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Population structure and culm production of bamboos under traditional harvest regimes in Assam, Northeast India

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Abstract: The status of three bamboo species, *Bambusa cacharensis, B. vulgaris* and *B. balcooa* in Barak Valley, Assam was studied with respect to population structure under the traditional harvest regimes and the effect of different harvest regimes on new culm production, culm size and culm height. A culm age class structure of almost 3:3:2:1:1(*B. cacharensis*) and 4:2:2:1:1(for both *B. vulgaris* and *B. balcooa*) for current to four-year-old culms was recognized under selective harvest system. Under clearfelling regimes during rainy and winter seasons, culm age class structure was represented by 8:2 and 5:5 (*B. cacharensis*) and, 8:2 and 7:3 (*B. vulgaris*) for current to one-year-old culms respectively. In *B. balcooa,* culm age class structure was represented by the current year culms only. The new culm production, culm height and culm dbh exhibited highest values under selective felling. Analysis of variance (ANOVA) indicated significant differences ($P < 0.05$) between the values of new culm production, culm height and dbh of new culms under selective and clearfelling harvest regimes within each species, suggesting the need for developing management strategies for enhancing bamboo productivity through restricting the clearfelling system.

Key words: Bamboo harvest regime, culm population structure, culm production, management strategies.

INTRODUCTION

Bamboos form an important component of the rural landscape of Barak Valley in southern Assam as also in other parts of northeastern India. Home gardens and bamboo groves of Barak Valley are rich in bamboo resources and *Bambusa cacharensis* R. Majumder ('betua'), *B. vulgaris* Schrad. ('jai borua'), *B. balcooa* Roxb. ('sil borua') form important bamboos prioritized by the rural people (Nath, 2001; Nath *et al.*, 2004). *B. cacharensis* is endemic to Assam (Majumder, 1983; Barooah and Borthakur, 2003) and distributed abundantly within Brahmaputra and the Barak Valley and other two species (*B. vulgaris* and *B. balcooa*) are among the 14 Indian priority bamboo

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species (NMBA, 2004) and 38 priority bamboo species for international action (Rao *et al.*,1998). A number of investigations with emphasis on the traditional as well scientific management of natural bamboo stands have been carried out (Kadambi, 1949; Huberman, 1959; Upreti and Sundriyal, 2001). Information on population structure and culm production of bamboos subjected to different management systems is scarce (Lodhiyal *et al.*, 1998; Embaye *et al.*, 2005). Knowledge of population structure and culm production of bamboo clump is important for development of a management approach to increase the production efficiency of bamboo clumps. The population structure and culm production of three bamboo species, *B. cacharensis*, *B. vulgaris* and *B. balcooa* were studied.

MATERIALS AND METHODS

Study site and climate

The study was conducted in Irongmara and Dargakona villages, in Cachar district of Barak Valley in southern Assam, India and is situated at latitude 24°41′N and longitude 92°45′E. The climate of the study site is sub-tropical warm and humid with an average annual rainfall of 2660 mm, most of which is received during the southwest monsoon season (May to September). The mean maximum temperature ranges from 25.1°C (January) to 32.6°C (August). The mean minimum temperature ranges from 11°C (January) to 25°C (August).

Methods

The population structure and culm production of *B. cacharensis, B. vulgaris* and *B. balcooa* under traditional harvest regimes were studied from November 2003 to November 2004, as growth of bamboo stabilizes by the month of November. Information regarding the traditional harvesting systems in home gardens and bamboo groves as practised by the rural bamboo growers was gathered through a questionnaire survey and backed by field observations. For each traditional harvesting system (selective felling, clearfelling in rainy season and clearfelling in winter season), 10 clumps with age ranging between 10 and 20 years for each of the three species were selected and labeled with paint. As only 10- to 20-year-old clumps are normally clearfelled, for the comparative study, clumps with similar age group were selected under selective felling system. The marked clumps were monitored regularly. Bamboo culms were categorized into six age classes depending on their maturity: (1) current year, (2) 1-year-old, (3) 2-year-old, (4) 3-year-old, (5) 4-year-old and (6) 5-year-old. Culm growth parameters,dbh and height, of all the three species were measured.

Statistical analysis

Data on new culm production, height and dbh of new culms under different harvest regimes for each species were analyzed by analysis of variance (ANOVA), using the statistical software STATISTICA version 6.0.

RESULTS AND DISCUSSION

Bamboo resources in home gardens and bamboo groves

Home gardens are traditional agroforestry systems located close to the houses and form a part of the intensively managed household management system. In the home garden system of Barak Valley, bamboo forms an important component as in the home gardens system of Kerala (Mohan Kumar, 1997). Bamboo grove is a separate zone within the home gardens or in the extended land where bamboo is grown either in a pure stand or mixed with other vegetation. Bamboo in the home gardens is principally managed for household purposes and in the bamboo groves for commercial purposes. *B. cacharensis* is the most predominant species in both home gardens and bamboo groves followed by *B. vulgaris* and *B. balcooa*.

Traditional harvest regimes

Three harvest regimes - selective harvest, clearfelling rainy harvest and clearfelling winter harvest could be identified depending on the mode and season of felling culms. Selective felling is mainly practised in home gardens and clearfelling in bamboo groves. In the study site, under selective felling, the mature culms (> 2 years) which constitute about 15-30 per cent of the total culms per clump are harvested each year. Traditional bamboo growers prefer to harvest *B. cacharensis* under the selective felling system for its multipurpose household uses and *B. vulgaris* and *B. balcooa* under the clearfelling system for paper industry due to their higher green weight. Under the clearfelling system, 85-95 per cent of the total culms per clump are harvested, leaving few current and one-year-old culms. Bamboo growers prefer the clearfelling system during rainy season as the harvested culms are constructed into rafts and ferried through water to reduce transportation cost. About 25 per cent of the total bamboo growers in the study site are involved in commercial utilization of bamboo resources

Table 1. New culm production under traditional harvest regimes

Bamboo species	New culm production per clump		
	Selective felling	Clearfelling (rainy season)	Clearfelling (winter season)
B. cacharensis	18.7^{a*}(13-25)	6.4^{b}(4-9)	4.4^{b}(3-6)
B. vulgaris	17.5^{a} (13-22)	5.4^{b} (4-7)	3.8^{b}(3-5)
B. balcooa	24.2^{a} (15-40)	5.8^{b}(4-9)	2.4^{b}(1-4)

[*] Average number of culms and range within parentheses.
[a,b] Mean values within species superscribed with different letters differ significantly at 5% level.

and they resort to clearfelling. It was recognized that these bamboo growers do not have any fixed income to sustain their family as they are poor labourers or farmers. However, these growers also manage at least 3-5 bamboo clumps under the selective felling system for their household utilization.

Population structure of bamboo culms

B. cacharensis, B. vulgaris and B. balcooa under traditional harvest regimes exhibited preponderance of younger culm age classes than older age classes. A culm age class structure of almost 3:3:2:1:1(*B. cacharensis*), 4:2:2:1:1 (*B. vulgaris*), 4:2:2:1:1 (*B. balcooa*) for current to 4-year-old culms was recorded under selective harvest. Selective felling is predominant in areas in which mature culms are harvested selectively in the dormant (mostly dry) season, and used for household purposes. Yuming *et al.* (2001) recommends an age class structure of 3:3:3:1 for 1- to 4-year-old bamboo culms in sympodial bamboo species for optimum culm production. The culm population structure of the present study under selective felling is in agreement with the recommended one, indicating a rational harvesting system. Embaye *et al.* (2005) reported that in Masha Forest, *Yushania alpina* stand age-structure heavily skewed towards older culms that resulted in low productivity of the bamboo stand. Therefore, it is important to harvest mature culms each year, to maintain the population structure with a preponderance towards younger culms. Under clearfelling rainy and winter seasons, culm age class structure of 8:2 and 5:5 (*B. cacharensis*) and 8:2 and 7:3 (*B. vulgaris*) respectively for current to 1-year-old culms was observed. In *B. balcooa*, culm age class structure was represented by the current year culms only. Presence of five-year age classes of culms under selective felling and two-year age classes under clearfelling in the population structure of 2004 in all the species are due to conversion of each of the age classes to its higher age class during the one year period (Figs. 1-3). Five different culm age classes in selective harvest system in comparison to two culm age classes in clearfelling system reflect over-exploitation of resources in the latter system. Steadily, home gardens are becoming the source of bamboo resources for industrial purposes, resulting in over-exploitation of resources without considering any proper management practices.

Culm production as affected by the harvest regimes

New culm production, the index of productivity of clump was greatest under the selective felling system. Under selective felling, the number of new culms produced in *B. balcooa* (24.2) is higher than that of *B. cacharensis* (18.7) and *B. vulgaris* (17.5), while under clearfelling rainy and clearfelling winter seasons, *B. cacharensis* (6.4 and 4.4 respectively) produced higher number of new culms than *B. vulgaris* (5.4 and 3.8 respectively) and *B. balcooa* (5.8 and 2.4 respectively) (Table 1). ANOVA indicated significant differences ($P < 0.05$) in new culm production under selective and clearfelling harvest regimes. Reduced new culm production under the clearfelling system suggests the need for retaining new and old culms in the clump to maintain

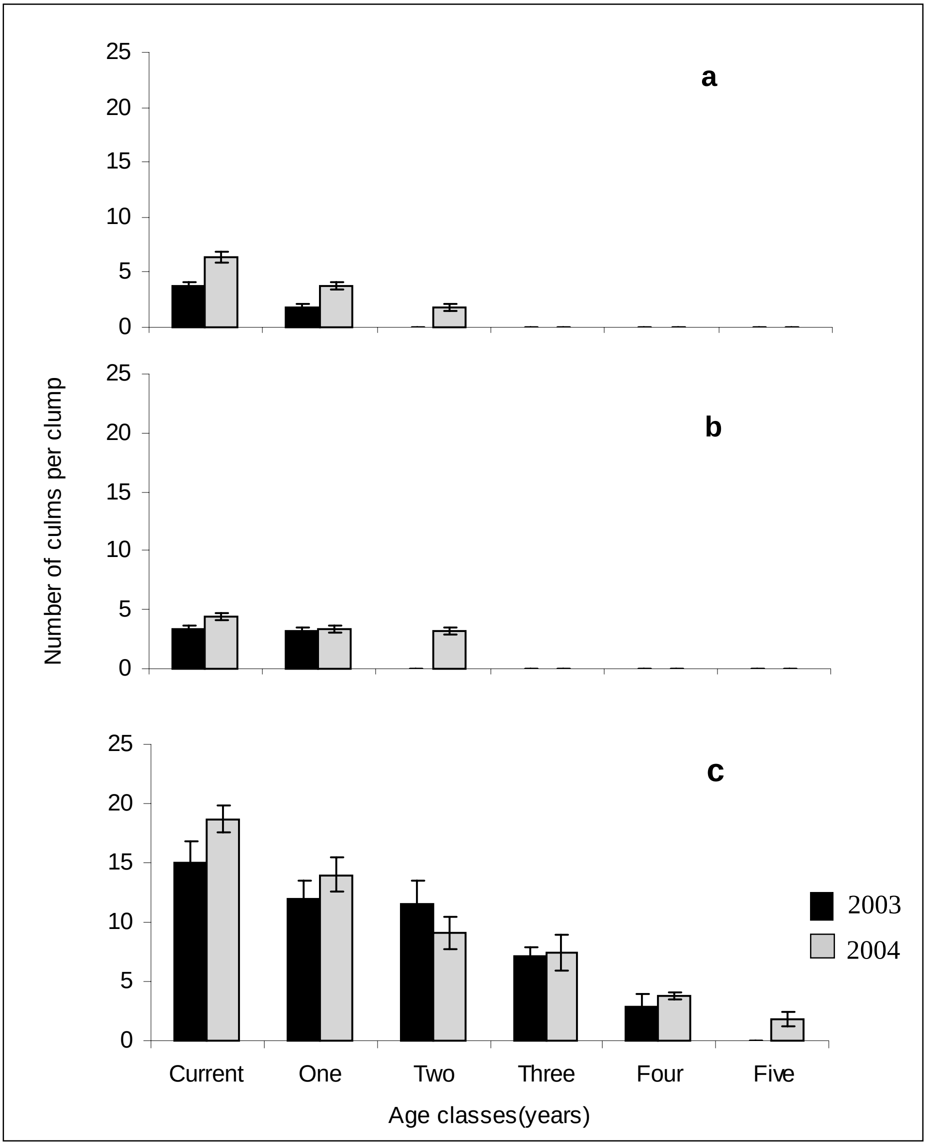

Figure 1. Population structure of *B. cacharensis* during 2003 and 2004 under different traditional harvest systems; a: clearfelling rainy season; b: clearfelling winter season; c: selective felling. Error bar represents standard error.

productivity. Huberman (1959) reported that harvesting should be conducted so as to cause a minimum of disturbance, and it is essential to retain a portion of old culms both for mechanical support of new shoots and to maintain the rhizomes in full vigour. In *B. cacharensis* and *B. vulgaris*, the number of new culms of 2004 was higher than that of 2003, but in *B. balcooa,* it was lower than that of 2003 (Fig. 3c). In *B. balcooa,* retention of relatively higher number of mature culms than *B. cacharensis* and *B.*

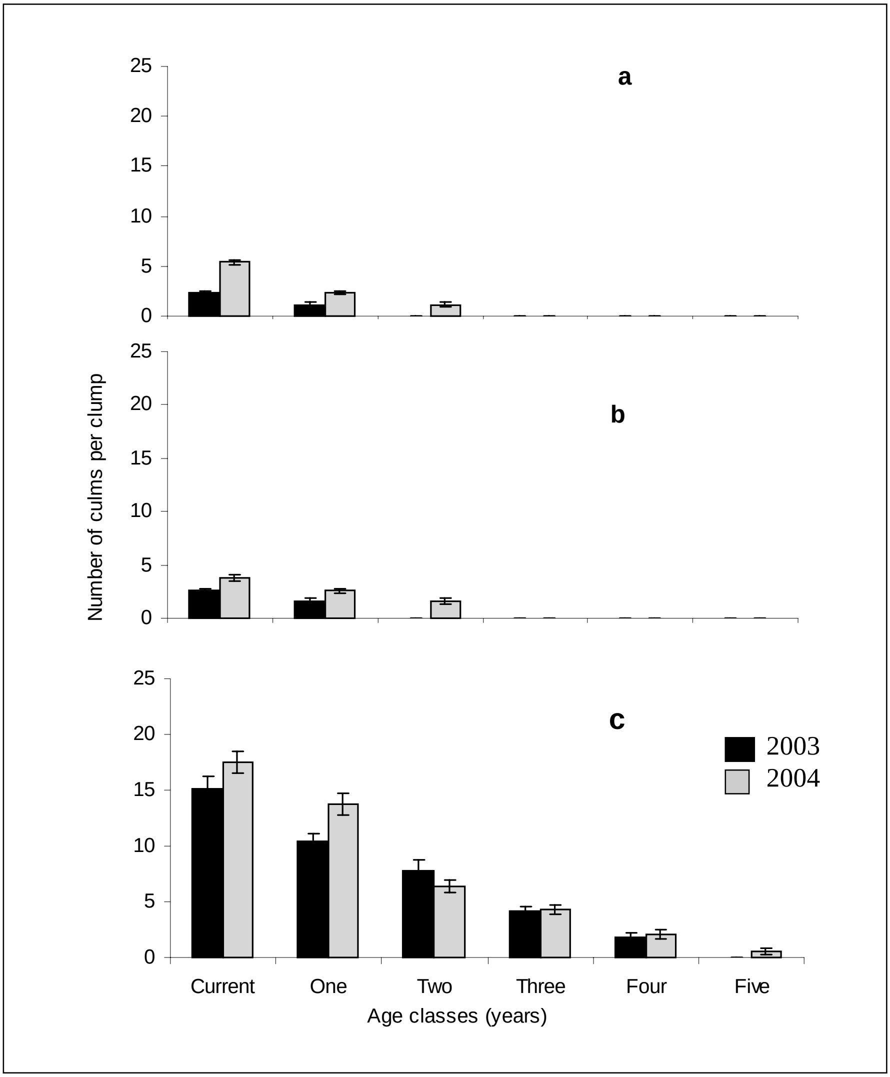

Figure 2. Population structure of *B. vulgaris* during 2003 and 2004 under different traditional harvest systems; a: clearfelling rainy season; b: clearfelling winter season; c: selective felling. Error bar represents standard error.

vulgaris led to congestion of the clump. Crowding and congestion affected the new emerging culms and also increased competition among them for survival (Khan, 1962). Such congested condition might have lowered new culm production in *B. balcooa.*

The analysis of height and dbh of new culms under different harvest regimes offers insight into the effect of clearfelling on vigour of the clump. Height and dbh of new culms for all the three species under selective felling were significantly ($P < 0.01$)

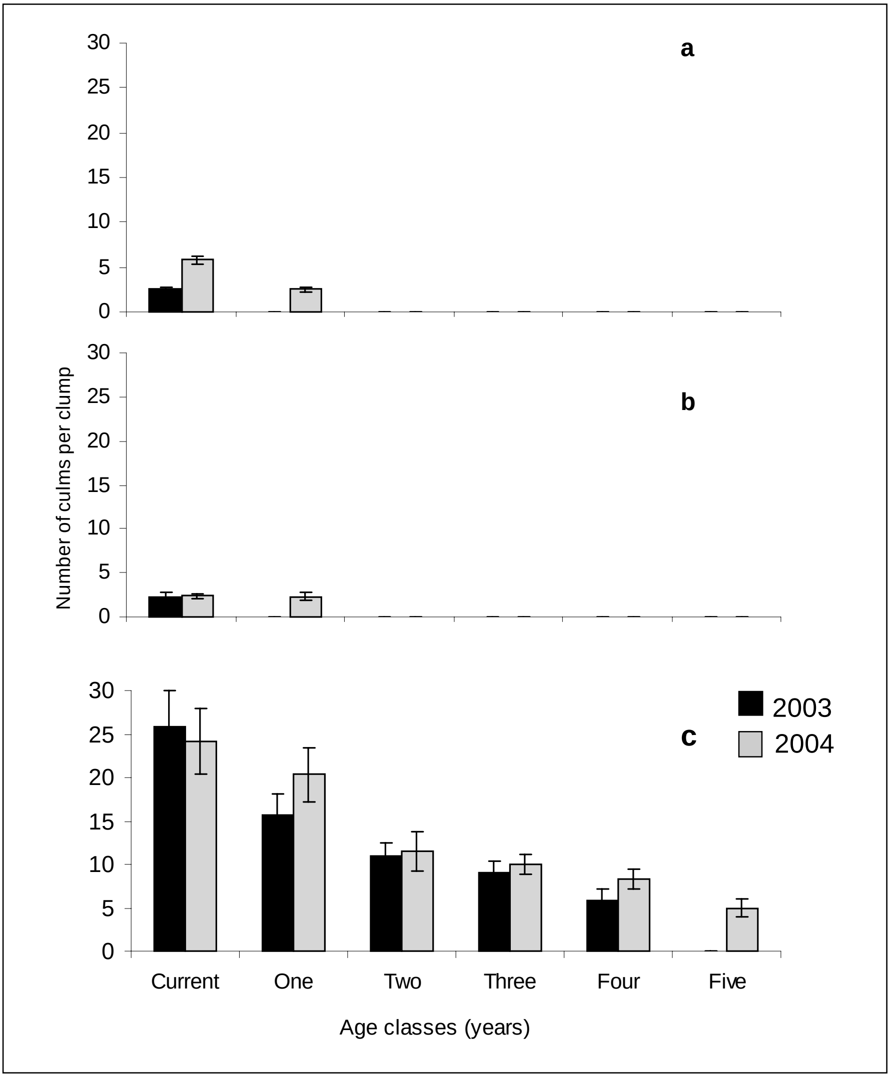

Figure 3. Population structure of *B. balcooa* during 2003 and 2004 under different traditional harvest systems; a: clearfelling rainy season; b: clearfelling winter season; c: selective felling. Error bar represents standard error.

higher than those of clearfelling. However, culm height in *B. cacharensis* and *B. vulgaris* and culm dbh in *B. cacharensis* under clearfelling rainy and winter harvests do not differ significantly ($P > 0.05$). In all the three species, new culms emerging from clearfelled clumps were shorter and thinner (Fig. 4). These observations are supported by the findings of Khan (1962) that after a clump is clearfelled, the newly emerging culms are smaller in length, thinner in diameter and less vigorous for the first few years. Retention of sufficient number of green culms (new and old) in selective felling maintained the vigour of rhizome enhancing maximum production and ensuring

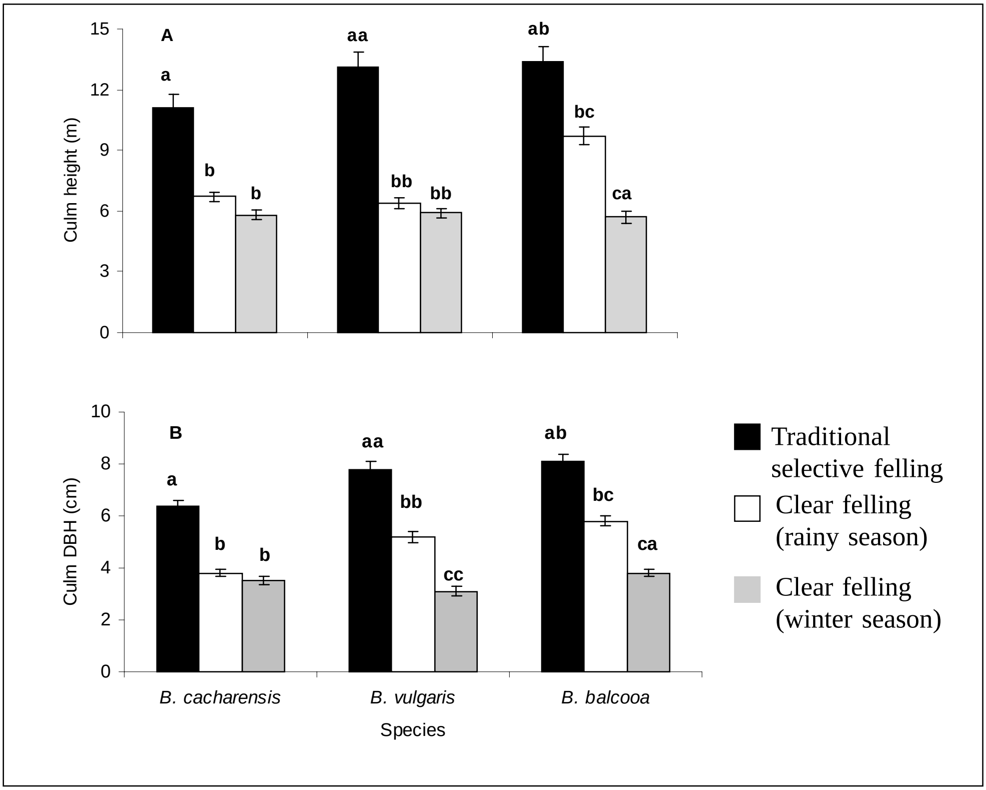

Figure 4. A: Culm height (m) and B: culm dbh (cm) of *B.cacharensis*, *B.vulgaris* and *B .balcooa* under traditional selective felling, clear felling (rainy season) and clear felling (winter season) regimes. Error bar represents standard error. Values above the bar with same letter do not differ at 5% level of significance within species.

sustained growth. Under the clearfelling regime, the lower number of culms per clump cannot maintain the vigour of underground rhizome and therefore substantially reduces productivity. The size of new culm is determined by the nutrient supply from the rhizome (Ueda, 1960). This suggests that the culm height and dbh of new culms are the response of vigour of rhizome. The greater yields under clearfelling in rainy season than in winter season can be attributed to the period of new culm emergence during the rainy season (Nandy *et al.*, 2004; Nath *et al.*, 2004) which coincides with the period of clearfelling (rainy season) and even in the absence of mature culms, newly emerged culms utilize the stored food in rhizome. In the clearfelling winter regime, drying up of stored food in rhizome due to longer gap between culm emergence (rainy season) and clearfelling (winter season) resulted in poor yield.

Management strategies

Over-exploitation of bamboo in villages takes place in the form of clearfelling of clumps. Therefore, there is a need for developing better management strategies for optimum yield without substantially impairing the potential of the bamboo resources. The following management strategies are suggested:

1. It is necessary to evaluate the stock of culms per clump and to harvest 30-35 per cent of total culms per clump annually by removing only the mature culms. Harvesting mature culms maintains a continuous harvesting cycle that enables maximum sustainable yield.
2. Farmers should be involved with integrated programmes that promote bamboo cultivation, management and utilization. They should be made aware of the problems that may arise with the ecologically unsustainable harvesting practices.
3. Guidelines should be brought out for harvesting bamboos in the villages to protect and manage this keystone rural resource.

Culm production exhibited a high degree of differences between the different harvesting regimes. Harvesting regimes, in turn, determine the culm population structure of a clump. Therefore, there exists a positive relationship between culm population structure and culm production. Higher new culm production and greater culm height and diameter can result from selective felling of mature culms each year. Ultimately, a culm population structure of five different age classes preponderant towards younger culms could optimize yield by producing more new culms with superior height and diameter.

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