Research Article
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Distribution, identification and genetic diversity among bamboo species: a phenomic approach

Abstract

Bamboo is grown irrespective of latitude, altitude and climatic factors on the planet earth. Despite its immense importance in human life from cradle to coffin, the study of distribution of bamboo and their identification is still very limited. On this backdrop, an extensive survey on entire bamboo resources was conducted at South 24 Parganas ($22^0$20' N to $22^0$06' N, $88^0$20'E to $88^0$60' E) district of West Bengal, India to document the distribution pattern of bamboo species followed by their identification. For selection of study area (blocks, gram panchayats and villages), probabilistic random sampling was used whereas non-probabilistic snow ball sampling was adopted for selection of respondents. Based on vegetative characters, species identification was done by Botanical Survey of India, Kolkata. Twenty-eight key photometric characteristics were recorded and the species diversity was analyzed. A total of 600 accessions were sampled which comprises 43 different variants. Of which *Bambusa balcooa* was the most predominant species in South 24 Parganas followed by *Bambusa vulgaris*. These two species are grown widely because of their suitability in construction of houses, bridges and also in agricultural activities. It is evident that the usability of the species was the chief reason of the diversity of bamboo species in the study area. Furthermore, the variation in the species may also be caused by the natural stress condition i.e. the variation in the level of salinity of the study area. The cluster analysis grouped the genotypes into ten different clusters.

Keywords: bamboo, distribution, diversity, identification, utility

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Introduction

The fastest growing perennial, evergreen, arbores cent bamboo plant is a member of the grass family Poaceae and constitutes a single subfamily Bambusoideae.[1] The distribution of bamboos on planet earth extends from 51^0N in Japan to 47^0S in South Argentina. The bamboo can grow in an altitudinal range which extends from just above the mean sea level up to 4,000m.[2] Bamboo can also thrive in hot, humid rainforests to cold resilient forests. It can tolerate extreme temperature of about -20^0C as well as excessive annual precipitation ranging from 32 to 50 inch.[3] About 14million hectares of the earth surface is covered by bamboos with 80 percent in Asia.[4] A total number of 1,400 bamboo species are distributed worldwide. The Bambusa tribe includes about 1,290 species worldwide and constitutes three major groups.[5] The major species richness is found in Asia-pacific followed by South America, whereas the least number of species is found in Africa and India is the second richest country in bamboo genetic resources next to China.[6] Several studies have been conducted to record the distribution of bamboo species in India. The report says that the number of species varies from 102[7] to 136.[8] As opined by many scientists, the distribution of bamboo is greatly influenced by agroclimatic zones,[9] human interventions[10] and climatic factors.[11] Overexploitation and genetic erosion of bamboo species have made it necessary not only for the collection and conservation of its germplasm[12,13] but also to classify and characterize them.[14–16] Characterization of germplasm is an important link between the conservation and utilization of germplasm.[17,18] To maintain the germplasm and conservation of biodiversity, the investigation of bamboo resources and even study of their local distribution is indispensable which is recorded to be limited till date in bamboo. The study of bamboo distribution in West Bengal is limited to northern part of the state.[3] The present study was conductedto estimate the genetic diversity among the bamboo species distributed in the district of South 24 Parganas after proper documentation and, identification of them.

Materials and methods

Survey, sample collection and identification

An extensive survey on entire non-forest bamboo resource was conducted in South 24 Parganas ($22^0$20' N to $22^0$06' N, $88^0$20'E to $88^0$60' E) of West Bengal, India. Multistage sampling technique was adopted for the completion of survey. For selection of blocks, gram panchayats and villages probabilistic random sampling was used. For selection of respondents non probabilistic snow ball sampling was adopted. To conduct the survey work an interview schedule was constructed in local language which includes 3 parts: The first part consists of basic questions regarding the background of respondents; the Second part consists of location and local name of the species along with the land holding; the third part is regarding the usability and economic benefit of the bamboo species. Hherbarium samples were sent to Botanical Survey of India (BSI), Kolkata, for identification and preservation. The accession number for all the entries was collected (Table 1) from BSI.

Morphological characterization

A total of 600 accessions were sampled which comprises 43 different variants. Data on 28 key photometric characteristics (6 quantitative and 22 qualitative characters) as suggested by Bhattacharya et al.,[21] were recorded of 43 accessions and also of eight standard samples (all the 8 species found in the district during survey) maintained by BSI. Two accession (Acc. No. 68501 and 68503) identified as *Bambusa oliveriana* for which no standard sample was available.

Statistical analysis

Three different culms were selected randomly from each clump or bamboo stand. Mean values from three independent replications were calculated for each quantitative characters. The qualitative data on culm and Culm sheath descriptors were then converted to a scale (showed as supplementary Table 4). Analysis of variance (ANOVA) and descriptive statistics were carried out for replicated quantitative data of culm and culm sheath using SPSS ver 16.0. Genetic diversity as depicted in the form of a dendrogram was constructed utilizing both qualitative traits and mean of quantitative traits using NTsys pc V 2.2.[19] Data on 28 descriptors were transformed into (0, 1) after selecting mean as subtract option and standard deviation as divide option. Euclidean dissimilarity coefficient was opted for the construction of the dissimilarity matrix among the genotypes. The Unweighted Pair- Group Method of Arithmetic average (UPGMA).[20] As clustering method and WARN in case of ties were used and dendrogram (Figure 1) was constructed.

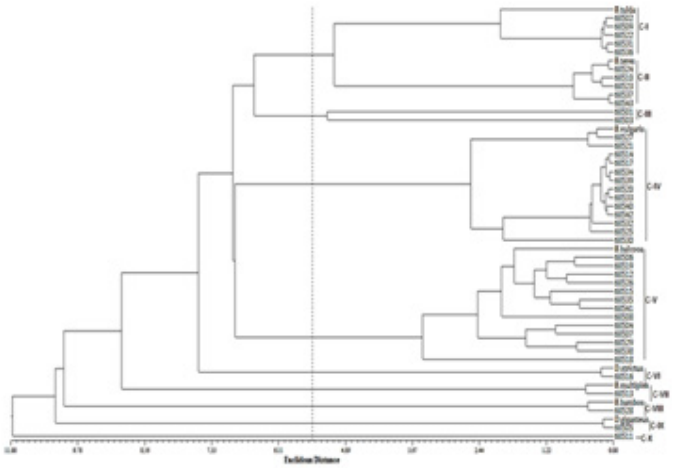

Figure 1 Dendrogram showing clustering pattern among 51 bamboo genotypes based on 28 Morphometric characteristics.

Results

Distribution, identification and utility of the bamboo species

A total of 600 entries were sampled from field which comprises 43 different variants for which accession was given by BSI, Kolkata (Table 1). All the 43 accessions were identified and divided into 9 different species (Figure 2) of bamboo under 2 genera after authentication from bamboo taxonomist of Botanical Survey of India (BSI). The two genera of bamboo, viz. *Dendrocalamus and Bambusa* were found in the study area. *Bambusa* constitutes 7 species and 2 species were recorded under *Dendrocalamus*. *Bambusa balcooa* was the most predominant species in the study area followed by *Bambusa vulgaris* (Figure 2). Besides, *B. tulda, B. teres, B. oliveriana, B. multiplex, B. bamboos, D. strictus* and *D. giganteus* were also found. It was evident from the present study that in different regions of the study area local names of the species was varied widely. A particular species of the bamboo was called with different local name e.g., B. balcooa were locally called as 'Gente (68504)','Dhuli (68506)', Bhalki (68508), Kechi (68518) and Bhalko (68538). On the contrary, the accession having same common name were identified as different species e.g., Acc. No 68503 and 68513 having common name *'Chhip bamboo'* were respectively identified as *B. oliveriana* and *B. multiplex*. The *Gente* (68516) was even identified as different genus as *Dendrocalamus strictus*. From the survey report it was found that 520 acres of area was cultivated under bamboo cultivation in non- forest region of South 24 Pgs district by the farmers. Species dependent multipurpose usability of different bamboos were established from the present study. Bambusa balcooa is a mechanically strong bamboo and it is mainly utilized for construction of houses and bridges. House and bridge construction, agriculture and allied activities consume 87% of the total bamboo production (Figure 3).

Photometric characteristics

Analysis of variance showed statistically significant variation among the accessions with respect to all the quantitative characters under study (Table 2). Huge variation was recorded for all the characters (29-41%). The variation is mainly due to the age difference among the accessions. The mean of the characters is given in (Table 3). Maximum and minimum culm height was recorded for *D. gianteus* (30m) and B. multiplex (2.8m) with SE (±m) 0.45. The length of the 5th internode was more than 20 cm for most of the species except *B. vulgaris*. The ration of culm diameter to cavity diameter was least in case of *B. teres* (0.04-0.05 cm) whereas it was ten times higher in *B. tulda* and *B. vulgaris* (>0.40). *B. balcooa* recorded lesser ratio of length and breadth of culm sheath. No such variation among the species was observed with respect to ration of length of culm sheath to length of blade.

Table 1 List of identified species based on phenology by botanical survey of India (BSI) along with BSI accession number and GPS location

Sl. No.	BSI accession	Local name	Scientific name	Location
1.	68501	Muli	*Bambusa oliveriana*	Lat: 22015.014'N/ Long: 88025.173"E
2.	68502	Talda	*Bambusa tulda*	Lat: 22015.04'N/ Long: 88025.19"E
3.	68503	Chhip	*Bambusa oliveriana*	Lat: 22015.04'N/ Long: 88025.19"E
4.	68504	Gente	*Bambusa balcooa*	Lat: 22015.20'N/ Long: 88025.16'E
5.	68505	Hom	*Dendrocalamus giganteus*	Lat: 22015.26'N/ Long: 88025.18'E
6.	68506	Dhuli	*Bambusa balcooa*	Lat: 22015.3'N/ Long: 88025.13'E
7.	68507	Gente	*Bambusa balcooa*	Lat: 22015.307'N/ Long: 88025.119'E
8.	68508	Bhalki	*Bambusa balcooa*	Lat: 22015.296'N/ Long: 88025.176'E
9.	68509	Kulor	*Bambusa tulda*	Lat: 22015.056'N/ Long: 88025.078'E
10.	68510	Java	*Bambusa teres*	Lat: 22015.635'N/ Long: 88025.332'E
11.	68511	Talda	*Bambusa tulda*	Lat: 22015.882'N/ Long: 88025.372'E

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Table Continued..

Sl. No.	BSI accession	Local name	Scientific name	Location
12.	68512	Gente	*Bambusa balcooa*	Lat: 22015.587'N/ Long: 88024.327'E
13.	68513	Chhip	*Bambusa multiplex*	Lat: 22012.59'N/ Long: 88015.346'E
14.	68514	Bashini	*Bambusa vulgaris*	Lat: 22011.981'N/ Long: 88015.309'E
15.	68515	Bhalki	*Bambusa balcooa*	Lat: 22013.18'N/ Long: 88014.263'E
16.	68516	Gente	*Dendrocalamus strictus*	Lat: 22011.995'N/ Long: 88012.918'E
17.	68517	Bashini	*Bambusa vulgaris*	Lat: 22013.503'N/ Long: 88016.683'E
18.	68518	Kechi Bhalko	*Bambusa balcooa*	Lat: 22036.506'N/ Long: 88035.487'E
19.	68519	Bhalko	*Bambusa balcooa*	Lat: 22036.395'N/ Long: 88034.260'E
20.	68520	Baria	*Bambusa vulgaris*	Lat:: 21°47.411′ N/ Long: 88°21.617′ E
21.	68521	Bhalki	*Bambusa vulgaris*	Lat:: 21°47.4′ N/ Long: 88°21.630′ E
22.	68522	Talda	*Bambusa tulda*	Lat:: 21°47.378′ N/ Long: 88°21.730′ E
23.	68523	Kaba	*Bambusa teres*	Lat:: 21°47.319′ N/ Long: 88°21.943′ E
24.	68524	Kal dhemni	*Bambusa teres*	Lat:: 21°47.257′ N/ Long: 88°21.335′ E
25.	68525	Baria	*Bambusa vulgaris*	Lat:: 21°47.445′ N/ Long: 88°21.197′ E
26.	68526	Gente	*Bambusa balcooa*	Lat:: 21°47.278′ N/ Long: 88°21.537′ E
27.	68527	Guri Bhalki	*Bambusa vulgaris*	Lat:: 21°47.278′ N/ Long: 88°21.537′ E
28.	68528	Kanta	*Bambusa bambos*	Lat:: 21°37.270′ N/ Long: 88°18.337′ E
29.	68529	Gente	*B. balcooa*	Lat: 22007.790'N/ Long: 88028.309' E
30.	68530	Lata falko	*B.Vulgaris*	Lat: 22007.719'N/ Long: 88028.566' E
31.	68531	Talda	*B. tulda*	Lat: 22008.244'N/ Long: 88026.073' E
32.	68532	Bauni	*B.Vulgaris*	Lat:22008.253'N/ Long: 88026.055' E
33.	68533	Kali Bhalki	*B.Vulgaris*	Lat:22045.666'N/ Long:88015.362' E
34.	68534	Bere	*B.Vulgaris*	Lat:22045.660'N/ Long:88015.376' E
35.	68535	Gente	B. balcooa	Lat: 22045.659' N/ Long:88015.371' E
36.	68536	Talda	*B. tulda*	Lat: 22045.599' N/ Long: 88015.507' E
37.	68537	Jawa	*B. teres*	Lat: 22011.87' N/ Long: 88042.937' E
38.	68538	Bhalko	*B. balcooa*	Lat: 22011.882' N/ Long: 88042.937' E
39.	68539	Bashini	*B.Vulgaris*	Lat: 22016.411' N/ Long: 88041.770' E
40.	68540	Bashini	*B.Vulgaris*	Lat: 22016.342' N/ Long: 88041.782' E
41.	68541	Bhalko	*B. balcooa*	Lat:22045.659' N/ Long: 88015.376'E
42.	68542	Bashini	*B.Vulgaris*	Lat: 22045.659' N/ Long: 88015.376'
43.	68543	Jawa	*B. teres*	Lat: 22018.232' N/ Long: 88035.056'E

Table 2 Comparison of qualitative morphological parameters of bamboo genotypes growing under study area along with standard sample growing in BSI: Scale of characters are as follows: 1. Internode Bending (absent: 0, present: 1), 2. Colour (Dark green: 0, Bright green: 1, Glossy green: 2, Pale green: 3, Grey green: 4, Yellow green: 5), 3. Swollen Node (absent: 0, present: 1), 4. Nodal Ring (absent: 0, whitish: 1, grayish: 2), 5. Nodal sheath Scar 6. Hairs at Nodal Ring, 7. Piercing Culm Sheath, 8. Curved Lower Nodal Branches (absent: 0, present: 1), 9. Modification of Branches (none: 0, thorns: 1, spines: 2), 10. Striation on Culm (absent: 0, present: 1), 11. Ciliate Margin, 12. Pubescentadaxial Side, 13. Pubescentabaxial Side, 14. Hair Colour (none: 0, golden brown: 1, brown: 2, dark brown : 3, black: 4), 15. Number of Hairs (absent: 0, profuse: 1, scanty: 2), 16. Shape of Blade (triangular: 0, lanceolate: 1, acuminate: 2, ovate: 3), 17. Blade Reflexed, 18. Hairy Margin of Blade, 19. Auricle, 20. Auricle Continuous with Blade, 21. Bristles on Auricle, 22. Auricle Fringed (absent: 0, Present: 1)

Accessions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Bambusa tulda	0	0	0	1	0	0	1	0	0	0	0	0	1	4	1	3	0	0	1	1	1	1
68502	0	0	0	1	1	0	1	0	0	0	0	0	1	4	1	3	0	0	1	1	1	1
68509	0	0	0	1	1	0	1	0	0	0	0	0	1	4	1	3	0	0	1	1	1	1
68511	1	0	0	1	1	0	1	0	0	1	0	0	1	4	1	3	0	0	1	1	1	1
68522	0	0	0	1	1	0	1	0	0	0	0	0	1	4	1	3	0	0	1	1	1	1

Table Continued..

68531	0	0	0	1	1	0	1	0	0	0	0	0	1	4	1	3	0	0	1	1	1	1
Accessions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
68536	0	0	0	1	1	0	1	0	0	0	0	0	1	4	1	3	0	0	1	1	1	1
B. vulgaris	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68514	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68517	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68520	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68521	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68525	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68527	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68530	0	1	1	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68532	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68533	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68534	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68539	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68540	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
68542	0	1	0	0	0	1	0	0	0	0	1	0	1	3	1	0	0	0	1	0	1	0
B. balcooa	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68504	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68506	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68507	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68508	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68512	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68515	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68518	0	0	1	1	1	2	1	0	0	0	1	0	1	4	2	2	0	0	0	0	0	0
68519	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68526	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68529	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68535	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68538	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
68541	0	0	1	1	1	1	1	0	2	0	1	0	1	4	2	2	0	0	0	0	0	0
D. giganteus	0	4	0	3	1	1	0	0	0	0	0	0	1	2	1	1	1	0	0	0	0	0
68505	0	4	0	3	1	1	0	0	0	0	0	0	1	2	1	1	1	0	0	0	0	0
B. multiplex	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
68513	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
B. teres	0	0	1	1	1	1	1	0	0	0	0	0	1	2	2	2	0	0	1	1	1	1
68510	0	0	1	1	1	1	1	0	0	0	0	0	1	2	2	2	0	0	1	1	1	1
68523	0	0	1	1	1	1	1	0	0	0	0	0	1	2	2	2	0	0	1	1	1	1
68524	0	0	1	1	1	1	1	0	0	0	0	0	1	2	2	2	0	0	1	1	1	1
68537	0	0	1	1	1	1	1	0	0	0	0	0	1	2	2	2	0	0	1	1	1	1
68543	0	0	1	1	1	1	1	0	0	0	0	0	1	2	2	2	0	0	1	1	1	1
B. bambos	0	4	1	0	0	0	0	1	1	0	1	1	0	4	2	0	0	0	1	1	1	1
68528	0	4	1	0	0	0	0	1	1	0	1	1	0	4	2	0	0	0	1	1	1	1
D. strictus	0	4	1	0	1	0	0	1	0	0	1	0	1	2	1	2	0	0	1	1	0	0
68516	0	4	1	0	1	0	0	1	0	0	1	0	1	2	1	2	0	0	1	1	0	0
68501	1	3	1	1	1	1	0	0	0	0	0	0	1	2	1	2	0	0	1	1	1	1
68503	0	3	1	1	1	1	0	0	0	0	0	0	1	2	1	2	0	0	1	1	1	1

Citation: Yeasmin L, Ali MN, Ray SS, et al. Distribution, identification and genetic diversity among bamboo species: a phenomic approach. *Adv Plants Agric Res.* 2017;7(2):256–263. DOI: 10.15406/apar.2017.07.00251

Table 3 Analysis of variance among accessions collected from study area for Culm height (CH), Culm Diameter (CD), length of 5th internode (LI5), ratio of culm diameter to cavity diameter (CC), ratio of length and breadth of culm sheath at base (LB) and ratio of length of culm sheath to length of blade (LL)

Sources of variation	Mean sum of squares						
	df	CH (m)	CD	CI5 (cm)	CC	LB	LL
Between population	50	91.653**	1319.61**	240.444**	0.089**	0.960**	3.303**
Error	102	1.049	13.902	0.963	0.001	0.006	0.099

Figure 2 Photographs of different Bamboo species encountered under study area. a. *Bambusa balcooa*, b. *B. tulda*, c. *B. multiplex*, d. *D. giganteus*, e. *B. vulgaris*, f. *B. teres*, g. *B. oliveriana*, h. *D. strictus*, i. *B. bamboo.*

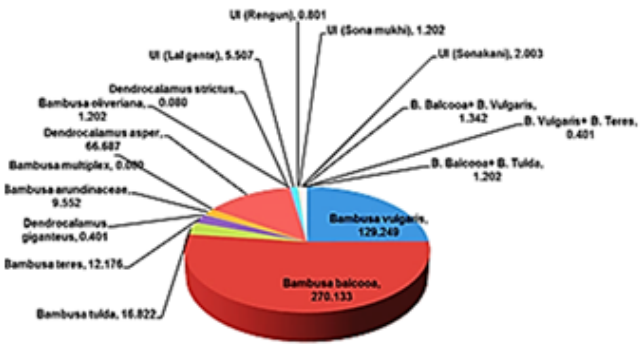

Figure 3 Area wise distribution of Bamboo species under study area. For unidentified species (UI) the local name is given within parenthesis.

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Table 4 Mean Performance of quantitative morphological parameters of bamboo genotypes growing under study area along with standard samples growing in BSI

Accessions	CH (m)	CD (mm)	CI5 (cm)	CC	LB	LL
B. tulda	18.33	56.33	38.4	0.43	1.08	3.67
68502	19.17	56.66	39.2	0.42	1.09	3.64
68509	19.4	57.33	40.17	0.43	1.1	3.67
68511	18.33	55	38.7	0.42	1.06	3.64
68522	19.5	58	39.53	0.45	1.09	3.67
68531	18.67	55.33	38.63	0.43	1.05	3.64
68536	18.83	56	38.9	0.45	1.05	3.66
B. vulgaris	19.07	85.33	23.77	0.51	1.65	2.76
68514	8.77	58.33	14.5	0.5	1.6	2.75
68517	8.83	57.67	14.93	0.51	1.62	2.71
68520	7.77	56	13.37	0.5	1.66	2.75
68521	20.77	84.67	24.77	0.51	1.65	2.72
68525	10.13	60.67	12.17	0.49	1.59	2.73
68527	17.93	82.33	22.43	0.51	1.69	2.77
68530	8.57	59.33	14.93	0.5	1.66	2.71
68532	9.27	62	16	0.5	1.66	2.76
68533	8.13	56.33	13.03	0.5	1.66	2.77
68534	8.47	58.67	13.77	0.51	1.65	2.71
68539	8.57	58.33	14.27	0.5	1.64	2.7
68540	8.23	57.67	13.1	0.48	1.61	2.74
68542	8.2	57.33	12.7	0.5	1.65	2.68
B. balcooa	19.9	91	20.6	0.32	1.35	4.23
68504	11.32	94.67	30.26	0.27	0.88	7.11
68506	11.87	83	26.97	0.2	0.68	4.22
68507	12.82	85.33	26.6	0.32	1.17	6.51
68508	10.57	63	25.77	0.43	1.08	3.25
68512	10.87	79	28.17	0.32	1.12	4.9
68515	18.93	76.33	28.69	0.28	0.8	3.76
68518	12.24	83.33	27.81	0.29	0.86	4.28
68519	11.99	88	26.44	0.3	0.85	4.23
68526	13.69	87.33	28.27	0.35	0.93	5.33
68529	10.07	69.33	21.03	0.39	0.98	6.06
68535	14.95	86	26.98	0.4	0.86	3.99
68538	12.08	66.67	23.57	0.31	0.92	5.94
68541	16.63	92	30.77	0.4	0.94	4.1
D. giganteus	30	131	39.3	0.69	1.32	3.34
68505	29.4	130	38.03	0.69	1.3	3.34
B. multiplex	3.3	20.33	21.07	0.1	2.87	2.89
68513	2.68	18.33	19.63	0.11	2.61	2.87
B. teres	9.31	65.67	31.43	0.042	1.58	3.23
68510	10.66	67.33	32.67	0.04	1.6	3.23

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Table Continued..

Accessions	CH (m)	CD (mm)	CI5 (cm)	CC	LB	LL
68523	11.78	67	33.03	0.05	1.58	3.24
68524	9.43	64	31.47	0.05	1.6	3.22
68537	13.53	73.33	33.5	0.04	1.58	3.22
68543	13.84	73.67	33.1	0.04	1.6	3.24
B. bambos	15.73	59	23.03	0.37	2.89	3.86
68528	13.63	55.67	21.37	0.36	2.93	3.88
D. strictus	15.07	49.33	37.4	0.61	1.38	3.85
68516	14.1	49	36.27	0.6	1.4	3.85
68501	14.27	39.33	35.27	0.52	2.67	2.37
68503	7.97	37.33	35.03	0.53	2.67	2.35
Grand mean	13.48	67.35	26.87	0.38	1.48	3.6
SE(±m)	0.45	1.7	0.72	0.01	0.05	0.09
LSD(0.05)	1.9	6.93	1.82	0.06	0.14	0.58
Range	2.5-30.5	18-135	11.8-40.5	0.04-0.70	0.67-2.95	2.31-7.80
CV (%)	41.2	31.27	33.22	45.02	38.21	29.8

Genetic Diversity

Dendrogram based on 28 phenometric characteristics was constructed to reveal the genetic diversity among the accessions. From the dendrogram, the genotypes were grouped into 10 different clusters. The distribution of the accessions into different clusters is shown in (Figure 4). It was evident that the most of accessions were clustered with their respective standard species with few exceptions. The accession 68511 identified as B. tulda was the member of a completely distant cluster (Cluster-X) from the others with maximum dissimilarity. The accessions 68501 and 68505 (morphologically identified as B. oliveriana,) for which no standard species were available, did not group with any other species. Most of population showed homogeneity (less dissimilarity coefficients) with their respective standard species except balcooa and tulda. The balcooa population was the most heterogeneous where all the accessions grouped in the same internode at dissimilarity coefficient more than 3.00. The pattern of diversity was in conformity with the morphological identification of the accession.

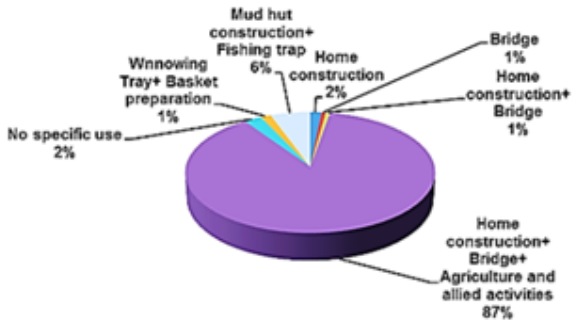

Figure 4 Economic usage of bamboo under study area.

Discussion

Bamboo is considered as "green gold" keeping in mind its economic importance and multiple end uses in human life, from cradle to coffin.[21] Despite of importance the study of distribution bamboo, their identification, classification and proper documentation is still very limited in bamboo. The present study is aimed to documentation of the distribution of bamboo species in a district of West Bengal, India. The findings were in agreement with previous workers that the distribution of bamboo is greatly influenced by human intervention[10] and climatic factors.[11] This documentation and classification will facilitate the collection and conservation of germplasms[14–16] at least in study area. In case of plant the identification keys are mostly based on floral characters.[22] But, Incidence of flowering of woody bamboo is uncertain.[23,24] As reported earlier, the reproductive cycle of bamboo is too long from 3years to 120years.[25] That is why the identification depending on reproductive structure is difficult. The present investigation classified and identified the bamboo collections based on vegetative characters (culm and cul-sheath characters) as suggested by many workers earlier.[26–29] The genetic diversity vis-s-vis phylogenetic relationships among 15 bamboo species were evaluated by Das[30] using morphological characters as done in this study. But the limitation of morphological characters which are influenced by the environmental factors was also evident in the study as reported by earlier reports.[28] There are several instances of taxonomical discrepancies because of unstable vegetative characters. In the present investigation few accessions were not properly identified possibly because of the inability of morphological characters which are not adequate enough to separate the genus and also unsuitable for identification of closely related species.[30,31] The molecular characterization is suggested for stable identification of the bamboo accessions in general and for closely related species in particular.

Conclusion

A total of 43 accessions collected from different locations of South 24 Parganas district of west Bengal, India. Almost all accessions were identified based on culm and culm sheath characters. The district was covered predominantly with *Bambusa balcooa* and *Bambusa vulgaris species*. Nine species under two genera i.*e Bambusa* and *Dendrocalamus* were found in the study area. The cluster analysis grouped all the accessions into 10 different clusters with the taxonomical discrepancy for an accession (68511) which stood alone in separate cluster though was identified as *Bambusa balcooa*.

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Conflict of interest

Authors declare that there is no financial interest or conflict of interest.

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