghalaya, Mizoram	Tropical,sub-tropical	Kakeo bans(Assam),Sairil(Mizoram)
44	Dendrocalamus giganteus	Arunachal Pradesh, Assam, Manipur, Mizoram Nagaland, Sikkim	Tropical,sub-tropical	Surung(Arunachal Pradesh), Boraka(Assam), Maribob(Manipur),Rawpui(Mizoram)
45	Dendrocalamus hamiltonii	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram	Tropical,sub-tropical, temperate	Eppo(Arunachal Pradesh), Kako bans(Assam), Wanap(Manipur),Wanoki(Meghalaya),Choya

		Nagaland, Sikkim, Tripura		bans(Sikkim) Phulrua(Mizoram)
46	Dendrocalamus hookeri	Arunachal Pradesh, Meghalaya, Mizoram Nagaland, Sikkim	Tropical,sub-tropical, temperate	Unap(Manipur),U ktang(Meghalaya),Rawlak(Mizoram), Pareng(Sikkim)
47	Dendrocalamus longispathus	Assam, Manipur, Mizoram , Tripura	Tropical,sub-tropical	Nal bans(Assam), Unap manbi/chingwa(Manipur), Lathi bans(Tripura)
48	Dendrocalamus maclellandii	Assam	Tropical,sub-tropical	
49	Dendrocalamus membranaceous	Arunachal Pradesh,Manipur	Tropical,sub-tropical	Unan khongdangbi(Manipur)
50	Dendrocalamus patellaris	Arunachal Pradesh, Assam, Nagaland, Sikkim	Tropical,sub-tropical	
51	Dendrocalamus sahnii	Arunachal Pradesh,Meghalaya	Tropical,sub-tropical	Tawang(Meghalaya)
52	Dendrocalamus sikkimensis	Arunachal Pradesh, Assam, Meghalaya, Mizoram Nagaland, Sikkim	Tropical,sub-tropical	Egi(Arunachal Pradesh), Wadah(Meghalaya),Rawmi(Mizoram),Bhalu bans(Sikkim)
53	Dendrocalamus strictus	Arunachal Pradesh, Assam, Manipur,Meghalaya, Mizoram , Tripura	Tropical,sub-tropical	Tansti bans(Assam), Unan(Manipur),Tursing(Mizoram), Muli(Tripura)
54	Gigantochloa macrostachya	Assam, Manipur,Meghalaya		Gonan(Manipur),Tekserah/Siej lakar(Meghalaya)
55	Melocanna baccifera	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram Nagaland, Sikkim, Tripura	Tropical	Tarai bans(Assam),Tyrlaw(Meghalaya), Dolu(Tripura)
56	Melocanna humilis	Assam	Tropical	
57	Melocalamus indicus	Assam, Manipur		Umu(Manipur)
58	Neohouzeoua dullooa	Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim, Tripura		Tokri bans(Sikkim)
59	Neohouzeoua helferi	Assam, Meghalaya		
60	Oxytenanthera abaciliata	Arunachal Pradesh, Assam, Manipur,Meghalaya,		Gotang(Manipur)
61	Oxytenanthera nigrociliata	Arunachal Pradesh, Meghalaya, Sikkim		
62	Phyllostachys assamica	Arunachal Pradesh, Assam		

63	Phyllostachys mannii	Meghalaya, Nagaland		
64	Pleioblastus simonii	Arunachal Pradesh	Alpine	
65	Pseudostachyum manii	Arunachal Pradesh		Tabo(Arunachal Pradesh
66	Pseudostachyum polymorphum	Arunachal Pradesh, Assam, Meghalaya, Mizoram Sikkim	Sub-tropical	Rawngai(Mizoram),Pheling(Sikkim)
67	Schizostachyum arunachalensis	Arunachal Pradesh		Tachur(Arunachal Pradesh)
68	Semiarundinaria pantlingii	Arunachal Pradesh, Sikkim	Temperate	Mailing(Sikkim)
69	Sinobambusa elegans	Nagaland		
70	Teinostachyum dullooa	Manipur		Tolluwaa(Manipur)
71	Teinostachyum falconeri	Sikkim	Temperate	Phurse nigalo(Sikkim)
72	Teinostachyum griffithii	Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland	Sub-tropical	
73	Teinostachyum wightii	Manipur		Naat(Manipur)
74	Thamnocalamus aristatus	Arunachal Pradesh,Sikkim	Sub-tropical, temperate,alpine	Ghode nigalo(Sikkim)
75	Thamnocalamus falconeri	Arunachal Pradesh, Sikkim	Sub-tropical, temperate,alpine	
76	Thamnocalamus prainii	Meghalaya, Nagaland	Sub-tropical, temperate,alpine	
77	Thamnocalamus spathoflorus	Arunachal Pradesh	Sub-tropical, temperate,alpine	
78	Thrysostachys oliveri	Arunachal Pradesh, Assam,Tripura		Barak(Tripura)

Source: (a) Distribution of various bamboo species in northeastern region of India (Biswas, 1988)
(b) National Mission on Bamboo Applications

Bamboo species belonging to diverse genera are found in different types of forests in the north eastern region of India. The bamboo species widely found in the tropical forests are from the genera, Bambusa, Dendrocalamus, Melocana and Neohouzeaua. In the sub-tropical forests, the bamboo species found belong to the genera, Chimonobambusa, Dendrocalamus, Neohouzeaua, Pseudostachyum, Teinostachyum and Thamnocalamus. The different species of bamboo found in the temperate type of vegetation belong to the genera Arundinaria, Chimonobambusa, Semiarundinaria and Thamnocalamus. Very few species are found in the alpine zone belonging to the genera Arundinaria, Pleioblastus and Thamnocalamus. In the higher altitudes, bamboos are usually found in the moist valleys, sheltered depressions, along streams, moist deciduous forests, wet temperature forests and alpine coniferous forests.

B. Utilisation of bamboo in northeastern India

Table No. 2: Uses of bamboo in different states of Northeastern India

Sl. No.	State	Common uses of bamboo species
1.	Arunachal Pradesh	1, 3, 4, 5, 6, 7
2.	Assam	1, 2, 3, 4, 5
3.	Manipur	1, 3, 4, 5
4.	Meghalaya	1, 2, 3, 4, 5, 6, 8
5.	Mizoram	1, 3, 4, 5
6.	Nagaland	1, 2, 3, 4
7.	Sikkim	1, 2, 3, 4, 5
8.	Tripura	5, 6

Data compiled from National Mission on Bamboo Applications (NMBA)

1: Construction, scaffolding, fencing, flooring, walling etc.
2: Ornamentals
3: Raw material for pulp and paper
4: Food item
5: Handicraft, musical instruments, furniture
6: Baskets, mats
7: Agricultural implements, weapons
8: Water pipes, water pitchers, food containers

Various species of bamboo have been found to be widely used for construction, scaffolding, walling, flooring, fencing and food item in majority of the states. From Table No. 2, we can observe that, in most states bamboo is being used as a raw material for pulp and paper industry, handicraft and furniture. The art of making baskets and mats from different bamboo species are more popular in Arunachal Pradesh, Meghalaya and Tripura. Different bamboo species used for making containers for food and water is significant in Meghalaya while making of agricultural implements out of bamboo is popular in Arunachal Pradesh. Some states like Assam, Meghalaya, and Sikkim use bamboo for various ornamental purposes.

Table No.3: Various species dominantly utilized in different states of northeastern India

Sl. no.	States	Bamboo species in descending order of their number of uses	Uses
1.	Arunachal Pradesh	B.tulda	1, 3, 4, 5, 6, 7
		B.pallida	1, 4, 6, 7, 8
		B.balcooa	1, 3, 5, 6, 7
		D.giganteus	3, 4, 5, 6, 8
		B.nutans	3, 4, 5, 6
		D.hamiltonii	1, 3, 4, 5
		S.pergracile	4, 6, 7
		S.arunachalensis	6, 7
2.	Assam	D.strictus	1, 3, 4, 6, 7, 8
		B.bambos	1, 2, 3, 4, 5
		B.vulgaris	1, 2, 3, 4, 5
		D.hamiltonii	1, 3, 4, 5, 6
		B.balcooa	1, 2, 3, 4
		M.baccifera	1, 2, 3, 6
		D.giganteus	1, 3, 5
		B.pallida	1, 6
3.	Manipur	D.strictus	1, 3, 4, 5, 6, 7
		B.vulgaris	1, 2, 3, 4, 5
		D.hamiltonii	1, 3, 4, 5, 6
		B.tulda	1, 4
4.	Meghalaya	D.hamiltonii	1, 2, 3, 4, 5, 6, 7, 8

		B.balcooa	1, 2, 3, 4, 5, 6, 7
		M.baccifera	1, 2, 3, 4, 5, 6, 8
		B.tulda	1, 3, 4, 5, 6, 7
		D.strictus	1, 3, 5, 6, 7, 8
		B.vulgaris	1, 2, 3, 4, 5
		D.longispathus	1, 3, 4, 5, 6
		D.sikkimensis	1, 2, 3, 4, 8
		B.nutans	1, 3, 4, 8
		B.pallida	1, 3, 6, 8
		C.callosa	1, 2, 5, 7
		D.hookeri	1, 4, 6, 8
		P.manii	1, 2, 4, 6
		S.dulloa	1, 4, 5, 6
5.	Mizoram	B.vulgaris	1,2,3,4,5
		D.hamiltonii	1,3,4,5,6
		D.strictus	1,3,4,5
		D.giganteus	1,3,4,5
		B.tulda	1,3,5
		D.munro	1,3,5
		M.bambuisoides	1,3,4
6.	Nagaland	D.hamiltonii	1,3,4,5,6,8
		M.baccifera	1,2,3,6
		B.balcooa	1,2,3,4
		D.giganteus	1,3,5
7.	Sikkim	B.vulgaris	1,2,3,4,5
		D.hamiltonii	1,3,4,5,6
8.	Tripura	B.cacharensis	1,5,6
		B.pallida	3,5,6
		B.tulda	1,5,6
		T.oliveri	1,3,5
		D.strictus	1,5,6
		D.longispathus	5,6
		M.baccifera	3,6

Data compiled from National Mission on Bamboo Applications (NMBA)

1: Construction, scaffolding, fencing, flooring, walling etc.
2: Ornamentals
3: Raw material for pulp and paper
4: Food item
5: Handicraft, musical instruments, furniture
6: Baskets, mats
7: Agricultural implements, weapons
8: Water pipes, water pitchers, food containers

D.hamiltonii is widely used in 7 states of the north eastern region of India and has utmost utility in Meghalaya, Mizoram, Nagaland and Sikkim. *B.tulda* also ranks among the species with highest number of uses and is popularly used in Arunachal Pradesh and Tripura. The species *D.strictus* has maximum utility in Assam, Manipur and Tripura followed by Meghalaya and Mizoram. *B.vulgaris* is found to have wide usefulness in around five states and is popularly used in Sikkim and Mizoram. *B.balcooa* and *D.giganteus* are found to be useful in around four states especially in Arunachal Pradesh where it ranks among the top species used. These 6 species have been observed to be dominantly used in majority of the northeastern states of India.

Table 3: Bamboo species dominantly used in northeastern India and their uses in different states of the region

Sl. No.	Bamboo species	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
1.	B.balcooa	1, 3, 5, 6, 7	1, 2, 3, 4	-	1, 2, 3, 4, 5, 6, 7	-	1, 2, 3, 4	-	-
2.	B.tulda	1, 3, 4, 5, 6, 7	7	-	1, 3, 4, 5, 6, 7	1, 3, 5,7	-	-	1, 5, 6
3.	B.vulgaris	-	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	-	1, 2, 3, 4, 5	-
4.	D.giganteus	3, 4, 5, 6, 8	1, 3, 5	-	-	1, 3, 4, 5	1, 3, 5	-	-
5.	D.hamiltonii	1, 3, 4, 5	1, 3, 4, 5, 6	1, 3, 4, 5, 6	1, 2, 3, 4, 5, 6, 7, 8	1, 3, 4, 5, 6	1, 3, 4, 5, 6, 8	1, 3, 4, 5, 6	-
6.	D.strictus	-	1, 3, 4, 6, 7, 8	1, 3, 4, 5, 6, 7	1, 3, 5, 6, 7, 8	1, 3, 4, 5	-	-	1, 5, 6

Data compiled from National Mission on Bamboo Applications (NMBA)

1: Construction, scaffolding, fencing, flooring, walling etc. 2: Ornamentals
3: Raw material for pulp and paper 4: Food item
5: Handicraft, musical instruments, furniture 6: Baskets, mats
7: Agricultural implements, weapons 8: Water pipes, water pitchers, food containers

B.balcooa is mainly used for construction, ornamental making, raw material for pulp and paper and food in the north eastern states. This species is commonly used for making handicrafts, basket, mats and agricultural implements in Arunachal Pradesh and Meghalaya. The culm of this bamboo species is generally 12-20m in height with a diameter of 8-15cm and is thick-walled. The branches from the lower nodes are hard and leafless characterized by young shoots that are blackish green with brown or orange tinged culm sheath, clothed sparsely with dark brown hair. The culm sheaths are green when young, tapering above and rounded at tip. The leaves have a rounded base with a short petiole, having rough margins and are glabrous above.

B.tulda is observed to be utilized mainly for construction, raw material for pulp and paper, handicrafts and basketry making, agricultural implements and weapons in majority of the states. It serves various purposes in a range of daily activities in the states of Arunachal Pradesh and Meghalaya. *B.tulda* is a large tufted bamboo upto 20m high and 8 cm in diameter. The culm sheath is rounded at tip and black inside. It has an oblique base, short petiole and leaf-sheath is glabrous or sparsely haired. The leaves have an oblique base, a short petiole and a glabrous leaf sheath.

B.vulgaris has been observed to be mostly utilized for the common purposes of construction, ornamental purposes, raw material for pulp and paper, food item and handicraft in majority of the states. Of the dominantly used species identified, this is most suitable for ornamental purposes. The culm is of 8-20 m high and 5-10cm in diameter, which is bright green but yellowish on maturing, glossy and erect. Its wall is 7-15mm thick, branching usually from mid-culm to top with prominent nodes, lower ones often with a narrow ring of roots, usually covered with brown hairs. The culm sheaths are rounded, truncated at the top and often beautifully streaked when young. The leaves are rounded or attenuate at the base, glabrous on the surface and sparsely hairy when young.

D.giganteus is found to be generally used for construction, raw material for pulp and paper and handicraft. The people of Arunachal Pradesh use this particular species for making containers to store food and water. It serves as a food item in Arunachal Pradesh and Mizoram. The culm of this species is over 30m tall, 15- 25 cm in diameter and are often naked at the base and branching above The nodes are hairy and the internodes are covered with white waxy scurf when young. Its leaves are large, broadly lanceolate and rounded at the base.

The bamboo species *D.hamiltonii* has been observed to be the species dominantly used in the north eastern states of India as its habitat is mainly in hilly terrains. It has the most variety of uses in the state of Meghalaya and the least in Arunachal Pradesh. It is being utilized for construction, scaffolding, fencing, flooring, walling, raw material for pulp and paper, food item, handicrafts, furniture and basketry making in almost all the states. It is being used for making food containers and water pitchers only in

Meghalaya and Nagaland while in Meghalaya it also has ornamental usages. *D.hamiltonii* is a large bamboo, both evergreen and deciduous, densely clumped, some times growing tall and erect, but more often sending out its stems at an angle or curved downwards. The culms are usually naked above while much branched below having long and stiff culm sheaths that are variable in size. The leaves are small and variable on the side branches but on new shoots it is broad and rounded at the base into a short thick petiole and leaf sheath is covered with white, appressed stiff hairs.

The species *D.strictus* is commonly used in Assam, Manipur and Meghalaya for the purposes of construction, raw material for pulp and paper, handicrafts and basketry making. Of all the dominant species identified, it is the most suitable species for making agricultural implements. In the states of Assam and Meghalaya, it is used for making containers for food and water storage. A densely tufted bamboo with culms hollow in wet climate and solid in dry climates and nodes somewhat swollen. Its culm sheaths are rounded at the top with triangular hairs on both sides. The leaves are rounded at the base into a short petiole and leaf-sheaths are striated and hairy.

C. Construction

The general characteristics of planning houses in north eastern India is confined to rectangular shape because of limitation of the construction system. Both inner and outer walls are of woven bamboos. Doors and windows are of wooden or even bamboo frames. *D. strictus* species has thick wall that can be easily bent into bows and is used in roofing of houses.

Riang tribals of Tripura build their houses with bamboo used as the primary material for construction. These houses are typical hill dwellings, constructed on bamboo slits to create a large horizontal platform, the floor of the house. The plan of the *Riang* house is normally a long rectangle, with a covered verandah in front and an open verandah at the back. A large enclosed room is located between these verandahs. Boards made of flattened bamboo culms are used to cover the floor of the room and are also used to make the walls and doors. The floor of both verandahs is made from either whole bamboo or longitudinal halves placed side by side and bound to the beam structure below the floor.

The *Meiteis* of Manipur harvest matured bamboos of about 3-4 years during the dry season. The culms of bamboo are kept deep inside water for 3-4 months to protect the culm from insect and fungal infections. After this, these culms are taken out and allowed to dry in the sun for another 10-20 days before they are utilized for various purposes. In earlier times, people living in the Manipur valley commonly built their houses, cooking huts, out-houses and granaries with bamboo. It is continued to be utilized in the lower and upper roof support of houses with thatched roof and the bamboo pillar retained in the south-western corner of the house where a secluded space is reserved for worshipping the Meitei household deity. The important feature of the architecture of a typical Meitei house is non-use of nails or any other metallic objects to secure or fasten the beams and the other supports. Cane and bamboo splits soaked in water are used for this purpose. To secure the beams and other supports firmly to each other, holes are drilled on the bamboo, and sharp pointed bamboo objects are driven into the holes. The Chin-Kuki groups commonly build houses having an extended verandah, where bamboo is extensively used. Temporary walls as well as permanent walls are constructed with bamboo-mats. The Naga groups living in Manipur build houses having roofs made of bamboo splits. Big bamboo poles are vertically split into two, and the bamboo splits are arranged in alternate turns, i.e. the pieces face up and down alternately. In some areas, the bamboo poles are cut into pieces and then smashed. Starting from the fringe of the roof, rows of the smashed bamboo are laid out one upon another to cover the whole of the roof.

In the state of Mizoram, most of the houses are built on the slopes and are invariably supported by wooden posts of varied lengths, so that the house is balanced horizontally with the level of the road. Cross beams are fastened against these posts and over the beams long solid bamboos are laid. Bamboo matting is then laid over the bamboo frame, which forms the floor of the house. The walls of the house are also made up of bamboo matting fastened to the outer posts while the doors and windows usually of bamboo matting are fastened against the wall. The roof consists of solid as well as split bamboo frames covered with thick thatch and some other kinds of leaves. The hearth is made of clay and stones and is raised about 2-3 ft above the floor supported by raised bamboo poles. Above the fire place is hung a bamboo frame which is kept suspended to keep various things used in cooking like dried chillies, dry fish, salt, etc.

D. Ornamental

In Assam, *Japi* can also be called a poor man's umbrella, because of its cheap price. Selected bamboos are split into small strips of required sizes that are woven in open hexagonal design into a circular disc with a dome in the centre for the head to fit in. It is more advantageous to the cultivators and other open air workers, because the cultivator after putting it on can tie the strings around his

chin leaving his hands free to work in any position-standing, squatting or stooping. It is also used as a decorative item that is available in various sizes.

The *Apatanis* and *Nishis* of Arunachal use combs carved out of single piece of bamboo where a fairly thin walled bamboo is used. The combs have coarse widely spaced teeth on one side and thinner closely spaced teeth on the other. The internal nodal ring of the bamboo culm is cut flat on the inside of the comb, and the outside ridge is retained. These combs are functional as well as decorative.

The *Changs* of Nagaland, use poker works to decorate their bamboo mugs which were originally made for head takers. However with the end of head hunting, it is used as a decorative item for those who can afford to buy or exchange it with a basket of paddy. Small decorative combs of bamboo splits are also made by Chang men as a gift to be given to girls. The *Ao* tribe make a cone shaped ceremonial hat having an outer and inner layer of which the outer layer is made from dyed bamboo strips. The dyeing of bamboo with natural dyes is a significant aspect of these hats and the process of dyeing differs from one tribe to another.

The *Kharam* tribals of Manipur decorate their ears with flowers made of bamboo. They also make wristlet or anklet out of bamboo to decorate their arms and legs. Besides being a form of decorative ornament, they served as a protective gear in battles in the earlier days.

The Khasi comb with a number of fine teeth are shaped from individual bamboo splits intricately assembled from several splits of bamboo. These teeth are sandwiched between a pair of thick splits and are bound firmly with cotton thread that creates the required gap. Beyond these, a single whole culm length of a very small diameter is used to finish the upper edge of the handle.

Basketry and mat making

In Arunachal Pradesh *B.balcooa*, *B.tulda* and *D.giganteus* are used for basket making. The 3 main varieties of pattern popularly used are namely, checker works, twilled and hexagonal. The angular and cross patterns for basket making are practiced by the *Adi* tribe while the diamond pattern is adopted by the *Apatani* and *Mishmi* tribe. The peculiar scenario of division of labour has led to basket making as the common activity. The womenfolk are responsible for cultivating jhum fields throughout the year while the work of men folk are restricted to felling and clearing of jungles after which they are engaged in weaving baskets.

In the state of Assam, *D.hamiltonii* and *D.strictus* species are generally used for the purpose of basket and mat making. Long bamboos are cut into several parts according to the desired length of mats to be woven. Each part is split into thin pieces and the soft portion of such bamboo split is removed with a hook whereupon the flat flexible bamboo strips are obtained for manufacturing mats. The twilled pattern is followed wherein slips are taken and woven breadth wise one after another and the process is repeated. On completing the weaving all the 4 sides of the mat are twisted a little and tide up with a long bamboo slip in order to frame the outer edges which keeps the woven slips compact.

In Manipur, *D.hamiltonii* and *D.strictus* species are widely used for basketry and mat making. Intricate patterns with dyed bamboo are worked on these baskets. A special feature of Manipuri basket ware is the variety of bamboo fish traps, which are so exquisitely crafted as to be almost sculptural. Another variety of baskets, the *chengbon* have a domed lid made of bamboo that have a square body of checks and squares in black and white, and rest on four prominent legs and are used for storing clothes. A type of double-weave mat known as *phak* is woven in the state.

In the state of Meghalaya, baskets are woven in an open hexagonal weave using wide but thin outer bamboo splits. The fruit baskets are parabolic dome shaped with wide outer splits of bamboo form the base. The *Khasi* basket is woven from split bamboo where the base is strengthened by a wide, thick split of bamboo, bent to form a square band, on which the basket rests. This split is made from bamboo of fairly large wall thickness. The concept of reducing the width or thickness to achieve flexibility in an otherwise rigid bamboo species is an interesting structural feature of Khasi and Jaintia products.

In the state of Mizoram, the commonly used species for this purpose is *D.hamiltonii*. The type of basket weaving practiced are mainly open and closed weave carrying basket. They are generally made entirely of thick bamboo outer splits. These baskets have a square base and gradually transforms into a circle at the rim of the basket. The main elements are those that form the base, sides and rim of the basket. In a particular type of basket called *paiem*, the elements used are smoked to rich red-brown colour before they are used and the species generally preferred is *D.longispathus* that is locally called '*rawnal*'.

The people of Nagaland generally use *D.hamiltonii* to weave basket and the pattern popularly practiced is checker twilled pattern or open work pattern in various sizes. The *Aos* and *Angamis* have adopted the conical and cylindrical pattern respectively. Bamboos of about a year old are selected and the points having longer internode are cut. Each piece is then split into bigger splints of about an inch in breadth, smoothened with a hook shaped knife and then arranged in a series and plaited in different patterns. While splitting, the purpose for which splints are put is also taken into account. For instance, mats have splints made out of one internode, baskets are from those with 2 internodes and larger baskets are from 4 or more internodes.

In Tripura, *B.tulda* and *D.strictus* species are used for making baskets. The open weave pattern is practiced by the *Jamatia* tribe for firewood basket that is made entirely from bamboo outer splits. It has a square base and the sides narrow down slightly before flaring outward to the rim. The *Reang* tribe has adopted the closed weave pattern which is mainly used for carrying grains. The Bengalis of Tripura weave shallow carrying baskets which have a square base and the sides flare out sharply to a large circular rim. These are popularly known as *tukri* and are used for carrying construction materials while another type called *laii* is used for washing rice and other grains. Baskets are also used for storing dates that are rectangular shaped pouch open at the top, woven from coarse bamboo inner splits using diagonal weaving method.

E. Food items

Healthy shoots of bamboo, stunted or even crooked, are used for the preparation of edible products. The outer sheaths are removed and the tender portions are cut into rings or pieces of suitable sizes. Bamboo shoots used as an edible item are the young culms harvested at the time or shortly after it appears above the soil surface. Researches undertaken by the Kerela Forest Research Institute (KFRI) have found that the time for first harvest of shoots is about two and a half years after planting, if seedlings are used. In case of rooted node cuttings used as planting material the harvestable shoot is obtained within two years. Shoot production varies from one species to another but in general it is from June to September. Shoots are harvested 7-14 days after the emergence when the shoot height attains a certain height that differs from a species to another.

Species	Period of shoot emergence	Height in cms.
B.balcooa	June-July	
B.tulda	March-September	150-200
D.giganteus	June-July	
D.hamiltonii	July-September	150-200
D.strictus	April-September	200-250

Source: National Mission on Bamboo Application (NMBA)

In north-east India, it is consumed either raw or processed because of its exotic taste and flavor. The processing of bamboo shoots starts with thorough washing, followed y peeling off the skin, shredding, slicing and cutting into cones. Amongst the edible bamboo species in Mizoram, *B.vulgaris, D.giganteus, D.hamiltonii* and *D.strictus* are most favoured. The pith of the young shoots are used for making bamboo pickle. In Arunachal Pradesh, the young shoots are ground and dried and are used as chutney or flavouring agent. Juice of fermented shoots stored for about 50–60 days is used for flavouring vegetables; shoots cut into pieces are boiled and used as vegetables. An indigenous method of preparing bamboo shoot as flavouring agent is by putting it in basket and covering it with leaves and then left for 2-3 days to ferment after which it is dried and grinded. In Manipur, *B.vulgaris, D.hamiltonii* and *D. strictus* are the main species whose young shoots are used as vegetables.

F. Handicrafts, musical instruments and furniture

In Manipur, the culms of harvested bamboo that are to be used for furniture is immersed in water for several days with some salt added to the water. Processing of bamboo is also done traditionally by putting the bamboo culm in pit full of cow dung for about 10-20 days. This makes the culms straighter and lustrous. The people of *Thadou* tribe cut three tubes of different lengths from the same bamboo stem and the tubes are separately blown with the mouth to produce different musical notes and are called *Theiphit.* The *Lambang* tribals use a peculiar musical wind instrument called *Relru* that is a one metre long hollow bamboo tube with an attached projection in the middle, through which one blows with the mouth to produce musical notes. They make use of both the hard outer layer or skin of the bamboo and the pulpy inner layer to make a musical instrument.

Gogona is a musical instrument popularly used in Assam during festivals. It is shaped from a thick bamboo outer split, so that one end forms the handle while the other end can be struck by fingers when the instrument is held against the mouth.

The *Lushai* tribe of Mizoram makes a bamboo smoking pipe called *vaibel* and the species of bamboo used is *D.strictus*. It is a solid bamboo upto 50 mm in diameter and it is very strong, as it does not break when dropped. A part of the culm including a node is used to shape the bowl. The hollow of the bowl is bored in the centre passing through the node in a small hole. The hole at the bottom is sealed with a piece of dried gourd. Locally grown tobacco is used and only men use this pipe. The Lushai women use a pipe called *tuibur* that is made in an interesting combination of bamboo and clay.

Tiny bamboo whistles in Tripura are made from small diameter culm lengths. The main tube has a node at one end tapered to form a cone, before a small hole is pierced near that node leaving a small gap of air to pass over the hole in the main tube.

In Nagaland, a musical instrument called bamboo trumpet, is made out of about 4-5 feet culm with two nodes, one in the upper and the other in the centre or middle with the lower end kept open. A hole in the centre node is opened with the help of a spear blade to enable the sound to pass through the hole while at the upper end of the node, a small hole is opened and another short bamboo pipe as big as a stick or a finger size is fixed tightly. The cup violin is one of the musical instruments popularly used by the *Ao* tribe of Nagaland. To make the cup violin, a good quality of hard and thin bamboo is selected which is about half an inch in width and about a feet long. Both men and women can play this instrument without any restriction. This instrument is called cup violin or mid night violin because it is played mainly at mid night.

G. Agricultural implements, weapons

The *Chang* tribe of Nagaland use thick and strong bamboo beam to make a cross-bow shaped weapon that is wider at the centre than the ends, held in a slot in the wooden cross-beam. The wooden cross-beam has a groove at the top on which the arrow rests.

In Assam, a shovel prepared with bamboo slip is either dragged along the bottom or placed on the water bed to catch the small fishes which take refuge in it when the weed is trampled. This is usually made from *B.tulda* bamboo species.

The Lushais of Mizoram use a bow made from a wide splint of bamboo held bent in tension by a bow-string made from a fine bamboo split to hunt birds and small animals. Unlike the usual bow, this one fires clay pellets instead of arrows. The bamboo species used for the beam is mainly *B.tulda* while for the bow string it is *Dinochloa compactiflora*.

H. Water pipes, water pitchers and food containers:

In Mizoram, a water tube called *tuium* is made from bamboo culm with two internodes and one nodal wall forming the base. The nodal wall between the internodes is pierced to connect the lumen. Half the circumference of the top open edge of the tube is cut at an angle to facilitate pouring. The outer skin of the bamboo is removed and the nodes are scrapped off to reduce the weight of the tube, to prevent it from cracking and to keep the water cool by evaporation through the internodal walls. The *Apatani* and *Mishmi* tribes of Arunachal Pradesh use containers made from bamboo for storing water.

IV. FINDINGS

Diverse bamboo species belonging to various genera widely found in different vegetation zones of north east India have been found to be as follows: (i) Bambusa, Dendrocalamus, Melocana and Neohouzeaua are found in the tropical forests zone, (ii) Chimonobambusa, Dendrocalamus, Neohouzeaua, Pseudostachyum, Teinostachyum and Thamnocalamus are found in the sub-tropical forests zone, (iii) Arundinaria, Chimonobambusa, Semiarundinaria and Thamnocalamus are found in the temperate forests zone and (iv) Arundinaria, Pleioblastus and Thamnocalamus are found in alpine type of forests.

Most common uses of bamboo in north eastern region of India have been found to be construction, scaffolding, walling, flooring, fencing, food item, handicraft, furniture and basket making. Baskets, mats and agricultural implements made from bamboo are popular in Arunachal Pradesh, Meghalaya and Tripura while, bamboo as ornamental usage is common in Assam and Meghalaya. The study reveals that out of the 78 species and 23 genera prevalent in the northeastern region of India, 6 species belonging to 2 genera Bambusa and Dendrocalamus are most popularly used.

The names of the species which have been found to be most widely used in the region are Bambusa balcooa, B.tulda, B.vulgaris, Dendrocalamus giganteus, D.hamiltonii and D.strictus. The species that is found to have highest utility in the states of north east India i.e. 7 out of the 8 states of north east India, is D.hamiltonii and is dominantly used in Meghalaya, Mizoram, Nagaland and Sikkim. In the state of Nagaland, the best type of bamboo splints for basket making is extracted from D.hamiltonii. This species is mainly found in hilly terrains, tropical and sub-tropical, evergreen and deciduous forests. It is followed by B.tulda, B.vulgaris, D.strictus species which are used in at least 5 states of north east India while B.balcooa and D.giganteus species are widely used in at least 4 states mainly in Arunachal Pradesh.

These species are generally found in tropical and sub-tropical forests zones. B.tulda species is most suitable for making floors and walls of houses in Nagaland. D.strictus has been found to be widely used for making agricultural implements in the region while in Assam and Meghalaya, it is preferred for making storage and containers for food and water. A variety of ornaments can be made from the species, B.vulgaris. The species D.giganteus is a favourite for making food item and is most popularly used in Arunachal Pradesh and Mizoram.

V. CONCLUSION

In the northeastern region of India, people mainly from rural areas are completely dependent on bamboo for their daily activities and it naturally becomes their vehicle of development because they generally have adequate access to it and are easily grown and harvested. An interesting finding is that a particular species found in different states is being utilized for various purposes that best fits the cultural and traditional needs of the people. Thus, most uses of bamboo in northeastern region of India continue to be traditional. Basketry making is common in this region because the jhum fields and water resources are located away from the village limits. They need to carry their loads such as, paddy, firewood and water on their backs and climb hilly terrains. The basketry works of the people depicts their real aspect of material culture. The study reveals high dependency on bamboo as a natural resource in the community, especially in house construction, production of household mats, containers and baskets.

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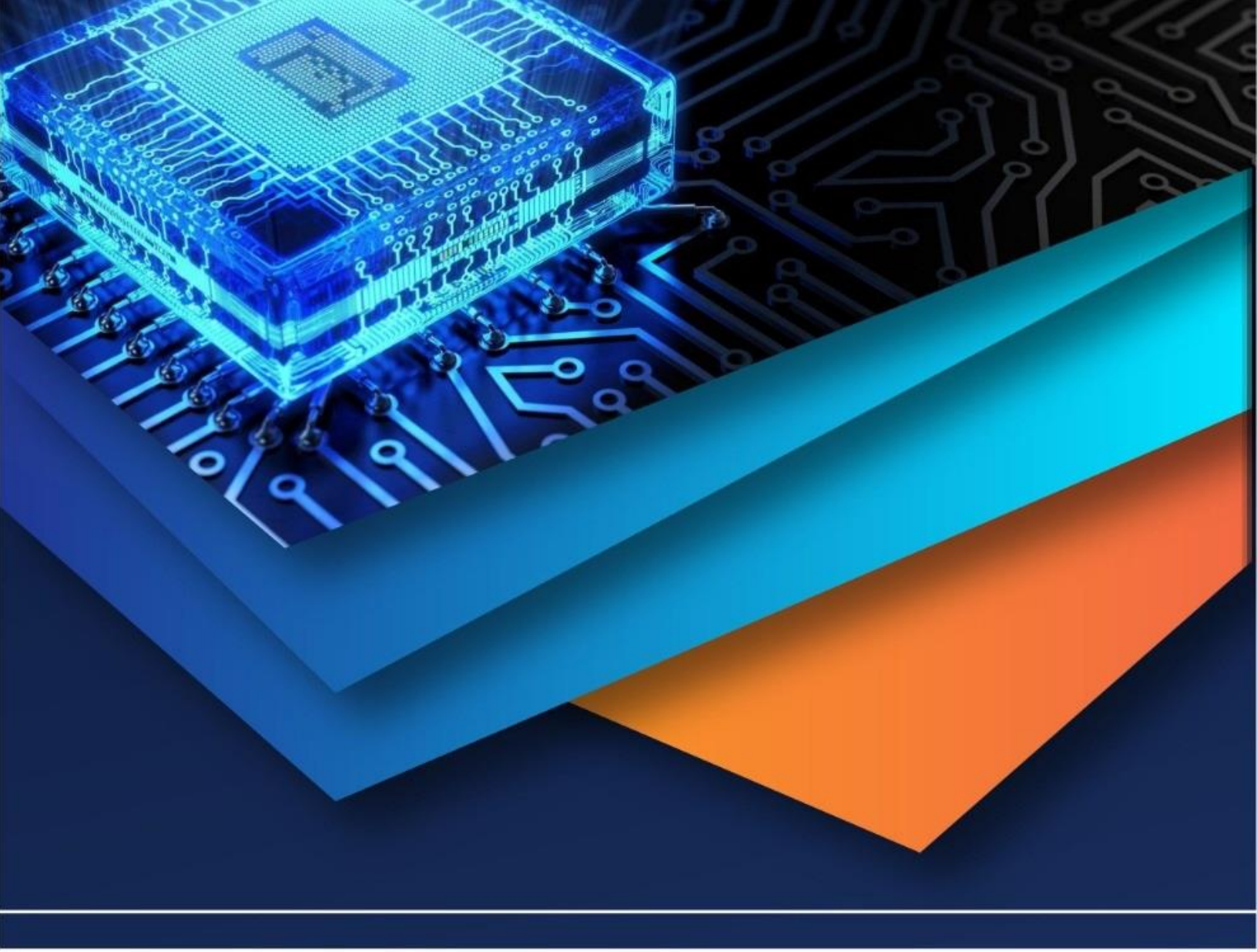

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