

**WORKSHOP ON SUSTAINABLE HARVESTING OF BAMBOO
IN
WESTERN GHATS OF KARNATAKA, INDIA**

Venue: Forest Bungalow, Sirsi, Uttara Kannada, Karnataka.

Date : March 16, 2002.

Organised by :
Parisara Sanmrakshana Kendra, Sirsi
Karnataka Forest Department
Prakruti, Sirsi

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EXECUTIVE SUMMARY

Flowering of bamboo is a natural phenomenon and it is going to happen soon in the Western Ghats. In the previous bamboo flowering, during 1962 there was no clear policy and scientific management techniques for sustainable harvesting of bamboo. As a consequence the area under bamboo has considerably decreased after each flowering.

Hence the workshop was organised to evolve a strategy and action plan to ensure the sustainable harvesting of the bamboo resources in Western Ghats, Karnataka. The technical issues pertaining to flowering of bamboo and to its regeneration was discussed.

- ◆ There are 8 species of bamboo. Priority species identified in the workshop are *Bamboosa arundinacea*, *Dendrocalamus strictus* for which flowering occurs once in about 45 years and *Ochlandra rheedii*.
- ◆ Biology of bamboo flowering, further management options and policy requirements for the utilisation of bamboo were discussed in detail.

Recommendations to Karnataka Forest Department:

The following recommendations were made in the workshop to evolve a sustainable utilisation of bamboo resources:

- ◆ To study the effect of partial removal of clumps before flowering on seed production and regeneration.
- ◆ Use of remote sensing for monitoring of bamboo flowering by conducting a short term forecasting value by re interpreting the images is suggested to the government.
- ◆ Geographic mapping of genetic differences
- ◆ Afforestation with two to three year old bamboo saplings should be considered.
- ◆ Management options need to be evolved for harvesting methods, monitoring of flowering and conservation options.
- ◆ Impart training on alternate occupation to those groups who are dependent on bamboo so that they could generate their income during the lean period.
- ◆ Implement an intensive bamboo regeneration project to generate bamboo resource as soon as possible after bamboo flowering and their subsequent death.

- ◆ Arrangements should be made to supply bamboo seedlings to farmers for raising bamboo plantations in private lands.
- ◆ In the coming three four years bamboo is going to flower in about 1,50,000 hectares in Uttara Kannada district. Each divisions in the Canara Forest Circle should take action in advance to identify the flowering areas and identify experimental plots in order to have prior knowledge on sustainable harvesting methods.
- ◆ It is also recommended to find out treatment to the bamboo so as to preserve it for longer duration since the amount of bamboo poles available after flowering is estimated at 20,00,000 in the district.
- ◆ Identify those areas rich in bamboo species for example 250 clumps per hectare of forestland. Within this it is recommended to harvest only those clumps in which number of clumps per clump is less (less than 100).
- ◆ To identify the place and timings of flowering it is recommended to take help of local people, school and college students.
- ◆ To collect and preserve from elite types for regeneration it is decided to collect seeds from good and strong bamboo clumps.

**TECHNICAL REPORT OF WORKSHOP ON SUSTAINABLE HARVESTING
OF BAMBOO IN WESTERN GHATS, KARNATAKA
(March 16, 2002, In Sirsi, Uttara Kannada, Karnataka)**

A one-day workshop on sustainable harvesting of bamboo was organised by *Parisara Sanmrakshana Kendra* and *Prakruti* along with *Karnataka Forest Department*. The objectives of the workshop were:

- 1) To discuss issues on *sustainable harvesting* of bamboo resources in the Western Ghats, Karnataka
- 2) To discuss the technical aspects related to mast *flowering of bamboo* in *Uttara Kannada*.
- 3) To discuss the relevance of existing policies on harvest of bamboo and suggest changes for improving the economics, environment and ecology.

Background:

Bamboo has a peculiar flowering behavior, in which there is gregarious flowering over large areas followed by sudden death of clumps. There are reports of bamboo flowering in several forest patches of *Uttara Kannada* (such as *Joida*) and *Shimoga* districts. Forester generally believe that there is an urgent need to extract all the available bamboo resources before they are destroyed due to the natural death following flowering. Further, if this is not done at a rapid phase, there is a risk of fire hazard in the protected areas.

Under such circumstances what is the method for extraction of bamboo, which helps towards regeneration? What are the practical methods to achieve this?

We need to discuss the technical issues with experts, resource persons and get feed back from them. The knowledge of people who traditionally use bamboo from generations may also be relevant to the sustainable harvesting of bamboo.

These issues were thoroughly discussed among panelist in five sub committees in the workshop. Earlier, papers were presented by experts after formal inauguration. Finally declaration were adopted in the concluding plenary session.

Pandurang Hegde of *Parisara Sanmrakshana Kendra* in his introductory speech emphasised the need of such workshop in order to protect the bamboo resources from the risk of fire hazard arising out of mass flowering of bamboo.

Shri A.C.Lakshman, a retired forest official, an eminent bamboo and cane specialist, who has authored several books on bamboo management said that mast flowering of bamboo is a natural phenomenon and the next cycle may occur in the near future in the Western Ghats. He is of the opinion that there is an urgent need to evolve a management strategy to ensure its sustainable harvesting. He urged that every forest division should start a small research work and collect information on intensity of bamboo flowering. He also suggested documenting traditional bamboo management practices of local people.

Sri Vinay Luthra Conservator of Forests *Canara Circle* appreciated efforts made by *Parisara Sanmrakshana Kendra*, *Prakruti* and the people of Uttara Kannada for initiating such a unique workshop and said that participation of local people would greatly help conservation efforts of the circle.

Presentation of papers:

Dr.Narendra Prasad, Dr.C.K John, Sri A.C.Lakshman and Sri R.K.Chopra presented papers on various aspects of bamboo, its flowering, possible methods of sustainable harvesting and the experience of past management tactics during flowering of bamboo. The details of the same are appended as annexures.

Group discussions:

Three sub groups discussed three different objectives of the workshop

Group I: This group discussed the issues related to **biology of bamboo flowering**, such as distribution of bamboo species, intensity, periodicity and ecological consequences of flowering.

Priority species for consideration identified based on importance, occurrence and urgency were *Bamboosa arundinacea*, *Dendrocalamus strictus* and *Ochlandra rheedii*.

Time frame for action was set to be between: 2002 to 2005

The group suggested to make operational observations on extent of bamboo flowering in forest range of U.K. district by the forest officials, further, it also urged to involve NGOs and local people, school / college students, in establishing a network to monitor and document bamboo flowering. It was felt that indicator of flowering such as non-

production or reduced production of new clumps in the previous year of flowering could be adopted in predicting the bamboo flower.

The committee felt the need to use of remote sensing for monitoring of bamboo flowering. State government can take up a short term forecasting by reinterpreting already acquired images.

The sub committee felt the need to initiate new studies in understanding the bamboo flowering and its implication to forest management. These included understanding ecological consequences of flowering effect of partial removal of clumps before flowering on seed production and regeneration etc.

Geographic mapping of genetic differences for flowering in different species should be done. In order to circumvent unpredictable flowering of bamboo plantation with rhizomes, afforestation with two to three year old seed raised plants could be undertaken.

Group 2: Second group discussed on **management options** such as existing harvesting regime, monitoring of flowering and conservation options.

Silviculture

While carrying out the silvicultural thinning following guidelines may be followed:

- the bamboo clump should be of 2-3 years size
- harvesting should be done at 1 ½ feet above surface,
- 8-10 clumps are to be left, older clumps are not cut to facilitate further regeneration.
- horse shoe type of harvesting can be practiced
- harvest can be undertaken at 4 years cycle,

Decongestion of bamboo clumps is to be done on priority basis. Cleaning up of branches –*aurandinaeaceae*, *Bamboosa* clumps having more clumps, should be partially cut.

The sub committee felt that the monitoring of flowering could be based on the historical records and observation on sporadic flowering. The management options should include: fire protection through clear-lines, banning grazing in some parts where bamboo regeneration is good, effective disposing of huge quantity of raw material that is resulted from bamboo harvest, and maintenance of appropriate density of bamboo clumps.(i.e. at 400 clumps per hectare).

The sub committee also felt the need to urgently under take survey of elite types and collection of seeds to create of a clonal ground nursery. Protocols for micro propagation could be considered on priority.

Group 3: Group three discussed on **policy requirement for the utilisation of bamboo.**

Issues discussed centered around stakeholders, socio economic status of stakeholders, present policy on bamboo and its impacts, suggestions for modifications.

Stakeholders: the stakeholders for bamboo resources identified are,

- ◆ Local bonafide users such as farmers, agriculture labourers, land less people.
- ◆ Cottage industries situated in the locality and out side including artisans, weavers (*Medars*), agarbathi stick making firms.
- ◆ Large industries.
- ◆ Wild animals dependent on bamboo for food as well as shelter.

Present policy: Bamboo has been treated as any other forest produce in Uttara Kannada. There is some specific rules regarding bamboo extraction in protected area '(PAs)' and forest other than '(PAs)'. Also there is some variation in rates at which bamboo is supplied to different stakeholders. Protected areas are excluded from bamboo extraction like any other forest product. Bamboo is not being extracted from protected areas even if they are dead and dry.

Now, bamboo is extracted only from state forestlands outside the protected areas for meeting the demands. Only green bamboo poles are supplied to weavers or *Medars* and cottage industries at concessional rate. They are supplied to others at commercial rates. Dry bamboo is supplied to industries at a rate fixed by the government.

Modification suggested or suggestions in support of the policy:

These suggestions encompass only excess bamboo resources that will be available after flowering.

- Bamboo should be made available to bonafide users at a subsidised rate, such that the pressure on natural forests is reduced.

- Treating the poles with chemical can enhance the life of bamboo that is used for construction. Hence it is desirable that treatment plants can be established at village level (or VFC level).
- Keeping in view of the large surplus of bamboo available following flowering, supply of bamboo to industries may be promoted.
- Supply of bamboo for firewood purposes could be considered.
- Impart training on alternate occupation to those groups who are only dependent on bamboo so that they could generate their income during the non-supply period.
- Arrangements should be made to supply bamboo seedlings to farmers for raising bamboo plantations on private lands.

Perhaps the most crucial policy issue that needs to be addressed is consequences of non – extraction of dried bamboo from Protected Areas. The present policy does not allow the collection of any material from PAs such that wild life is not disturbed. However, the risk of fire hazard due to accumulation of dead bamboo could be so great that it might have a huge cascading effect on delicate ecological balance of the PAs. Hence there is a need to review/revise the present policy and suitably modify, at least to apply for this mast flowering years. A multidisciplinary monitoring cell should be constituted in the office of the Conservator of Forests to assess the different aspects of bamboo flowering and deal with the consequences. The experience would be useful in future.

Concluding session:

After presentation of each group the issues were discussed in panel point by point. Finally following recommendations were made to the government.

- ◆ In the previous bamboo flowering time that is during 1962 there was no clear policy and scientific management techniques for sustainability of the bamboo. Hence the area under bamboo has considerably decreased after each flowering period.
- ◆ Therefore this time in the coming three four years bamboo is going to get flower for about 1,50,000 hectares in Uttara Kannada district. Each five divisions in the canara forest circle should take action in advance to identify the flowering areas and identify experimental plots in order to have prior knowledge on sustainable harvesting methods.

- ◆ It is also recommended to find out any treatment to the bamboo so as to preserve it for longer duration since the amount of bamboo poles available after flowering is estimated as 20,00,000 tons in the district.
- ◆ Identify those areas rich in bamboo species for example 250 clumps per hectare of forestland. Within this it is recommended to harvest only those clumps in which number of clumps per clump is less (less than 100).
- ◆ To identify the place and timings of flowering it is recommended to take help of local people, school and college students.
- ◆ To collect and preserve from elite types for regeneration it is decided to collect seeds from good and strong bamboo clumps.

Participants:

Karnataka Forest Departments officers, members of Parisara Sanmrkshana Kendra, Scientists, representative from Indian Institute of Science, Staff, scientists and students of college of forestry and villagers participated in the workshop.

(A separate list of participants is attached in Appendix 1)

Appendix 1

The Participants List of Bamboo Workshop

Sl.No	Name	Organisation/occupation	Address
1	A.C.Laxman	Retired Forest Secretary	Bangalore
2	Dr.C.K.John	Scientist	NCL Pune.
3	Vinay Luthra	Forest Department	Conservator of Forests Canara circle, Sirsi
4	S.M.Puttabuddhi	Forest Department	Deputy Conservator of Forests Sirsi Division. Sirsi
5	Dr.Narendra Prasad	Scientist	SACON Field Station 21, Aekta Vihar Mohlapur, Dehradun, 248005 Uttaranchal
6	Dr.Vasudeva	Professor	College of Forests, Sirsi
7	Prof.K.B.Devar	Professor	College of Forests, Sirsi
8	Shivanand murthy	Forest Department	Deputy Conservator of Forests Yellapur Division, Yellapur
9	Vanashree Singh	Forest Department	Assistant Conservator of Forests, Sirsi
10	Prabhakar Bhat	Scientist	Centre for Ecological Sciences Sirsi
11	Ramesh Bhat	Scientist	Agriculture Research Station Sirsi
12	Anant Hegde	Farmer	Vanalli, Ta.Sirsi
13	G.S.Hegde Ajjibal	Ex - MLA(Member of Legislative Assembly)	Chowkimath , Sirsi-582401 UttaraKannada
14	S.G.Hegde	Chartered Accountant	SBI colony, Sirsi-581402
15	Pandurang Hegde	Prakruti	Chowkimath, Sirsi (U.K.)

16	Jairam Shigehalli	Farmer	Po: kalave Ta: Sirsi (U.K.)
17	Narasimha Hegde	Prakruti	Hulemalgi Brothers, Chowkimath, Sirsi
18	Shivanand Kalave	Farmer, Journalist	Po:Kalave,Ta:Sirsi, (U.K.)
19	Shailaja Goranmane	Reporter, television channel – <i>Udaya</i>	Marathikoppa road. Sirsi
20	R.K. Chopra	Business	General Manager, the West Coast Paper Mills Ltd, Dandeli
21	V. S. Bhat.	Project officer (BAIF)	BAIF Institute for Rural Developments, Habbu Circle Sirsi.
22	R.G.Naik	R.F.O.	R.F.O. Sirsi Range
23	Vijayananda	Reporter	Lokadhwani, Sirsi
24	Ravi Naik	Reporter	Janamadyama, Sirsi.
25	D. G.Hosamane	Business	W.C.P.M WD Dandeli
26	Aravinda. Kothal	BPO	BAIF, Dasanakoppa
27	Vipin Singh	ACF Siddapur	C/o A.C.F. Siddapur Sirsi , U.K.
28	B.Basappa		CF, MPM. Shimogga
29	M.U.Hosamane	CF,MPM Engineer & Environmentalist, Ecologist	'Matashri' behind Padmashri Sirsi
30	Satish M. Hegde	Lecturer	M.E.S. College of Commerce
31	G.S.Hegde	Deputy Conservator of Forests	Technical Assistant to CFKC Sirsi
32	Girish H.V.	Lecturer	College of Forestry Sirsi
33	B.N.N Murthy	Forestry student	College of Forestry Sirsi

34	D.Raghu	Forestry student	College of Forestry Sirsi
35	Veerabasavant Reddy	Forestry student	College of Forestry Sirsi
36	Rajesh Nayak	Farmer	At;Kuntagani,Po:Achave, Ta;Ankola-581344U.K.
37	Balakrishna Hegde	Reporter	U.N.I. District. Reporter Sirsi
38	P.K.Pai	R.F.O.	Dandeli.
39	Manjunath. L.	Student	Forestry College. Sirsi.

Appendix 2

Flowering of bamboo

And sustainable conservation of the resource

C. K. John and R. S. Nadgauda
Tissue Culture Pilot Plant
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Pune 411008 India.

Introduction:

Bamboos have a very long history of being a versatile and widely used natural resource (Mc Clure 1966). In India, like in many other countries rich in bamboo resources, they have innumerable uses in the daily lives of people, both rural and urban (John and Nadgauda 1995, 2001). At present, bamboos constitute a group of highly sought-after industrial raw material. India has over 130 species of bamboos belonging to about 24 genera (Sharma 1987), occurring in an area of about 9.59 million hectares, i.e. about 12.8% of the forest-land in the country. The world annual production of bamboo has been estimated at 10 million metric tonnes. In India, the annual production of bamboo is around 3.2 million metric tonnes. Of this almost 99% come from natural forests and only about 1% is derived from plantations. With the increasing industrial uses, the demand for bamboos is expected to increase sharply. By the year 2015, the shortfall in the production and demand of bamboo resources in the country is projected at 10.24 million metric tons. Large-scale cultivation and sustainable extraction is the only way in which further depletion can be prevented, and a constant supply of raw material can be ensured. One aspect of bamboo biology that can play havoc with the sustainable extraction of bamboos is their peculiar behavior of flowering and seeding only once at the end of very long vegetative growth phases and dying afterwards. There are many misconceptions about bamboo flowering. A better understanding of the current scientific knowledge about bamboo flowering will be useful in better planning to meet the challenge posed by gregarious flowering of bamboo forests spread over thousands of hectares.

The peculiar flowering behavior of bamboos

One of the distinguishing features of most woody bamboos is their behavior of flowering and seeding only once at very long intervals and dying afterwards. This

peculiar behavior of bamboos has intrigued mankind for long and still remains a mystery (John et al. 1995). Brandis (1899) classified bamboos into three categories based on their flowering behaviour: (i) species which flower annually or nearly so (mostly herbaceous bamboos), (ii) species which flower gregariously and periodically, and (iii) species which flower irregularly. Most of the economically important woody bamboos belong to the second category (e.g. *Bambusa arundinacea*, *Dendrocalamus strictus* etc.) and few to the third category (e.g. *Bambusa vulgaris*). Many bamboos which flower gregariously at the end of species specific inter-mast periods, also flower sporadically. Sporadic flowering usually involves only few culms of a clump, or a few clumps in a population (Sharma 1994, John et al. 1995). Sporadic flowering is very common in *Dendrocalamus hamiltonii* to the extent flowering occur somewhere in almost every year and seed is available. Sporadic flowering occurs at times in *Bambusa arundinacea* and *Dendrocalamus strictus*.

There are two widespread misconceptions about bamboo flowering. The first one is about the rigidity of flowering cycle (i.e. all members of a species flower simultaneously, wherever they happen to be). This is not wholly correct. Flowering in mast crop of a species or cohort occurs in three or more consecutive years (Seifriz 1920, Deogun 1937). Of these, the median is the main mast flowering year when a vast majority of the clumps flower, and there are preceding and succeeding tails of one or more years when few clumps flower (John et al. 1995). Generally this aspect of the distribution of flowering in a mast crop of bamboo is not given due importance (Janzen 1976, John et al. 1995). Kawamura (1927) reported a distribution of flowering and seeding in *Phyllostachys henonis* population in Japan over a period of 10 years; i.e. 1903-1912. A similar distribution is reported in *P. bambusoides* also. More recently, Widmer (1997) has reported a similar temporal sequence of flowering in *Chusquea* species. The second misconception is about the death of the flowered clumps. There are few reports of revival after flowering, and a belief that flowered clumps can be revived. After flowering (and seeding) three types of mortality behavior are known in bamboos: (i) flowering does not result in the death of either aerial or underground parts (e.g. some species of *Arundinaria*, *Phyllostachys*, *Bambusa atra* etc.), (ii) flowering results in complete death of aerial parts, but the rhizomes remain alive and regenerate (e.g. *Arundinaria amabilis*,

A. simonii, *Phyllostachys nidularia*), and (iii) flowering results in complete death of both aerial and underground parts, and regeneration is possible only from seeds (e.g. *Bambusa arundinacea*, *B. tulda*, *Dendrocalamus strictus*, *Melocanna bambusoides*, *Thyrsostachys oliveri* etc.). In our experience (with clump forming bamboos of the tropics), most bamboos die after flowering and seeding. Death of the flowered clumps per se may not be a peculiarity of bamboos, but an extension of similar behavior very common among grasses (John et al. 1993).

In most of the woody bamboos, which flower gregariously at the end of long inter-mast periods, the sequence of events is as follows: gregarious flowering of bamboos starts in September-October, immediately after the rainy season. Initially there are many young inflorescence. Within few weeks whole clumps get transformed into huge inflorescence. There is wind pollination and seed-set. Over a period of 5-7 months a large quantity of seeds is produced. Then there is the very rapid and crucial transition from summer to the rainy season. By the onset of the rains bamboo seeds germinate in a few days, resulting in a lush green carpet of bamboo seedlings below the parent clumps. The flowered clumps die, break and collapse. Cutting culms from flowered clumps by the end of summer (just before the onset of the rainy season) results in profuse coppicing in the rainy season, followed by flowering and seeding (John et al. 1995).

Bamboo flowering as a catastrophe

From time immemorial many believes are associated with bamboo flowering. In general bamboo flowering is considered as bad omen. Mention to this can be found in 'Mahabharata' written more than 5000 years ago. People in many bamboos growing area believe that bamboo flowering is the harbinger of natural calamities such as famine, epidemics and landslides.

Though famines are common after the gregarious flowering of bamboos in some east-Asian countries like Myanmar and Japan, and also southern Africa, in the Indo-Myanmar frontier tract, especially in Mizoram, they cause much devastation. The scientific community, in general, perceives a connection between bamboo flowering, increase in rat population and famines, as hypothetical (Nag 2001). From our

observations of the flowering of natural bamboo stands for the past many years, we feel that this belief may not be a myth but may have some basis (John and Nadgauda 2002). By the end of summer (last week of May – first week of June) there is enough seeds on the forest floor. The abundant supply of seeds attracts seed predators, mostly rats. Germination of bamboo seeds into seedlings by the onset of the rainy season deprives the rats of their abundant food supply and forces them out of the forest. They devour standing crops and grains stored in granaries, and precipitate famine. It is reported that after gregarious flowering of bamboos, farmers face problem protecting their crops (Bennett and Gaur 1990).

Epidemics are also known to occur after gregarious flowering of bamboos. Since there is a many-fold increase in rat population, a concurrent incidence of epidemic diseases of which rats are vectors is possible. As the flowered bamboo clumps die, the soil bound by their roots and rhizomes lose this binding and become susceptible to landslides.

The apprehension that forest fires are possible after the gregarious flowering and death of bamboo clumps is not totally misplaced. There are reports of a linkage between death of bamboo clumps after flowering, occurrence of wild fires and seedling recruitment. For example, Kadambi (1949) reported “fierce forest fires followed the death of bamboo to be accompanied almost immediately thereafter by copious natural regeneration”. Recently, Keely and Bond (1999) have forwarded a hypothesis that “delayed reproduction, mast flowering and semelparity are character syndrome selected to promote catastrophic wild fires, which open forest canopies and maintain the early successional stages necessary for seedling success and long-term persistence of clones.” Whether forest fires are, part of a character syndrome selected by bamboos for opening up the forest canopies, and maintaining the early successional stages necessary for seedling success and long-term persistence of the clones, or a result of accumulation of large quantities of dry matter in the forest after the flowering and death of bamboo clones, is debatable.

Harvesting of bamboo culms

Felling cycle, felling intensity and method of felling are important factors in the management of bamboo forests. The general felling rules (based on observations on

Bambusa arundinacea and *Dendrocalamus strictus*) as given by Seethalakshmi and Muktesh Kumar (1998) are:

1. Culms are cut as per a thinning out principle so that the remaining culms are distributed around the young shoots preventing their bending.
2. Unless damaged or infected, immature culms are not cut.
3. Clumps are considered mature for harvesting if it contains more than eight mature culms.
4. In a mature clump, culms of the current season and eight culms of the previous years are retained after the harvest.
5. Old and deteriorating culms which cannot last for one more felling cycle are cut before any good culms are harvested.
6. As cutting of the culms towards periphery restricts the outward growth of the clump, cutting along the periphery be avoided.
7. Culms are cut at a height of 15-30 cm from the ground.
8. As it results in wastage and clump congestion later (due to sprouting of buds) leaving stumps of 60-90 cm be avoided.
9. Flowered culms/ clumps are cut only after the seed fall is completed.
10. Tending operations (cutting of any malformed, dead, diseased or otherwise useless culms/ stumps and climbers) are carried out along with felling.

However, impending flowering is an emergency and need a radically different approach. Death of bamboo forests after gregarious flowering results in much loss, and precipitates an ecological crisis. To devise a method for the harvest of bamboo on the face of an impending gregarious flowering, the following points may have to be taken into account:

1. In the season just before flowering bamboo clumps show reduced (or even absence of) culm production and culm vigour. This can be considered as a signal of impending flowering.
2. Mature bamboo culms harvested before flowering are strong and are known to have a density between 500-800 kg/m³. Bamboo culms grow during a few months. Structural modifications take place in a maturation period of 1-2 years. In older culms further changes such as cell wall thickening of the living fibers, and parenchyma by the formation of additional layers, occur. This is known to

influence the physical and mechanical properties of the culms (Liese and Weiner 1997). However, after flowering the culms lose their strength and break easily. Though scientific studies on this aspect are scanty, Kitamura (1975) has reported significant reduction of both specific gravity and strength properties of flowered culms of *Phyllostachys heterocycla* var. *pubescens*. Such culms are unsuitable for the normal uses to which bamboo culms are put.

3. The gregarious flowers of bamboos produce large quantities of seeds. It is reported that "A 40 square yard clump of Indian *Dendrocalamus strictus* can produce 320 pounds of seeds, and there are 800-1000 seeds to an ounce" (a quote from Janzen 1976).

As the country is facing a shortfall in the production and demand of bamboo resources, harvesting bamboo culms without compromising the regeneration can greatly contribute to the demand for bamboos to be met from the natural forests elsewhere. Younger culms (of the past 2-3 years) may not be useful for any purpose and can be allowed to flower and seed. Harvesting of culms can reduce the seed production which otherwise results in an increase in the rat population, leading to standing crop/stored grain damage. As a single clump produces very large quantities of seeds the removing substantial quantities of culms may not compromise regeneration. But this needs to be done after ascertaining the impending flowering and also taking into consideration the spatial distribution of the bamboo clumps in the forest. Harvesting the culms by the end of summer can also be another option as this will result in coppicing, flowering and seed-set which can help regeneration. Cutting the culms above 2-3 lower-most nodes can be beneficial as this will help in bud-break and branching in the ensuing rainy season, further increasing the seed production. Harvesting a substantial quantity of bamboo culms from forests facing impending flowering can greatly reduce the accumulation of dead and dry culms in the forest and lower the chances of forest fires.

Though achieving natural regeneration can be one of the methods of afforestation, in bamboos it can result in catastrophic gregarious flowering at periodic intervals (say 30, 40, 50 years). Other alternative is to afforest with many clones, which have varying inter-mast periods. Efficient biotechnological methods are now available for mass propagation of bamboos (John et al. 1997, Nadgauda and John 2000).

Appendix 3

Bamboo flowering, a challenge. A.C. LAKSHMANA I.F.S.(Retired)

(Former secretary to Government of Karnataka)

The oldest reports with 4 gregarious flowering of *Dendrocalomus strictus* details are available from Madhya Pradesh (A.P. Dwevedi 1980 and Ramprakash 1990)

Area	Year of gregarious flowering recorded				Physiological Cycle years
	1900	1921	1946	1987	
Mandla south		(21yrs)	(25yrs)	(41yrs)	29
Seoni	1921	(18yrs)	(25yrs)	(26yrs)	23

Though the physiological cycle can be recorded as 29 years and 23 respectively there is variation in each area ranging from 18 years to 41 years interval in flowering cycle.

Distribution: -

Bamboo is found distributed from sea- level to *Mullianagiri* in Karnataka. It is found in the dry district of *Bellary- Sandur* to the wetter part of Karnataka *Sringeri*. Though it was not found growing naturally. It has been introduced to the plantation at *Bidar, Bijapur* and *Gulbarga* district. Bamboo's also found in private lands and back yards of the houses. Their area and quantity is not available. My efforts were feeble.

Species list of Karnataka

- 1) *Dendrocalamus strictus*.
- 2) *Bambusa bambos*
- 3) *Oxyera stockiitenanth*
- 4) *O. monostigma*
- 5) *O. nigrociliata*—South Canara and Meccera.
- 6) *Ochindra talbotii*
- 7) *O. reedet/ scriptoria*
- 8) *O. setigera*—new report from Bandipur.

9) *Teinostachyum beddomet*

Exotic.

- 1 Dendrocalamus
- 2 B. polymorpha
- 3 Vulgaris
- 4 B. wamin

Private collectors of bamboo in Karnataka.

- 1 Shri Manerikar- Khanapur
- 2 Devangi prapulla chandra - Shimoga
- 3 Dr. Soans - Moodabidre
- 4 K.U. shetty - Chikkamagalore
- 5 A.C. Lakshmana - Bangalore.

Bamboo plays an important role in the welfare of the society. Anything happening to bamboo will have a great impact on the economical, social, environmental and employment generation.

a flowering or seed setting not reported -- *Sasa tesellata*

No flowering in 115 years. *Stocksii vulgaris*, *B. atra/kurzii*,
Arundinaria wightiana

b annual flowering – no death of *Ochlandra ebracteata*, *b. liniata costant flog:*

c flowering at long interval / gregarious flowering – *B. bambos*

Dendrocalamus strictus.

d) Overlapping category – others.

Bamboo is reported 3000 years in the vedic period and again in *koutilyas arthashastra* 2400 years back.

The earliest record of flowering is reported from Japan during 83 *Phyllostachys henosis*, *Ditrich brandis* reported during 1899.

Prominent among others who have reported are, Troup – 1921, blatter – 1929, Osmaison 1934, N.deogn 1936, kadambi 1949, Ueda 1960, meclure 1966, Janzen 1976, Deshmukh and Kureshi-1980, kudas-1980.

Recent reports include that of Banik- Bangladesh, Thammincha-Thailand, Bettyshor U.S.A. Trevedi , Ramaprakash and Lakshamana – India.

Only three people had the distinction of reporting bamboo flowering more than once.

1) Parodis documentation of *Guda trinii* flowering during 1955, 1985, 30 years interval is really unique.

2) Raizada's report on three generations of *Bambusa copelandii* his and his predecessors notes during 1896, 1943, - 48 years interval.

3) Serfriz observed flowering of *Chusouea obtifolia* based on circumstantial evidences 1884-85, and 1918-19 - interval of 32 years.

4) Threat - Karnataka loss of soil and moisture leading to the deterioration of the health of the soil. Habitat destruction leads to shrinkage of forest. Food of ungulate primate's, elephant etc. is affected. Pandas - China. Livelihood of medars and others is affected.

Disaster in north-east: Karnataka is better equipped to carry on the research studies - willing and dedicated people, research institutes to support, climate and environment. Bamboo plantation in Thailand 130 million U.S. dollars.

Recommendation -- proposed

- 1) There is urgent need to assess the current area under bamboo in government lands and private lands and its growing stock. Productivity, utilization, and market problems.
- 2) Scientific management of bamboo areas requires attention. This includes bamboo flowering and regeneration -- natural.
- 3) Increasing durability and manufacturing of value added products require attention.
- 4) Bamboo research should be strengthened particularly in the field of conservation, management, flowering, regeneration and value added products.

Action plan -- proposed

- 1) Collecting historical evidence of flowering of some species of bamboos of Karnataka.
- 2) Laying down experimental plots in each division and make independent observation. This will help both as a demonstration plot and also helps in drawing correct inferences.

Observe flowering and regeneration process.

Mark early flowering and late flowering and seeding clumps.

Identify and mark superior genotypes and collect seeds or planting material from them – maintain records for them properly.

- 3 Storing of bamboo and giving proper treatment to them is a priority work.
- 4 Understanding mysteries of flowering – biological clock is essential.
- 5 Framing proper policies keeping in farm – forestry farmers interest in view.
- 6 Supporting bamboo society of India by active participation by public.

We have meet at the time, at right place, in the middle of the right people. Let us work like a team. Individual, brilliance dose not counts much.

Appendix 4**SUSTAINABLE HARVESTING OF BAMBOO – PULP AND PAPER INDUSTRIES PROSPECTIVE**

R.K. Chopra,
General Manager – Raw Materials,
The West Coast Paper Mills Ltd.,
Dandeli – 581 325,

Of late, Pulp and Paper Industry have shifted their choice of ligno-cellulosic raw material from Bamboo to Wood species viz. Eucalyptus, Casuarina, Subabul and Acacia due to inherent advantages; more particularly when survival of the industry is threatened due to global competition.

There are many advantages in using fast growing Pulpwood over Bamboos and some are enumerated below. This change has mainly come due to stringent pollution control norms and many user industries feel that Bamboo is not an environmental friendly species for manufacture of Pulp and Paper.

Disadvantages of using Bamboo:

1. Requirement of cooking chemical is more by 2%.
2. Due to low bulk density production per digester reduces by 10%.
3. Requirement of bleaching chemical is more by 2%.
4. Silica present in the Bamboo reduces the efficiency of Evaporators. Hence, more energy is required to concentrate the liquor.
5. More refining is required to make the formation smooth.
6. Pollution load increases.
7. Optical properties are much better in short fibered pulp when compared with the Bamboo Pulp.

Advantages of Bamboo :

1. Strength properties are much better compared to the Paper produced from Pulpwood.

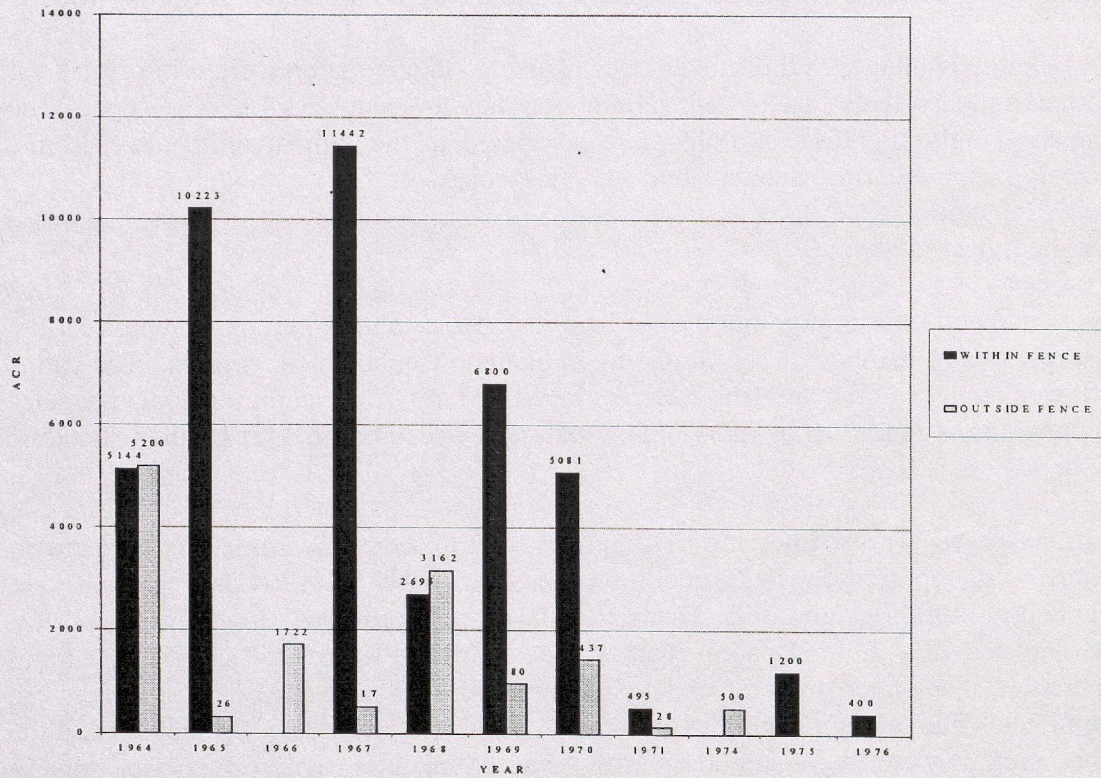
If overall advantages and disadvantages of using Bamboo is converted into financial terms, industry feels that by using Bamboo; has to spend Rs.1,000/- (Rupees one thousand only) Per MT of Pulp more compared to the Pulp manufactured from . Eucalyptus, Casuarina, Subabul and Acacia species.

Flowering in Karnataka:

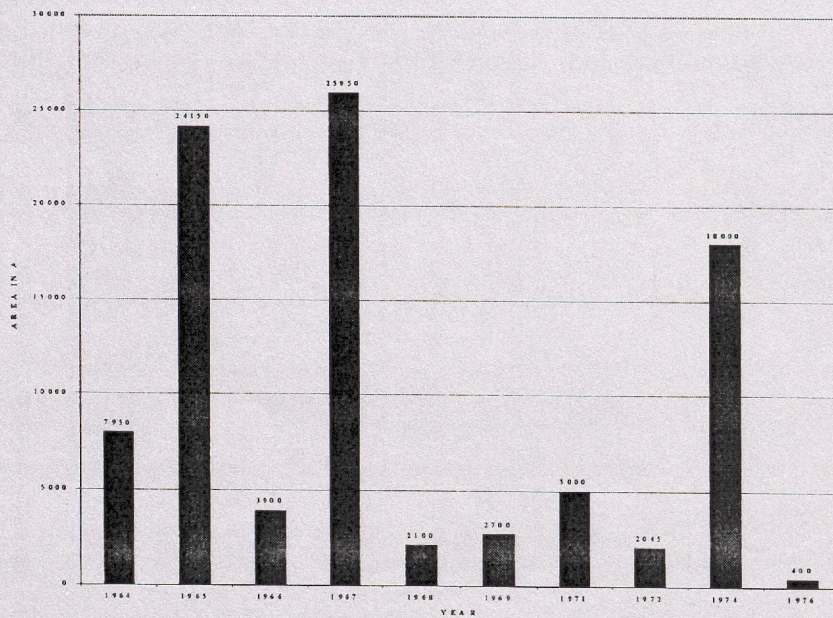
India is endowed with a large number of bamboo species and is perhaps having world's largest reserves of bamboos. The flowering in bamboo is a botanical enigma. The culms that flower often die after the fruit has developed. Many of the common Indian species have populations made up of individuals, that seed synchronously at regular and long supra-annual intervals.

In Karnataka gregarious flowering of *Bambusa arundinacea* now named as *Melocanna baccifera* was reported in 1922 and then in from 1959 to 1964 and presently in Chickmaglore, Shimoga and other Districts. During 1959 to 1964 flowering, The West Coast Paper Mills Ltd., Dandeli had taken enormous steps to save the natural regeneration of Bamboo by way of fencing the area over an extent of 90000 acres in Yellapur and Haliyal Divisions. Apart from the above, wherever the density of the Bamboo clumps were less than 200 clumps per acre, replanting with offsets was done in 43000 acres in fenced area and 14000 acres outside the fenced area. For proper development of clumps, soil working was done in the month of May/June i.e. when pre-monsoon showers are received and 25 grams of fertiliser containing NPK was given to each clump during August/November and severe fire protection measures were scrupulously followed.

HISTOGRAPH OF BAMBOO (DOWGA) PLANTATION RAISED
BY THE WEST COAST PAPER MILLS LTD., DANDELI



YEARWISE FENCING WITHIN CONCESSION AREA
OF BAMBOO TAKEN BY WCPM



With the above operations, profuse growth of Bamboo was established and can be seen in the concessional areas allotted to The West Coast Paper Mills Ltd., Dandeli even today.

Pre-harvesting Precautions:

The area which is due for flowering should be identified in advance and compartment lines, fire lines and other lines if not properly maintained should be cleared from all under-growth and control burning in the month of December may be given. The fire lines should be continuously kept clean from debris, under growth and leaf litter. Prior to the flowering of clumps, silvicultural felling as usual should be carried out and congestion amongst the culms, if any, should be removed by harvesting dead, dying, diseased and malformed culms. Over grown branches should be removed scrupulously, which will facilitate clear filling of clumps after the flowering and seeding is over. Harvesting of the Bamboo culms should not be permitted after the onset of flowering.

Post harvesting Precautions:

Compartment and fire lines should be always kept clean and grazing in the area should be totally banned, debris produced while clear filling the clumps should be evenly spread or collected at the open place.

Some of the Recent Bamboo Flowerings:

1978-79	-	East Melghat Division, Maharashtra
1981-82	-	Chandrapur District in Maharashtra
1987-88	-	Sironcha Division, Maharashtra
1993-94	-	Bhamragarh Division, Maharashtra
2000-2001	-	East Melghat Division, Maharashtra

1981-82 flowering:

During September 1981, all of a sudden the swollen nodes were observed on Bamboo culms and in the month of October the flowers started emerging from the nodes and within a month entire area about 60 to 70% gregariously flowered. Silvicultural working was immediately stopped. Shedding of leaves was noticed in the month of December 1981 and control burning was given in the month of December. Adequate fire protection measures were taken by way of cleaning compartment and other intermediate lines.

The flowers ripe to the seeds in April and May and starts falling from the branches. The germination of the seeds can be observed in moist places in May itself. If fire occurs just after the seed falling, the seed is liable to be totally burnt. In well-protected areas, germination is profuse and the whole ground is carpeted with the seedlings after rain.

The seedlings, though they come up in millions in the first year, start competing ruthlessly amongst themselves for survival. The struggle for existence is more severe

among themselves than with the other species of vegetation. The thinning out process of nature gradually spreads and seedlings get apart, and finally establish at a respectable distance from each other.

Fire, grazing, repeated hacking of young culms, trampling of rhizomes by cattle, removal of new shoots by men and monkeys and damage by elephant's result in congested clumps, and, thus, its growth is retarded. If protected from these agencies, the growth is normal.

Following points should be taken care of to maintain sustainability.

1. Planting bamboo species other than the one growing considering future requirement of locals and industrial need.
2. Initiating bamboo plantations so that in the event of large scale flowering of bamboo, alternate source is available.
3. Growing species from different cohorts to avoid occurrence of gregarious flowering of the present magnitude.
4. Conducting multi location bamboo cultivate trials for identifying suitable material for plantation program.
5. Planting species other than bamboo for overall growth of the area.
6. Protecting bamboo flowering area against fire and grazing for three years to stimulate regeneration.
7. More stress to be given for home grown Bamboo from different regions.

Silvicultural Working and Productivity:

To maintain sustainability in the production of Bamboo, silvicultural rules are of prime importance and it should be adhered scrupulously, failing which the productivity of Bamboo forest goes down and sustainable production of Bamboos becomes a casualty. The silvicultural requirement of Bamboo clump is that all mature culms should be harvested, as mature culms do not play any role whatsoever in further production of the new culms. It is observed that when mature culms are harvested; new culms are emerged from the rhizomes which at times are equal to the mature culms harvested and in the next rainy season the production of new culms is almost half and the third year only few culms are noticed and again when harvesting is done at a rotation of three years the cycle is repeated and productivity is maintained.

The best period for harvesting is between October & February when the starch content in the Bamboo culms is at the lowest. In other season when starch content is more, it is susceptible to all sorts of diseases and infections.

Appendix 5

**WORKSHOP ON BAMBOO FLOWERING
PROGRAMME DETAILS**

MARCH 16, 2002. FOREST IB, SIRSI

10 AM TO 10.30 AM	REGISTRATION AND INAGURATION	(30 MINUTES)
10.30 TO 10.45 AM	TEA BREAK	(15 MINUTES)
10.45 TO 11.15 AM	SHRI A.C.LAKSHMANA	(30 MINUTES)
11.15 TO 11.45 AM	DR NARENDRA PRASAD	(30 MINUTES)
11.45 TO 12.30 PM	SHRI R.K.CHOPRA	(30 MINUTES)
12. 30 TO 1 PM	DR.C.K.JOHN	(30 MINUTES)
1 TO 1.30 PM	DISCUSSION & FORMATION OF GROUPS	(30 MINUTES)
1.30 TO 2 PM	LUNCH	(30 MINUTES)
2. TO 3 PM	DISCUSSION IN GROUPS	(60 MINUTES)
3 TO 3.15 PM	TEA BREAK	(15 MINUTES)
3.15 TO 4.15 PM	PANEL DISCUSSION	(60 MINUTES)
4.15 TO 4.30 PM	TEA BREAK	(15 MINUTES)
4.30 TO 5.30 PM	CONCLUDING SESSION	(60 MINUTES)

NOTE: Each speaker as well as participants to discuss on the basic issue of flowering of bamboo, management options during the flowering and the policy interventions required towards sustainable use of the resource.