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Bamboo Growers' Indigenous Knowledge on Highland Bamboo Management Practice and Characterization Study of Highland Bamboo Landraces in Bore District, Southern Ethiopia

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Abstract: *Bamboo plays manifold role in day-to-day life of rural community. However, in Ethiopia it is utilized below its potential due to lack of scientific knowledge and awareness on its management and utilization. To fulfill needs of rural people, recording bamboo growers' indigenous knowledge and effective conservation and sustainable utilization of the bamboo resource is very important. Therefore, the overall objective of this study was to identify bamboo growers' indigenous knowledge on management practice of highland bamboo and to characterize and select superior landraces of highland bamboo species in Bore highland District of Guji Zone, Southern Ethiopia. Primary data of the survey parts was collected through focus group discussion, key informant interview and semi structure interview. The findings of this study indicated that local communities of the study area have experience of developing bamboo stands using their indigenous knowledge. Bamboo growers' of the study District have their own calendar of bamboo planting time and planting techniques. Moreover, bamboo growers' of the study District easily identified commonly growing landraces of highland bamboo species of the area. Based on their criteria, the three commonly growing landraces of highland bamboo species such as Okotu, Shanto and Uratiti were collected from Bore highland District. All collected landraces of highland bamboo species were planted in a randomized complete block design (RCBD) by three replications at spacing of 3m between seedlings, 3m between blocks and 2m between plots. The findings of this study showed that, in terms of their survival rate and number of shoots, all collected landraces of highland bamboo species (Arundinaria alpina) of the study area were not significantly different. However, Okotulandrace of highland bamboo species was significantly higher (at $P \leq 0.05$) than the others landraces in terms of its culm diameter, culm height, internode length and number of nodes growth parameters. Therefore, for this superior landrace of highland bamboo species sustainable conservation should be vital for long term use of the resources. Moreover, based on their experience, bamboo growers' local communities of the study area have deep knowledge on highland bamboo management practice. Therefore, integration of their indigenous knowledge with modern scientific fact is very significant for long term utilization of highland bamboo resources of the study area.*

Keywords: *Bamboo growers, Characterization study, Highland bamboo species, Indigenous knowledge, Landraces, Management*

1. INTRODUCTION

Bamboo is the fastest growing perennial grass species that belongs taxonomically to the subfamily of Bambusoideae under the family of Pocaceae [1].More than 1,500species and 90 genera of bamboo are found in the world and distributed in the tropical and sub-tropical belt between460 North and 470South latitude at elevations as high as4000m above sea level. Bamboo plants are commonly found in Africa, Asia and Central and South America [2].

It is estimated that about 21 million hectares of the earth surface is covered by bamboo forests [3].The Ethiopian natural bamboo forest is about more than 1 Million hectares, which is about 7% of the world total and 67% of the African bamboo forest area [4]. Two indigenous species of bamboo in Ethiopia, highland bamboo (*Arundinaria alpina*) and lowland bamboo (*Oxytenanthera abyssinica*) are scattered in the south, south-west and central parts of Ethiopia which encompasses four regions, namely Benishangul Gumuz, Oromia, Southern Nations and Amhara [3;5]. Highland bamboo comprises 130,000 ha (13.3%) while lowland bamboo constitutes 850,000 ha (86.7%) [6].

Bamboo is a plant of enormous importance in several regions of the world and it has age old connection with human needs. It is a preferred material for various uses due to its straightness, high strength, light weight, easiness to work with, suitable fiber for pulp production and absence of bark [7].Bamboo has become suitable for a variety of uses and services. It provides food, shelter and other consumer goods. The bamboo has high physical property for construction, industrialutilization and a considerable value in agriculture and stabilization of ecological balance [8].

Bamboo is one of the world's most important non timber forest products (NTFPs) since; it is a superior wood substitute, cheap, efficient, fast growing (up to 91cm per day), and it has high potential for environmental protection and wide ecological adaptation [9]. Moreover, bamboo plays manifold role in day-to-day life of rural community and it has an imperative role in cultural, artistic, industrial, agricultural, construction and household needs of human beings [10].

In Ethiopia, highland bamboo species (*Arundinaria alpina*) widely growing naturally in the south, south-west, central and north-west highlands of Ethiopia at altitudes range from 2200 to 4000 meters above sea level [3].However, the bamboo resource in Ethiopia is utilized far below its potential due to lack of knowledge on its management and utilization [3] such as lack of technology for its utilization and lack of information on the propagation methods. The resource was neglected in the past but currently there are different initiatives to manage and develop the resource sustainably [3; 11].

In Southern Ethiopia, Guji zone have five potential highland bamboo growers' Districts and over 7,460 hectare of land is covered by bamboo plantation. However, bamboo growers' indigenous knowledge on highland bamboo management practice, Collection and characterization study of commonly growing different landraces of highland bamboo species existed in the high land Districts of Guji zone is not yet identified.

As well, the potential of these fast growing and high yielding perennial plants regarding to the economic development and improvement of the income of small scale farmers of Guji zone is very little. Therefore, this research was designed to identify bamboo growers' indigenous knowledge on management practice of highland bamboo species and to collect, characterize and identify the superior landraces of high land bamboo species *(Arundinaria alpina)* of the study area for further diversification of the resources.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

Bore is one of the highland Districts of Guji Zone, in Southern Ethiopia. The District is situated at a distance of 385km from Addis Ababa the capital city of Ethiopia and 210km from the zone capital city Negele. Astronomically, Bore District is located between $5^0$57'23''-$6^0$26'52''North latitudes and $38^0$25'51''-$38^0$56'21''East longitudes (Figure 1). The District has elevation ranging from 1450-2900 meters above sea level.

The area receives an annual rain fall ranging from1400-1800mm with a bimodal pattern that is extended from April to November. The mean annual minimum and maximum temperature of the study District is 10^oC and 20^oC respectively. The major soils of Bore District are Nitosols (red basaltic soil) and Orthic Acrosols. The two soil types are found on the highland areas, and they are red brown and black brown in colors and on sloping topography and their utilization are good under natural vegetation respectively.

From the total area of Bore District, 29% is arable land, 33% pasture land, 30% forest land and the remaining 8% is considered swampy and degraded land. According to 2007 national census reports, a total population of Bore District was 210,179, of whom 105,726 were men and 104,453 women; 10,258 or 4.88% of its population were urban dwellers and with an estimated area of 1,296.88 square kilometers [12].

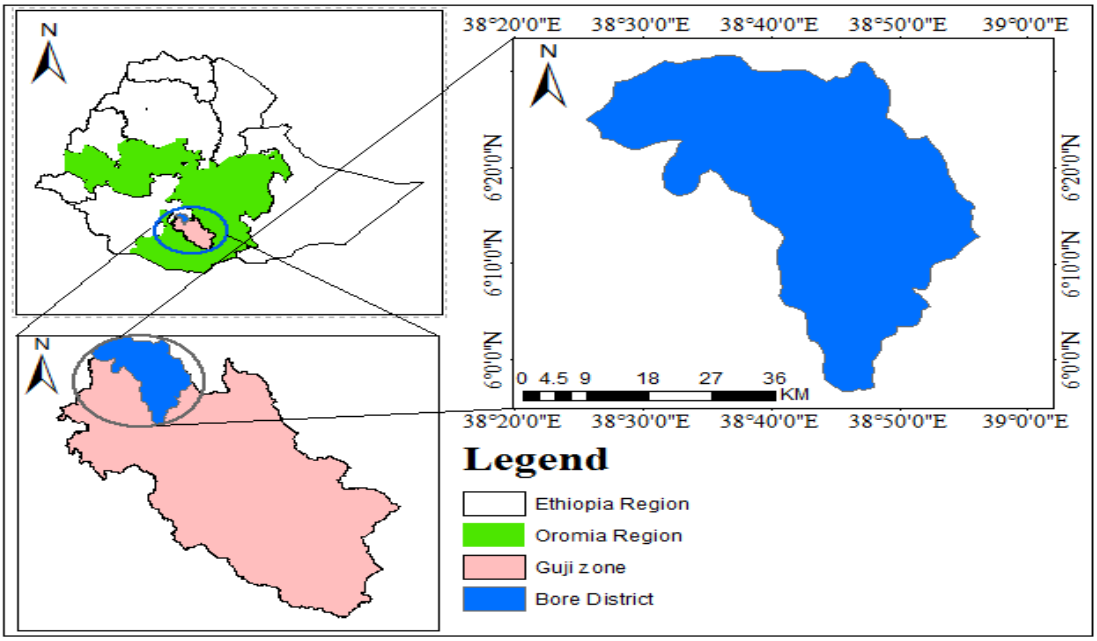

Figure1. *A map showing the study area*

2.2. Data Collection Methods

To identify bamboo growers' indigenous knowledge on management practice of high land bamboo species (*Arundinaria alpina*) of the study District, data collection tools employed were focus group discussion, key informant interview and semi structured interviews. By using these tools, bamboo growers' local communities of the study District were identified the three commonly growing landraces of highland bamboo species. After those commonly growing highland bamboo species landraces of the study area were identified, their collection and characterization study was carried out.

2.3. Sources of the Planting Material and Experimental Design

The three commonly growing landraces of highland bamboo species (*Arundinaria alpina)* namely; *Shanto, Uratiti* and *Okotu* were collected from Bore highland District. Those collected landraces of highland bamboo species were planted in a randomized complete block design (RCBD) in three replications. Plot size of 9mx9m was used and on each plot nine bamboo seedlings were planted. They were planted at spacing of three meters between seedlings, three meters between blocks and two meters between plots. The size of the planting pit used for this study was 50 cm deep at a size of 50 cm wide x 50 cm long pits and their planting carried out with some inclination.

2.4. Management and Assessment of the Experiment

Prior to the planting time, forest soil, animal dung and compost were prepared at Bore Agricultural Research Center, on station. For better growth performance of the bamboo seedlings the prepared materials were mixed and used at planting time to make the soil more porous for the planted seedlings. After those collected landraces of highland bamboo species seedlings were planted out on experimental site basic managements such as mulching, watering, weeding and hoeing were provided properly. After the planting time, to see the growth performance of each landraces of highland bamboo species (*Arundinariaalpina)* necessary data such as survival rate, number of node, number of shoot, internodes length, culm height and culm diameter were recorded quarterly until the end of the study.

2.5. Statistical Analysis

Both descriptive and inferential statistics were employed to analyze and organize the qualitative data of the survey parts. The experimental research data was summarized and analyzed using appropriate statically package of SAS version 9.1. Aone-way analysis of variance (ANOVA) was used to compare the mean using the least significant difference (LSD) at 5% level. Mean separations was done for those parameters which showed statistically significance difference using least significance differences.

3. RESULTS AND DISCUSSION

3.1. Bamboo Growers' Indigenous Knowledge on Management Practice of Highland Bamboo Species

3.1.1 Bamboo Growers' Participation and their Experience on Bamboo Planting Activity

According to the information obtained from focus group discussion, key informant interview and questioner survey both genders (male and female) and youngsters and aged farmers are participated during bamboo planting time. The finding of this study indicated that, in terms of gender category 81.6% and 18.4 % participated on bamboo planting task were men and women respectively (Table 1). As well, respondent households indicated that, during bamboo planting time 75% participated farmers were aged and the rest 25 % were youngsters (Table 1).

Majority of bamboo growers' farmers of the study District have experience of bamboo planting for many years. About 70% of respondent households in the study District got the experiences of bamboo planting from their family, 26% respondent households got practice of bamboo planting from their neighbors and the remaining 4% respondent households were obtained experience of bamboo planting from government organization (Figure 2).

As the finding of this study showed that, in the study District the involvement of other sectors in provision of highland bamboo species planting material, technical support and training on highland bamboo management practice was very low. Therefore, government and non-government organization could be supported bamboo growers' local communities of the study district for effective conservation and sustainable utilization of bamboo resources of the area.

Table1. *Bamboo growers' participation on bamboo planting activity in terms of gender and age category*

Gender category	**Frequency**	**Percentage (%)**
Male	49	81.6
Female	11	18.4
Total	**60**	**100**
Age category		
Aged	45	75
Youngsters	15	25
Total	**60**	**100**

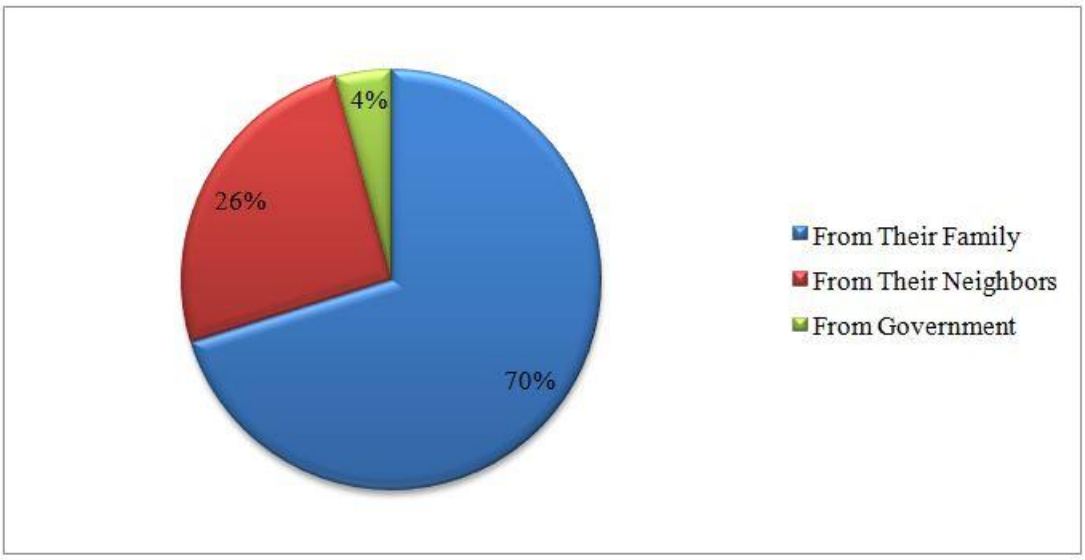

Figure2. *Bamboo growers' source of experience on bamboo planting activity*

3.1.2. Bamboo Growers' Indigenous Knowledge on Identification of Commonly Growing Landraces of Highland Bamboo Species

In the study District, majority of respondent households identified all available different commonly growing highland bamboo species landraces of the area and they have experience of naming different

bamboo high land bamboo land races as *Okotu, Shanto* and *Uratiti*. Similar to this study finding, the study result conducted at Choke Mountain, Northern Ethiopia showed that farmers have experience of naming different bamboo landraces as *Tifro, Wonde, Welele* and *Enkotekot* [13]. In contrary to this study finding, the study result carried out in Kokosa District, South East Ethiopia revealed that, even if local communities of the area known availability of different bamboo landraces, they do not have experience of naming different bamboo landraces [14].

Bamboo growers' of the study District identified commonly growing different land races of high land bamboo species based on their criteria used to recognize highland bamboo characteristics. The participants of key informant interview and focus group discussion indicated that the criteria bamboo growers farmers used to classify highland bamboo landraces were internodes length, culm diameter, stem color, splitting nature and sprouting nature of the bamboo landraces after harvesting time.

Bamboo growers' indigenous knowledge used to recognized commonly growing land races of highland bamboo species of the study District is partially similar to that of criteria used in the study result of [13;14].Moreover, the finding of this study is similar with indigenous knowledge of bamboos by Naga community, Tasikmalaya District, West Java, Indonesia. Community of the area identified locally available bamboo speciesand variation of bamboos based on several groups, namely based on color of bamboo culm, size of stem diameter, bamboo reed wall thickness, edible and non-edible of bamboo shoot, utilization types, economic or selling price, and ecological functions [15].

3.1.3. Bamboo Growers' Indigenous Knowledge on Highland Bamboo Planting Practice

Based on information obtained from bamboo growers' local communities of the study District, location for planting highland bamboo is selected, particularly that close to water sources and being moist, such as river bank. This is intended to provide good condition to new rhizome to adapt with new environment. Participants from focus group discussion and key informant interview indicated that local communities of the study area have their own calendar of planting time and usually planting of bamboo activities conducted at the beginning of the rainy season.

From different propagation techniques commonly used for planting of highland bamboo species (*Arundinaria alpina*),majority of 95% of the total households responded that, they used offset plating technique and the remaining 5% responded households used rhizome planting technique(Figure 3).Bamboo offset planting technique is the process through which farmers carefully uproot bamboo culms and transporting it together with the soil held by the roots and then plant in holes dug wider and deeper prepared. However, bamboo growers' farmers of the study District stated that, this type of propagation has many difficulties, such as time consuming and impossible to transport more culms at a time. Similar to this study finding [16; 17], on their study finding indicated that the traditional production method using offset technique is cumbersome and too inefficient for practical use.

However, in contrary to this study finding, on their study results [18]stated that use of bamboo cutting propagation technique is a viable alternative in most bamboo species but the indigenous bamboo species of Ethiopia have proved difficult to raise planting materials through cuttings. According to the information obtained from participants of Focus Group Discussion, key informant interview and respondent households farmers' practice of using Rhizome planting technique is very little. Bamboo growers' local communities of the study District used this technique by separating of rhizome base from bamboo clump and then planted in the prepared land. On their study findings [19] indicated that, the technique of using rhizome is better than using of stem cutting because the rhizome has still nutrient stored in its base which can avoid desiccation.

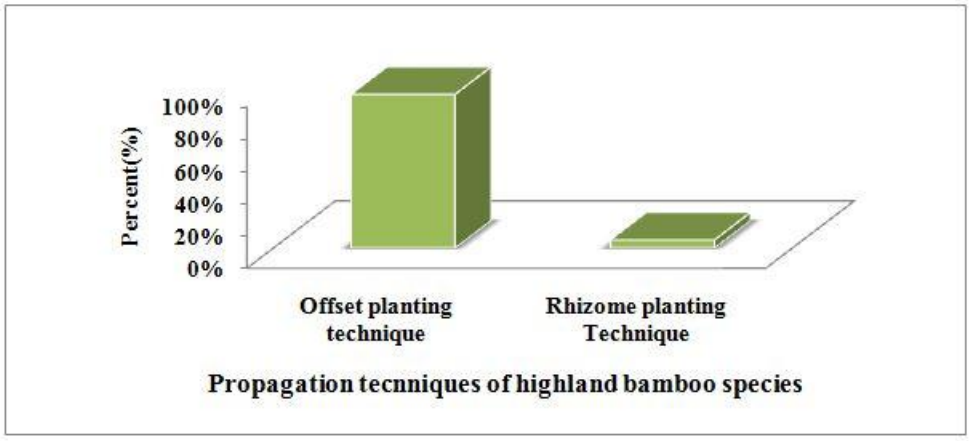

Figure3. *Highland bamboo propagation techniques used by local communities of the study area*

3.2. Collection and Characterization Study Results of Commonly Growing Highland Bamboo Species Landraces of the Study Area

3.2.1. Survival Rate and Number of Shoots Growth Parameters of the Collected Landraces of Highland Bamboo Species

As the finding of this study indicated that, in terms of their survival rate and production of number of shoot, all collected landraces of highland bamboo species *(Arundinaria alpina)* were not showed significant($P \leq 0.05$)different(Table 2).This could be due to all landraces of highland bamboo species (*Arundinaria alpina)* were collected from similar a groecology their survival rate and production of new shoots were very similar. However, [20]on their study results suggested that the study of young vegetative shoots which sprout annually during rainy season is very significant for identification and characterization of different bamboo species. Another research finding also indicated that the production of new culms (shoots) can be very prolific one year and quite sparse in another year, that is the growth rate may vary widely between the individual growing seasons [21].

Table2. *Survival rate, number of nodes and number of shoots of collection and characterization study results of highland bamboo landraces*

Highland bamboo landraces	Growth parameters of highland bamboo landraces		
	Survival rate (%)	Number of nodes	Number of Shoots
Okotu landrace of Arundinaria alpina	92.67[a]	24.84[a]	66.75[a]
Shanto landrace of Arundinaria alpina	88.33[a]	21.91[b]	57.78[a]
Uratiti landrace of Arundinaria alpina	92.26[a]	21.29[b]	53.71[a]
Mean	92.56	22.67	59.25
CV (%)	11	4.97	13.83
LSD (5%)	NS	2.552	NS

Level of significance ($p \leq 0.05$), NS =non-significant, Means with the same letter are not significantly different, Means with different letter are significantly different, CV=coefficient of variance, LSD=least significant difference

Table3. *Internodes length, Culm height and Culm diameter of collection and characterization study results of highland bamboo landraces*

Highland bamboo landraces	Growth parameters of highland bamboo landraces		
	Internodes length (cm)	Culm height (m)	Culm diameter(cm)
Okotu land race ofArundinaria alpina	24.625 [a]	5.227[a]	3.408[a]
Shanto land race ofArundinaria alpina	22.213[b]	4.943[b]	2.808[b]
Uratiti land race ofArundinaria alpina	20.067[b]	4.275[b]	2.772[b]
Mean	20.067	4.815	2.996
CV (%)	20.067	7.52	5.5587
LSD (5%)	20.067	0.8204	0.3776

Level of significance ($p \leq 0.05$), NS =non-significant, Means with the same letter are not significantly different, Means with different letter are significantly different, CV=coefficient of variance, LSD=least significant difference

3.2.2. Number of node and internodes length growth parameters of the collected landraces of highland bamboo species

The results of this study indicated that, in terms of their number of node and internodes length, all collected land races of high land bamboo species (*Arundinaria alpina*)were significantly different at ($p \leq 0.05$).The finding of this study is supported with the previous study of [7]. On their study findings they were indicated that number of node, internodes length and other vegetative parameters are a key for identification and good characters for distinguishing the different bamboo species.

From all collected local landraces of highland bamboo species, *Okotu landrace* of *Arundinaria alpina* was significantly higher ($P \leq 0.05$) than the others landraces of highland bamboo species in terms of its internodes length and number of nodes growth parameters (Table 2&3). Accordingly, mean values of number of node and internodes length of *Okotu land race* of highland bamboo species was higher than by 2.85, 4.56 cm respectively as compared to the remaining landraces of highland bamboo species. However, as it is indicated in Table 2and 3 above as compared to *Okotu* and *Shanto landraces* of *Arundinaria alpina*, mean values of *Uratitiland race* of *Arundinaria alpina* was the lowest in its internodes length (20.1cm) and number of node(21.3).

3.2.3. Culm Diameter and Culm Height Growth Parameters of the Collected Landraces of Highland Bamboo Species

Based on collection and characterization of commonly growing landraces of high land bamboo species of this study, *Okotu*l and race of *Arundinaria alpina* was significantly higher ($P \leq 0.05$) than *Shanto* and *Uratiti* land races of *Arundinaria alpina*. Culm diameter and Culm height mean value of *Okotu*l and race of *Arundinaria alpina* was higher than by 0.412m, and 0.412m respectively as compared to the remaining land races of high land bamboo species used on this study. Similar to this study finding, growth characteristics of collected highland bamboo (*Arundinaria alpina*) landraces from Choke Mountain, Northern Ethiopia showed that in terms of their culm diameter at breast height (DBH) and culm height significant difference were showed between the collected highland bamboo landraces of the area[22].

4. CONCLUSION AND RECOMMENDATION

It is important to characterize and documented the existing bamboo growers' indigenous knowledge on management practice of highland bamboo species for development of bamboo stands and for effective sustainable utilization of the bamboo resources. Moreover, Collection and characterization study of locally available different landraces of highland bamboo species (*Arundinaria alpina*) is vital for their conservation and effectively use of the resources without overexploitation.

The results of this study indicated that, bamboo growers' local communities of Bore District have sound experience of developing bamboo stands. Bamboo growers' farmers of the study site have their own planting season and they are planting bamboo seedlings during the beginning of rainy season. Bamboo growers' farmers of the study District also identified commonly known different landraces of highland bamboo species of the study area based on their different criteria of bamboo characteristics and they have experience of naming different bamboo land races as *Okotu, Shanto* and *Uratiti*.

Based on the findings of this study, significant difference was observed among the collected commonly growing highland bamboo species landraces of the study area in terms of their growth parameters. From those three highland bamboo species local landraces, *Okotu* was higher than the others landraces by its internodes length, culm diameter and culm height growth parameters which make it more superior than the others. Whereas, highland bamboo landrace of *Uratiti* was the lowest in its internodes length, culm diameter, culm height and number of node as compared to the remaining collected local landraces of the study area. Generally, from the results of collection and characterization study of locally available three commonly growing landraces of highland bamboo species of the study District,*Okotu landrace* of highland bamboo species (*Arundinaria alpina)* was the most superior local landrace. Therefore, for sustainable utilization of this superior highland bamboo

species landrace effective conservation is crucial to diversify benefits of local communities ranging from domestic household products to industrial applications. Moreover, integration of bamboo growers' indigenous knowledge with modern scientific fact is very important for sustainable management and utilization of bamboo resources.

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