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Effect of harvesting techniques on culm yield of *Gigantochloa scortechinii* natural stands

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Abstract: A harvesting study was conducted on *Gigantochloa scortechinii* natural stands in two forested sites in Peninsular Malaysia using four harvesting techniques. After a period of 18 months from harvesting, it was found that the harvesting techniques and clump types had highly significant effects on the emergence of the new culms and culm mortality. There was no significant effect on site between Nami and Betau. Based on the results, X-shaped harvesting technique is recommended for natural bamboo management due to the least destruction and lower initial removal of bamboo culms (7.1%). The method produced higher number of new good culms (7.6) and lower mortality of new culms (2.9) as compared to the horse-shoe shaped harvesting technique. Furthermore, it is suggested that only clumps with 26 culms/clump and above are suitable for this harvesting technique. Selective harvesting seems more appropriate for the smaller clumps. Clearfelling method is not recommended for harvesting the natural stands of *G. scortechinii* due to slow recovery of the clumps.

Key words: Harvesting, *Gigantochloa scortechinii*, clump management.

INTRODUCTION

Gigantochloa scortechinii is one of the most commonly used bamboo species, endemic to the Peninsular Malaysia. This species occurs extensively in logged-over areas, particularly in the states of Kedah, Perak, Kelantan, Selangor and Pahang. The culms are mainly used for *sawali*, a woven article, which has varied uses in the rural areas.

Like other commercial species of bamboo, *G. scortechinii* stands have been severely depleted and the supply continues to decline due to unregulated exploitation. Many of the problems faced by the harvesters are related to the natural characteristics of the bamboo stand itself. The peripheral culms tend to bend and produce low quality material. The high quality culms that are straight and mature, are commonly located at the centre of the clumps, but are difficult to harvest. Furthermore, these bamboos grow wild, scattered and are practically unmanaged.

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Due to lack of systematic management, this valuable resource is harvested indiscriminately. In order to sustain the production of bamboo, the existing natural stands need to be managed systematically. However, information on a suitable harvesting regime that is essential in managing bamboo stands in Malaysia is still unavailable. This study was conducted to determine the appropriate system of harvesting to improve the productivity of natural clumps of *G. scortechinii*.

MATERIALS AND METHODS

Study sites

This study was conducted in logged-over areas of Chebar Forest Reserve in Nami, Kedah and Betau Kuala Lipis in Pahang. Past records showed that bamboo stands in Nami had been disturbed with uncontrolled harvesting activities. In contrast, bamboo areas in Betau were still intact without any harvesting activities carried out. The topography of these areas was flat and undulating. There was not much difference in annual rainfall, temperature and humidity between the two sites; an average rainfall of 1500 mm, mean temperature of 30 °C and relative humidity of 89 per cent. The distribution of natural *G. scortechinii* in these areas was scattered with density between 204-250 clumps/ha and mean density of 3780 culms/ha.

Harvesting techniques

A randomised design consisting four harvesting techniques as the main-plot, three clump categories as the sub-plot and two sites as a sub-sub-plot was used. Four harvesting techniques were chosen. The first one was taken as control with no felling. The second technique was the horse-shoe shaped felling, the third was the X-shaped felling and the fourth was clearfelling. The horse-shoe technique involves felling the mature culms aged three years and above, located mostly in the inner part of the clump, so that the remaining culms form a horse-shoe shaped clump. The X-shaped harvesting involves felling of mature clumps of three years and above, leaving an X-shaped clump.

The trial was conducted at two sites where one hectare plots were established. A total of 15 clumps were used for each harvesting technique which consisted of five experimental units for each clump category at each site. The clump categories consisted of 10-25, 26-40 and 40 and more culms per clump. A total of 120 clumps were selected randomly and observed in this trial. Observations were recorded following the harvesting treatments and were continued for an 18 month period. The parameters observed were number of new culms produced, mortality rate and the culm characteristics. Data were subjected to Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Number of culms before and after harvesting

Mean values of the total number of culms recorded before and after the harvesting treatments are shown in Table 1. In the initial stage, the percentage of removable culms for the horse-shoe shaped and X-shaped harvesting techniques consisted of 14.5 per cent and 7.1 per cent respectively and the mean number of culms per clump after felling were 26.7 and 30.6 respectively. In terms of time required for felling and clearing, X-shaped technique needed the least time as compared to the horse-shoe and clearfelling techniques.

Clump development

Table 2 gives details on the culms produced for different harvesting treatments used. At 18 months after harvesting, the response of the control clumps was the highest. The control clumps produced a total of 353 new culms, while the horse-shoe and X-shaped harvesting techniques produced 227 and 215 new culms respectively. It was also found that the X-shaped and horse-shoe techniques showed no significant difference in the total number of good culms produced and both harvesting methods gave an equal mean of eight good new culms per clump. However, X-shaped method is recommended to be adopted due to lower damage during the initial removal of bamboo culms. Of the four methods, clearfelling technique produced the lowest number of new culms.

The analysis in Table 3 reveals that the harvesting techniques and clump type had highly significant influence on the emergence of the new culms and mean number of

Table 1. Number of culms before and after harvesting

Technique	Total no. of culms	Total no. of culms after felling	% of removable culms	Mean no. of culms/clump
Control	1138	1138	0	37.9
Horse-shoe shaped	938	802	14.5	26.7
X-shaped	988	918	7.1	30.6
Clearfelling	822	0	100	0

Table 2. Number of culms produced 18 months after harvesting

Technique	Total no. of new culms	No. of good culms	No. of bad/ dying culms	Percentage of good culms	Mean no. of good culms/clump
Control	353	282	71	79.9	18.8
Horse-shoe shaped	227	121	106	53.3	8.1
X shaped	215	123	92	57.2	8.2
Clearfelling	62	62	0	100	4.1

Table 3. Analysis of variance of total new culms produced and culm mortality of *G. scortechinii* stands

Source of variation	df	F - values	
		Total no. of new culms	No. of dying culms
Site	1	0.184ns	0.211ns
Technique	3	0.001*	0.002*
Clump type	2	0.001*	0.001*

Note: ns – not significant at P< 0.05; * Significant at P < 0.05.

dying culms after the felling treatments. However, there was no significant effect of site on the number of new culms produced and number of dying culms.

Comparison of these values reveals that the mean culm yield and mortality of culms per clump significantly varied with harvesting techniques (Table 4). Control produced 10.4 culms per clump, followed by X-shaped harvesting with 7.6 culms per clump. Horse-shoe shaped felling produced 6.1 culms and clearfelling gave the lowest yield of 4.4 culms per clump. However, there was no significant difference between the X-shaped and horse-shaped harvesting technique in the culms produced. The clearfelling and X-shaped harvesting techniques produced significantly lesser number of dying culms when compared with control and horse-shoe shaped harvesting techniques. This shows that the harvesting techniques affected the recovery of clumps. The results also show a negative relationship between harvesting intensity and culm regeneration. Hence, as the intensity increased the recovery rate reduced which resulted in lower productivity. It is also interesting to note that the use of X-shaped harvesting produced more new culms and significantly reduced mortality of culms as compared to the horse-shoe shaped harvesting technique.

The mean yield revealed that felling of culms in the category of more than 40 culms/clump resulted in higher culm production (Table 5). Felling of culms in this group gave significantly higher culm production (10.5) in comparison to 7.2 and 3.8 culms per clump for categories 10-25 and 26-40 respectively.

Table 4. Effect of harvesting techniques on culm production and mortality in *G. scortechinii*

Harvesting technique	Mean values	
	New culms	Dying culms
Control	10.4^{a}	5.3^{a}
Horse-shoe shaped	6.1^{b}	6.2^{a}
X-shaped	7.6^{b}	2.9^{b}
Clearfelling	4.4^{c}	0.1^{c}

Note: Values with the same letter(s) not significantly different at P<0.05.

Table 5. Effect of clump category, culm production and mortality in *G. scortechinii*

Clump category (no. of culms/clump)	Mean values	
	New culms	Dying culms
10-25	3.8[a]	1.8[a]
26-40	7.2[b]	3.3[b]
> 40	10.5[c]	4.9[c]

Note: Values with the same letter(s) not significantly different at P<0.05.

To sustain the yield and productivity of *G. scortechinii,* culm selection system of harvesting should be adopted. From this study it is indicated that harvesting technique is closely related to removable culms and felling intensity in a clump. The clump size also gave significant effect on culm production and clump condition. This study showed that X-shaped harvesting method was preferable for bamboo clumps with more than 26 culms. For bamboo clumps having less than 26 culms, selective harvesting will give better culm production. Thus, harvesting should be done selective to the smaller clumps until it reaches the limit of more than 26 culms per clump. It is important to have a systematic management of bamboo resources to ensure adequate and continuous supply of raw materials over a long period of time.

In order to ensure maximum culm quality and volume, it is essential to enforce the correct felling practice (Azmy *et al.,* 1977). Thus, harvesting system does play an important role in determining the yield and to overcome the problem of clump congestion in the natural bamboo stands. Systematic harvesting also increases the production of bamboo stock (Fateh Mohamad, 1931; Numata, 1979).

In this study it was also found that clearfelling cannot be recommended as a harvesting option due to subsequent slow recovery. Similar results have also been reported by Varmah and Bahadur (1980) based on experiment conducted on *Dendrocalamus strictus* in India. They found that felling of all culms, except the newly produced ones, results in high mortality as well as in lower and poorer quality culm production.

Culm characteristics

Culm characteristics based on height and DBH after 18 months of harvesting treatments are given in Table 6. Analysis of the mean height and DBH indicated that the site and the harvesting techniques were significant ($P < 0.05$) on culm height and DBH, and there was no significant difference on clump type. Duncan's New Multiple Range Test (Table 7) further revealed that the mean values of culm height and DBH between sites was significantly different. Bamboo culms produced in Betau were superior than those from Nami.

The effect of harvesting technique on mean culm height and DBH of *G. scortechinii*

Table 6. Analysis of variance of culm height and DBH after harvesting

Source of variation	df	F - values	
		Culm height	Culm DBH
Sites	1	0.01*	0.001*
Techniques	3	0.001*	0.002*
Clump types	2	0.88ns	0.83ns

Note: ns – not significant at $P < 0.05$; * - significant at $P < 0.05$.

Table 7. Effect of site on height and DBH of new culms produced in *G. scortechinii*

Site	Mean values	
	Height (m)	DBH(cm)
Nami	13.79^{a}	6.3^{a}
Betau	15.78^{b}	7.6^{b}

Note: Values with the same letter(s) not significantly different at $P<0.05$.

18 months after felling is shown in Table 8. Results of the analysis show that the mean values of culm height and DBH between harvesting techniques did not differ significantly between horse-shoe shaped and X-shaped harvesting methods. However, these two methods were significantly different from the control and clearfelling method. Horse-shoe and X-shaped methods gave the best culm characteristics with mean culm height of 17.4 m and 17.7 m respectively and with equal DBH of 8.1 cm. On the other hand, the clear cutting method gave the poorest results with mean culm height and DBH of 6.9 m and 3.6 cm respectively.

The present study also indicated that site conditions significantly affected the culm characteristics of bamboo in natural stands. Results show that bamboo culms grown on sandy clay soil in Betau were better than those grown on lateritic soil in Nami. Research done in China has shown that sandy loam is most favourable for the development of bamboo culms, followed by the light loam, clay and stony soil, in that sequence (Wan, 1990).

Table 8. Effect of harvesting technique on culm height and DBH in *G. scortechinii*

Harvesting technique	Mean values	
	Height(m)	DBH (cm)
Horse-shoe shaped	17.7^{a}	8.1^{a}
X-shaped	17.4^{a}	8.1^{a}
Control	17.1^{b}	7.9^{b}
Clearfelling	6.9^{c}	3.6^{c}

Note: Values with the same letter(s) not significantly different at $P<0.05$.

Production of good quality culms also depended on age of the culms to be harvested and the harvesting cycle. In Indonesia, Yudodibroto (1985) reported that bamboo stands are harvested selectively to maintain good quality. Experiments conducted in this line resulted in the recommendation that cutting be done of 3 to 4-year-old culms; at the rate of 5 culms per clump during the first year and 10 to 20 culms per clump with the increase in age. Some growers cut their bamboo culms every three years rather than annually. In China, 3-year-old culms are retained while those over four years are felled, except for those necessary for maintaining the required canopy density (Guoging, 1985).

Sharma (1980) in his review of bamboo in the Asia Pacific region, mentions that bamboo forests in India, Bangladesh and Myanmar are generally managed according to a culm selection method. This method generally removes the poor-quality culms while one or two mature culms are retained adjacent to the new culms to give stability. In Myanmar, the bamboo areas are usually divided into sections, and felling is rotated so that a section is harvested and left for two, three, or four years, depending on the felling cycle, to regenerate. In Japan, fellings are also selective and carried out in autumn with cutting cycles varying from 3-5 years for *Phyllostachys reticulata* and 5-10 years for *P. edulis*. Ueda (1960) suggested that 1- to 3-year-old bamboo culms must always be left as stock and those over four years cut for development of new culms.

CONCLUSIONS

The results indicate that the harvesting techniques and clump types have highly significant effects on the emergence of the new culms and mortality of culms. X-shaped harvesting technique is recommended for natural bamboo management due to the least damage and lower initial removal of bamboo culms (7.1%). The method produces higher number of new healthy culms (7.6) and lower rate of mortality in new culms (2.9) as compared with horse-shoe shaped harvesting technique (6.1 and 6.2 respectively). Furthermore, it is recommended that only bamboo clumps with 26 culms/clump and above are suitable for harvesting using this technique. Selective harvesting seems more appropriate for the smaller clumps until they reach the limit. Clearfelling method is not recommended for harvesting the natural stands of *G. scortechinii* as it leads to slow recovery. With proper clump size selection and harvesting techniques used, sustainable management of natural stands of bamboo is possible.

REFERENCES

Azmy Hj. Mohamed, Norini Haron and Wan Razali Wan Mohd. 1997. Management Guidelines and Economics of Natural Bamboo Stands. FRIM Technical Information Handbook No.15: 40p.

Fateh Mohammad, M. 1931. The bamboo forest of Hoshiarpur District, Punjab. *Indian Forester* 57: 491-510.

Guoging, L. 1985. Improved cultivation techniques of bamboo in North China. In: Recent Research on Bamboo. Proceedings, International Bamboo Workshop, October 6-14, 1985. Hangzhou, China: 71-78.

Numata, M. 1979. The structure and succession of bamboo vegetation. In: M. Numata (Ed.). Ecology of Grasslands and Bamboo Lands in the World. The Hague: 222-236.

Sharma, Y.M.L. 1980. Bamboo in the Asia-Pacific region. In: Bamboo Research in Asia. Proceedings, Workshop held in Singapore: 99-120.

Ueda, K. 1960. Bamboo Cultivation. Report by Resources Council, Science and Technics Agency of the Prime Ministers Office, Resources Bureau, Japan: 144-155.

Varmah, N.C. and Bahadur, K.N. 1980. Country report and status of research on bamboo in India. In: Bamboo Research in Asia. Proceedings, Workshop held in Singapore: 19-46.

Wan, Z. 1990. Study on the relationship between site condition and development in *P. pubescens*. *Bamboo Research* 9(4): 38-45.

Yudodibroto, H. 1985. Bamboo Research in Indonesia. In: Recent Research on Bamboo. Proceedings, International Bamboo Workshop, Oct. 6-14, 1985. Hangzhou, China.