ESTABLISHMENT OF A PILOT SCALE BAMBOO STAND FOR EDIBLE BAMBOO SHOOT PRODUCTION IN KERALA

(Final Report of the Research Project No. 264/96)

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PROJECT PROPOSAL

Project Code : KFRI 264/96

Project Title : Establishment of a pilot scale bamboo stand for edible bamboo shoot production in Kerala

Principal Investigator : Muktesh Kumar

Objectives:

The main objectives of the project are:

1. Introduction of edible bamboos from different parts of India (indigenous/exotic).

2. Establishment of a bamboo shoot stand by planting the seedlings or offsets in the appropriate agro-climatic zones.

3. Study the feasibility of shoot production of edible bamboo shoot for commercialization.

Project Period : December 1996-June 2002

Funding Agency : Kerala Forest Department (Development)

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ABSTRACT

In the present report, results of the preliminary studies conducted on six species of edible bamboos namely, *Bambusa bambos*, *Bambusa tulda*, *Dendrocalamus brandisii*, *Dendrocalamus hamiltonii*, *Dendrocalamus longispathus* and *Dendrocalamus strictus*, are presented. It is observed that the shoot production season in Kerala is from June to September and 3-6 shoots are produced from a clump during this period. Shoots are also produced during November-December when Kerala receives northeast monsoon rains. However, if regularly watered, new shoots develop at specific intervals. The shoots can be harvested 7-14 days after the emergence when the shoot height will be about 15-30 cm depending upon the species. It has been estimated that a freshly harvested young shoot of *Bambusa bambos* weighing 5 kg could yield 1.5-2.5 kg edible bamboo. Growth rate of bamboo is very fast and attains harvestable maturity in less than five years resulting in enhanced culm production. The average number of shoots produced in *Bambusa bambos* is 23 per annum with an approximate weight of 32-50 kg. In *Dendrocalamus hamiltonii* the average number of culm production is recorded to be 53 and weighing approximately 20-40 kg. It has become evident that bamboo has emerged as a cash crop to generate income for the rural communities.

The study of the nutrient status of all the six species of bamboos clearly indicated that *D. strictus* is more nutritious than *D. hamiltonii* and *B. bambos*. Nutritive analysis of other edible bamboo species needs to be carried out in order to understand their potential as a dietary.

INTRODUCTION

The multifarious uses of bamboo that contribute to the income of the rural people throughout the world, especially in the tropics, are well known. Bamboo shoot production is one of the major sources of income for farmers in China, Thailand, Japan, the Philippines, Laos and Korea. Bamboo shoot industry is thriving well and fast expanding in Asian countries. However, edible bamboo species are not raised for shoot production in India. Presently, people collect the shoot from the forests for their use as well as for marketing. In the North Eastern states over seven species of bamboos are used for edible purposes. Therefore, popularisation of bamboos as food and their commercial production for local market need to be encouraged. Edible bamboo shoot production definitely has a great potential as an emerging rural industry. Bamboo shoots are important constituents of stir-fry cuisine and specialized recipes, and are produced and consumed in great quantities in China, Taiwan, Thailand, Japan and Korea. Taste and presentation vary in different countries. Bamboo shoots are also canned and exported from Taiwan, China and Thailand, and the latter two countries largely supply the world market.

Bamboo plantations can produce good quality salable bamboo shoot each year as a by-product of the plantations, thus giving two separate incomes per year (shoots and culms).

Asian countries produce canned shoots, but fresh shoots are far superior. Japan is a big importer of bamboo shoots. Recently, Australia has started bamboo shoot industry in a big way. It is claimed that off-season fresh shoots fetch up to USD 10/kg. There are periods when fresh shoots are not available in the northern hemisphere, usually replaced with canned and dried shoots that are obviously inferior. In order to have sufficient plants to establish plantations and to sustain a reliable market supply, they tissue culture systems have been developed for the particular clones and species and clones most suited for high production and high quality edible shoots. There are particular species and clones of the already proven bamboos grown in areas totaling thousands of hectares in

Thailand (54,000 ha), China (incalculable) and Taiwan (more than 100,000 ha) and several other Asian countries.

In India, bamboo shoots are being eaten specially by people of bamboo growing belts in North Eastern India, the Andaman and Nicobar Islands, several other parts of India including Kerala. The most popular species are *Bambusa bambos* and *Dendrocalamus strictus* due to their availability almost all over India. In Kerala and the Andaman and Nicobar Islands, *Bambusa bambos* is popular whereas in North of Karnataka and Maharashtra, shoots of *Dendrocalamus strictus* are relished.

It is mostly the tribal communities in Kerala who utilize bamboo shoots. Even though the usage of bamboo shoot in urban areas, especially in Chinese food, is gaining popularity, all the demand is met through canned products from North Eastern states. However, bamboo shoot farming has immense potential in the rural sector in Kerala. This can provide job opportunities to women and additional income to others who take up bamboo shoot production.

In the study on edible bamboos conducted by KFRI on the six species namely, *Bambusa bambos, Bambusa tulda, Dendrocalamus brandisii, Dendrocalamus hamiltonii, Dendrocalamus longispathus* and *Dendrocalamus strictus,* results have shown that the shoot production season in Kerala is from June – September and 3-6 shoots are produced from a clump during this period. Shoots are also produced during November-December when Kerala receives northeast monsoon rains. However, if regularly watered, the new shoots develop at specific intervals. The shoots can be harvested 7 – 14 days after the emergence when the shoot height will be about 15-30 cm depending upon the species. In the North East India, bamboo shoots are sold for Rs. 8-10 per shoot in local markets. However, if they are processed and canned they can fetch 5 - 6 times its price. It has been estimated that a freshly harvested young shoot of *Bambusa bambos* weighing 5 kg could yield 1.5-2.5 kg edible bamboo. The growth rate of bamboo is very fast and attains harvestable maturity in less than five years resulting in enhanced culm production. The average production of shoot in *Bambusa bambos* is 23 numbers per annum with an

approximate weight of 30-50 kg. In *Dendrocalamus hamiltonii* the average culm production is recorded to be 53 numbers and weighing approximately 20-40 kg. It has become evident that bamboos have emerged as a cash crop to generate income for the rural communities.

The rhizomes start sprouting throwing erect shoots during rainy season and are harvested when they are about 0.5 m in height. The tender portions or internodes are cut into small thin pieces and soaked in plenty of water for 24 hours to remove the water-soluble hydrocyanic acid. They are again soaked in fresh water for 24 hours before cooking. The edible shoot pieces can be kept soaked in salt for 3-4 months and then dried in sun and fried to use as vegetable dish. Some pieces can also be eaten raw. There are 20 species of bamboos in India that are used for the production of edible shoots (Table.1).

Table 1: Potential edible bamboo species in India

No	**Species**	**Location**
1	*Bambusa balcooa*	Nagaland, Meghalaya, Assam, West Bengal, Bihar and cultivated in other states
2	*Bambusa bambos*	Occurs throughout India up to an elevation of 1250m
3	*Bambusa galucescens*	Cultivated in several parts of India and Assam
4	*Bambusa vulgaris*	Frequently cultivated in the warm tropics, pan tropical areas
5	*Bambusa polymorpha*	Bengal , Assam, Other eastern states
6	*Bambusa tulda*	Eastern India up to 600m, cultivated in most of the states in the plains and foot hills
7	*Dendrocalamus asper*	Cultivated in several parts of India
8	*Dendrocalamus brandisii*	West Bengal, Uttar Pradesh and other tropical regions
9	*Dendrocalamus giganteus*	Cultivated in several states of India

10	*Dendrocalamus longispathus*	West Bengal and other parts of Eastern India
11	*Dendrocalamus hamiltonii*	Occurs in the foothills, north west, central and eastern Himalayas up to 900m, cultivated in other southern states as well.
12	*Dendrocalamus strictus*	Assam , Manipur, Tripura, Meghalaya, Southern States
13	*Gigantochloa atter*	West Bengal
14	*Gigantochloa verticillata*	West Bengal
15	*Arundinaria elegans*	Nagaland
16	*Phyllostachys bambusoides*	North east India and under cultivation in other parts
17	*Pyllostachys pubescens*	North east India and under cultivation in other parts
18	*Schizostachyum brachycladum*	West Bengal
19	*Thyrsostachys siamensis*	Cultivated in West Bengal and other parts of India
20	*Melocanna baccifera*	West Bengal, Assam, Tripura and other parts of India in the plains and foot hills.

REVIEW OF LITERATURE

There are innumerable publications available on edible bamboos and mostly are from the South East Asian countries like China, Thailand, Singapore, Malaysia, Vietnam and Laos. Recently, several studies are being conducted in Australia. Some of the important publications on edible bamboo shoot industries are: Kennard and Freyre, 1957; He and He, 1983; Das, 1988; Cheng *et al.*, 1989; Chen, 1993; Dokey, 1992; Elsmore and Cusack, 1998; Kleinhenz, 1999; Midmore, 1997, 1998a, 1998b, 1999, 2000 and Midmore, *et al.*, 1998. There are few publications available from India on edible bamboos but mostly are on the micro-propagation studies of selected species. Joshi *et al.* (1994) and Kushalappa (1997) have emphasized the need to exploit the potential of establishment of bamboo for edible shoot production.

India is rich in edible bamboos and their shoots are traditionally consumed by a majority of the tribal population. More than 20 bamboo species occurring in the country yields edible shoots, some are reputed for their high quality. *Bambusa polymorpha* shoots are ranked as the best in the world for their tenderness and distinctly sweet flavour when consumed raw (Kennard and Freyre, 1957; Vivekanandan, 1987). Bamboo shoots are consumed in variety of ways e.g. *Bambusa bambos*, *Dendrocalamus hamiltonii* and *D. giganteus* as vegetables (Janmejay Singh, 1986; Das, 1988; Mitra and Nair, 1972), *Bambusa bambos* as pickles (Mitra and Nair, 1972). Besides, some are consumed raw and also processed into consumable products such as curry, candy, chutney, pickles, etc. for the local markets. In North Lakhimpur Forest Division (Assam) consumption of very soft shoots is considered as an effective birth control measure (Tewari, 1993).

MATERIALS AND METHODS

Experimental sites and establishment of experimental plots

Two experimental plots were established:

1. Field Research Center Velupadam, Palappilly (76^0 23' 57" Long; 10^0 26' 21" Lat.; Altitude 195 m a.s.l.).
2. KFRI Subcenter Nilambur (76^0 18' 11" Long; 11^0 21' 02" Lat.; Altitude 70 m a.s.l.).

The Field Research Center, Velupadam is in Palappilly Forest Range of Trichur Forest Division. The annual rainfall is about 2395 mm. The temperature ranges from 38 – 42 °C and minimum 18 °C.

The campus of KFRI Subcenter at Nilambur receives a rainfall of over 1700 mm/year with maximum precipitation of about 600 mm (Map 1).

An area of half hectare (80m × 65 m) each was selected at FRC Velupadam and at KFRI Sub Center Nilambur. The following six species of bamboo species namely, *Bambusa bambos*, *Bambusa tulda, Dendrocalamus hamiltonii, Dendrocalamus longispathus, Dendrocalamus brandisii* and *Dendrocalamus strictus* were planted in randomized block design. Eighteen plants of each species were planted with a spacing of 5 m × 5 m (Plot charts 1 and 2).

Establishment

Seeds were sown and seedlings were raised. Since seedlings were used as propagules for raising plantation, there was considerable delay in the production of culm and harvestable shoots.

Fertilizer application

Fertilizer application was done for two seasons.

Growth measurements

Number of emerging shoots, shoot diameter, date of emergence of shoot, etc. were also recorded.

Harvesting of edible shoots

The shoots were harvested 7 – 14 days after the emergence when the shoot height will be about 15-30 cm depending upon the species.

Preparation of bamboo shoots for nutrient analysis

Collected shoots were transported to the laboratory in refrigerated flasks and the inedible parts as well as the sheaths were removed using a stainless steel knife. The edible portions were cut into small cubes. From this 500 g was taken as sample and out of that 20 g was dried at 105 °C for 20 min. Fresh samples were used for analysis of moisture content. The other samples were then dried at 80 °C and the dried samples were ground to powder and stored in bottles for further analysis.

Moisture content

Moisture estimation was carried out using a standard method by AOAC (1990).

Micronutrients

The micronutrients were determined through the atomic absorption spectrophotometer (AAS) method. The plant samples digested with Sulphuric acid were passed through AAS using different lamps calibrated for different micronutrient.

Potassium

Potassium was determined using flame photometer, by digesting a known weight of sample with Sulphuric acid.

Protein

Crude protein was determined using Micro-Kjeldahl Method. Total nitrogen was estimated and multiplied with 6.25 to find out crude protein content.

RESULTS AND DISCUSSION

The project was initiated by the middle of January 1997. From the known 20 species of bamboo that could be used for the shoot production, six species were tried in the experimental plots established by KFRI.

It is recorded that the shoot production season is from June – September. The shoots can be harvested 7 – 14 days after the emergence when the shoot height will be about 15-30 cm depending upon the species. From the experimental plot established at FRC Velupadam and Subcenter Nilambur, growth performance of all the six species of edible species was monitored. It was observed that 4-6 shoots were produced per clump at a time and of these 60 per cent of the new shoot can be removed for edible purposes. Details of shoot emergence and the culm produced for each year is given in Tables 2 and 3, Fig. 1 and 2).

Table 2: Number of culms produced per year for each species at FRC Velupadam

Species	Year		
	2000	2001	2002
Bambusa bambos	10	20	20
Bambusa tulda	10	18	27
Dendrocalamus hamiltonii	25	30	39
Dendrocalamus longispathus	12	17	19
Dendrocalamus brandisii	13	23	29
Dendrocalamus strictus	6	12	16

Table 3: Number of culms produced per year for each species at Subcentre Nilambur

Species	Year		
	2000	2001	2002
Bambusa bambos	9	17	23
Bambusa tulda	45	55	68
Dendrocalamus hamiltonii	8	12	13
Dendrocalamus longispathus	16	23	27
Dendrocalamus brandisii	42	49	85
Dendrocalamus strictus	7	16	16

Fig. 1. Number of culms produced per year in the plot established at FRC Velupadam

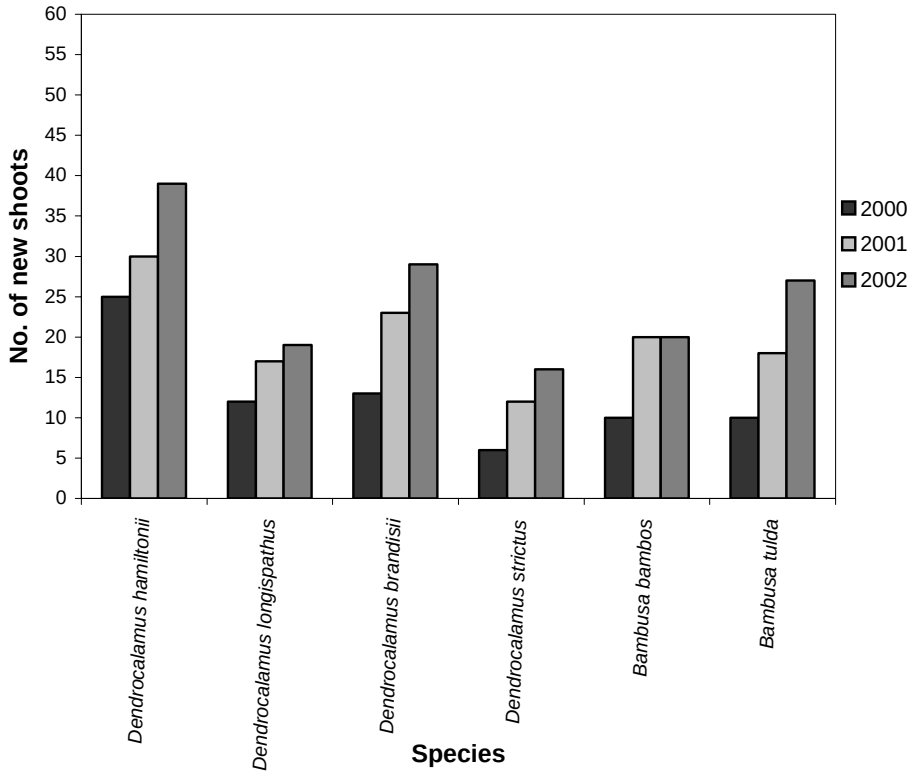


Fig. 2. Number of culms produced per year in the plot established at Subcentre Nilambur

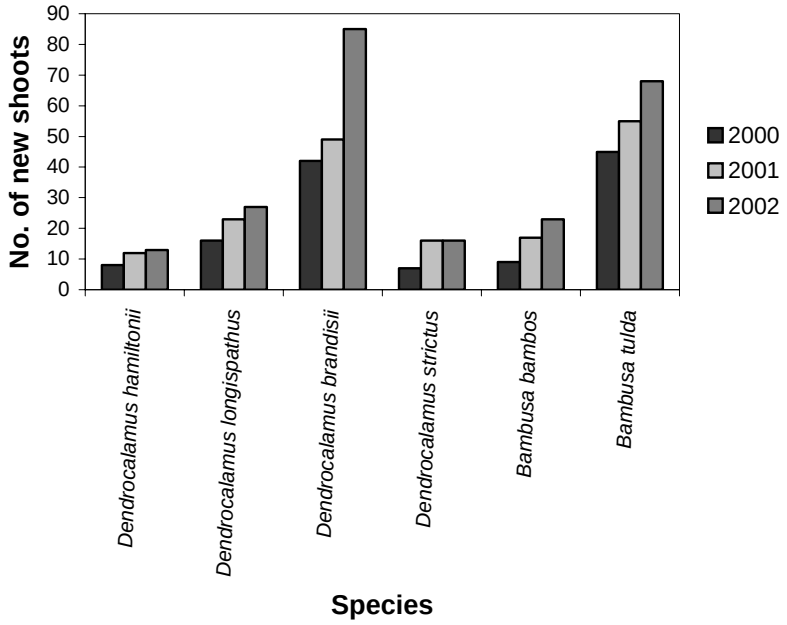
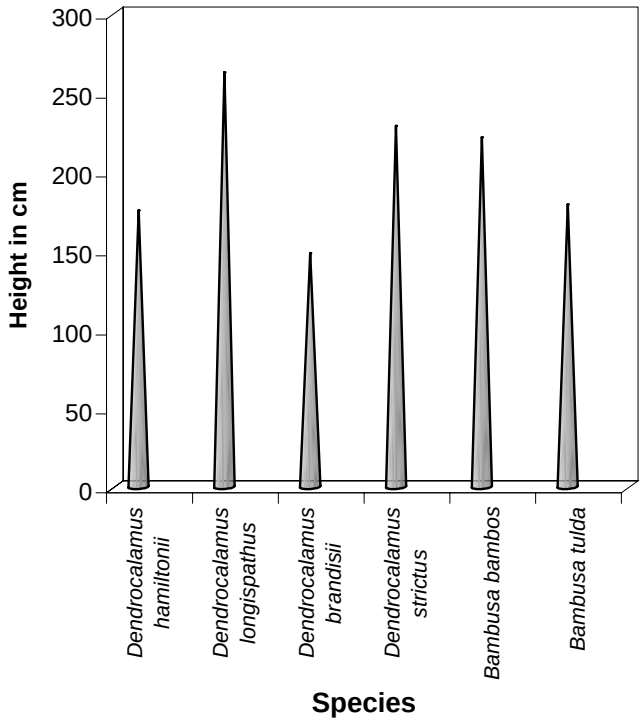


Fig. 3. Mean height of new culms produced in 7 days



Fertilizer application in bamboo plantations

Fertilizer application is important to increase the yield. Nitrogen, phosphorus and potassium are most essential for proper growth. While planting one-year-old seedlings, ammonium phosphate (300 g), potash (150 g) and cow-dung (10 g) per plant can be added in the pits. One and a half times of the above dose can be added during the second year. Then there is no need to add any fertilizer till harvesting. After first harvesting, 1.5 kg of ammonium phosphate and 750 g of potash and 45 g of cow dung can be added annually. The fertilizer is added in the trench made (about 15 cm deep) around the clump. If the stands are situated in steep slopes, it is better that the fertilizer is directly applied at the base of the clump. Organic fertilizers are best applied during the onset of monsoon (Table 4).

Table 4: Fertilizer application in bamboo plantations

Age of the crop	N (g)	P (g)	K (g)	Cow dung (kg)
1	20	10	30	1
2	100	50	150	5
3	300	150	450	30
8	300	150	450	45

Cow dung has been found almost equivalent to NPK mixture in boosting growth. However, a basal dressing of cow dung during the South West monsoon showers followed by top dressing of fertilizer mixture at the beginning of North East monsoon in the rooting zone will be of added advantage.

The time for the first harvest of shoot is about two and a half years after planting, if seedlings are used. In the case of rooted node cuttings used as a planting material the harvestable shoot is obtained within two years.

Some of the observations like mean height and girth of the new shoots produced in different species are shown in Figures 3 and 4.

From the experimental plots at Velupadam it was observed that *Dendrocalamus hamiltonii* produced the greatest number of culms in

each of the three years followed by *Dendrocalamus brandisii*, *Bambusa tulda*, *Bambusa bambos* and *Dendrocalamus longispathus*. *Dendrocalamus strictus* had a low number of shoots (Table.3). From the experimental plots at Subcenter Nilambur, the highest number of culm production over the period was observed in *Dendrocalamus brandisii* and the lowest in *Dendrocalamus hamiltonii* (Table 5). *Dendrocalamus brandisii* produced the largest shoots as indicated by the shoot diameter and *Dendrocalamus longispathus* produced the smallest.

Table 5: Count for emerging shoot and maximum girth recorded

Species	Year/s 1999 - 2000		
	No. of shoots	**No. of shoots emerged**	**Girth of shoots (in cm)**
Bambusa bambos	23	11	10.3
Bambusa tulda	68	9	11.2
Dendrocalamus hamiltonii	13	8	5.3
Dendrocalamus longispathus	27	10	4.7
Dendrocalamus brandisii	85	23	12.9
Dendrocalamus strictus	16	19	8

However, with good management practices like irrigation and fertilizer applications, shoot production from the individual species harvesting mature shoots could be extended up to 6 months. With the shoot season of different species peaking at different times, maximum shoots can be extracted for a longer period. Bamboo shoots are rich in vitamins, cellulose and amino acids. At harvesting, a shoot may contain as much as 90 per cent water. The edible content is only about 50 per cent. Shoots have a high nutritive value, low fat content and are a good fibre source. The extractability of each species is given in Table 6.

Table 6: Extractability of the different species of bamboo

No.	Name of the Species	Edible portion (%)
1	*Bambusa bambos*	30.3
2	*Bambusa tulda*	19.8
3	*Dendrocalamus hamiltonii*	45.8
4	*Dendrocalamus longispathus*	40.0
5	*Dendrocalamus brandisii*	32.6
6	*Dendrocalamus strictus*	20.8

Nutrients composition of edible shoots

The analysis of nutrition compositions of six different species namely, *Bambusa bambos, Bambusa tulda, Dendrocalamus hamiltonii, Dendrocalamus longispathus, Dendrocalamus brandisii* and *Dendrocalamus strictus* was carried out. Details of the test results are given in the Table 7.

The moisture content of *D. brandisii* and *D. longispathus* was recorded as high as 93.5 per cent followed by *D. hamiltonii* (92.5%). Lowest moisture content was observed in *B. bambos*. Overall moisture content of the *Dendrocalamus* spp. except *D. strictus* was found higher than that of *Bambusa* spp. However, mineral nutrients were found to be highest in *D. strictus* followed by *D. brandisii*. Lowest mineral content of 1.01 per cent was recorded for *Bambusa tulda*. Phosphorus content was highest in *D. strictus* (two times higher than that of all other species studied) and it was 56.23 per cent. Phosphorus content was found lowest in *D. brandisii*. The Calcium content was maximum in *Bambusa bambos* and *D. hamiltonii*, and the values are 48.21 and 46.26 per cent, respectively. Calcium content was low (13.63%) in *D. strictus.* Iron content was distinctly higher in *D. strictus* (2.91%) compared to all the species selected for the study. *Bambusa bambos* showed lowest iron content of 0.78 per cent. Protein content was highest in *D. hamiltonii* and the values are 2.60 and 2.51 per cent. Niacin content in *D. hamiltonii* was markedly higher than all other bamboo species studied. The highest carbohydrate content was found

in *B. bambos* (4.53%) followed by *D. longispathus* (4.12%) and *D. strictus* (4.12%), respectively.

The comparison of the nutrient status of all the six species of bamboos studied clearly indicated that shoot of *D. strictus* is highly nutritious followed by that of *D. hamiltonii* and *B. bambos*. But the higher hydrocyanic acid content in *D. strictus* made it toxic to be consumed as raw. *D. longispathus* and *D. brandisii* showed more or less equal nutritional status. Among the six species studied *B. tulda* showed poor nutritional value.

Statistical analysis: Statistical analysis could not be performed on any of the data sets presented. Propagation material and yield measurements were taken from the two experimental plots established and this allowed for only one replication for each treatment or measurement. This, of course, limits the scientific merit of the results. The results, at best, can only be regarded as a guide.

Table 7: Nutrient composition of edible shoots in different bamboo species

No	Name of the Species	Test Result									
		Moisture content (%)	Ether Extract (%)	Minerals (as total ash) (%)	Phosphorus mg/100g	Calcium mg/100g	Iron mg/100g	Hydrocyanic acid (%)	Protein (%)	Niacin mg/100g	Carbohydrates (%)
1	*Bambusa bambos*	91.25	0.76	1.08	28.25	48.21	0.78	0.056	2.09	2.31	4.53
2	*Bambusa tulda*	91.65	0.65	1.01	17.27	22.02	1.02	0.028	2.21	2.61	3.81
3	*Dendrocalamus hamiltonii*	92.5	0.312	1.02	28.16	46.26	1.68	0.075	2.60	6.28	3.98
4	*Dendrocalamus longispathus*	93.5	0.482	1.09	15.62	29.63	1.17	0.038	2.38	1.53	4.12
5	*Dendrocalamus brandisii*	93.5	0.501	1.12	12.57	21.38	1.08	0.044	2.51	2.48	3.83
6	*Dendrocalamus strictus*	86.5	0.82	1.14	56.23	13.63	2.913	0.18	2.01	2.06	4.12

CONCLUSION / IMPLICATION

The multifarious uses of bamboo that contribute to the income of the rural people throughout the world, especially in tropics are well known. Bamboo shoot production is one of the major sources of income for farmers in China, Thailand, Japan, the Philippines, Laos and Korea. Bamboo shoot industry is thriving well and fast expanding in Asian countries. The edible bamboo shoot production generates good income to the growers. In India, the young shoots of 20 species of bamboos are known to be edible. However, edible bamboo species are not raised for shoot production. Presently, people collect the shoot from the forests for their use as well as for marketing. In the North Eastern states, over seven species of bamboos are used for edible purposes. Therefore, popularization of bamboos as food and their commercial production for local market need to be encouraged. Edible bamboo shoot production definitely has a great potential as an emerging rural industry.

It is mostly the tribal communities in Kerala who utilize bamboo shoots. Even though the, usage of bamboo shoot in urban areas, especially in Chinese food, is gaining popularity, all the demand is met through canned products from North Eastern states. However, bamboo shoot farming has immense potential in the rural sector in Kerala. This can provide job opportunities to women and additional income to others who take up bamboo shoot production.

The study of the nutrient status of all the six species of bamboos clearly indicated that the *D. strictus* is more nutritious than *D. hamiltonii* and *B. bambos*. Nutritive analysis of other edible bamboo species needs to be carried out in order to understand their potentiality as a dietary.

This is the first attempt to study the feasibility of establishing bamboo shoot industry by popularization and commercialization in Kerala. The data obtained on shoot production and growth performance during the present study can be treated only as a guide.

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