CONSTRAINTS TO PRODUCTION OF BAMBOO AND RATTAN

INBAR Technical Report No. 5

CONSTRAINTS TO PRODUCTION OF BAMBOO AND RATTAN

With special reference to planting materials and management of natural stands

Report of a Consultation held 9-13 May 1994
Bangalore, India

Co-sponsored by

International Network for Bamboo and Rattan (INBAR) and
Khoday Biotek, Bangalore

INBAR
New Delhi
1994

FOREWORD

The publication of these proceedings marks an important step in INBAR's evolution, since it sets forward a number of proposals for priority research in two important areas.

INBAR is a network that relies heavily on the inputs from the members of its working groups, which are composed of senior scientists from premier research institutions across Asia. Most have already had years of experience with IDRC-supported bamboo and rattan research projects over the past fourteen years. The creation of INBAR in 1993 aimed to take research on bamboo and rattan to a higher plane - one involving research collaboration across the region, between scientists from different institutions in different countries, linked by common interests.

INBAR's Production Working Group met in Bangalore, India in order to address two major issues: *delivery systems for planting materials* and *sustainable management of natural stands*. These topics had been identified by INBAR's secretariat in response to various activities conducted during INBAR's first six months. The papers included in this volume have been rigorously edited so that this will be a significant and lasting contribution to the literature on bamboo and rattan.

INBAR wishes to acknowledge the contributions of Khoday Biotek, co-sponsor of the Bangalore consultation. In particular, Dr. I.V. Ramanuja Rao assisted in a significant way with local arrangements. We are also grateful to two members of IDRC's Board of Governors, Dr. Vulimiri Ramalingaswami and Mr. Brian Felesky, for joining us for the first morning's deliberations. In addition, Mr. Shantanu Mathur from the International Fund for Agricultural Development (IFAD) in Rome not only confirmed IFAD's support for this network activity, but willingly chaired one of the scientific sessions. Finally, we thank the participants for their active involvement and contributions to a successful consultation - one that may serve as a model for future INBAR meetings.

The real challenge still lies ahead of us - to pursue action programmes on each of the priorities identified.

Paul Stinson
Manager, INBAR

December 1994

CONTENTS

INTRODUCTION

1. The Research Advisory Group of INBAR, meeting in December 1993, noted that two areas relating to production of bamboo and rattan needed in-depth assessment. These were propagation and supply of planting materials and the sustainable management of natural stands. As a result, the INBAR Production Working Group and the Secretariat organised a research consultation in Bangalore, India, 9-13 May 1994. The agenda and list of participants is shown in Appendices 1 and 2.

2. Local arrangements for the consultation were made by Khoday Biotek, a private company in Bangalore, which kindly co-sponsored the week's activities.

3. Participants included experts from national programmes in Asia, resource persons, and representatives of international organisations and programmes: Food and Agricultural Organization of the United Nations, FORSPA and FORTIP; Consultative Group on International Agricultural Research, CIFOR and IPGRI (IBPGR); and the UN International Fund for Agricultural Development (IFAD).

4. The consultation was opened by Dr. Cherla B. Sastry of the International Development Research Centre (IDRC), the New Delhi office of which houses the INBAR Secretariat. IDRC is one of the major donors to INBAR and two Governors of IDRC welcomed participants and expressed their interest in the objectives and action of the network.

5. Prof. J.T. Williams, Science Adviser to INBAR, provided a background to the meeting and expected outputs (Appendix 3). He stressed that ecosystem conversion for bamboo and rattan harvesting and production has resulted in short-term economic gains but at the risk of long-lasting environmental damage. Both topics of this consultation are relevant to a wide range of land utilisation patterns.

6. For bamboo planting materials, the major constraint to raising more plantations is the limited availability of seed. A range of propagation techniques is currently in use, including for some species mass propagation through tissue culture. The consultation was asked to focus on the opportunities to quickly establish reliable delivery systems of planting materials. For rattans, seeds are usually available, and in recent years nursery techniques for a limited number of species have been standardised. However, much more research is needed in relation to seed handling and prolonging viability. Although some research has been carried out on tissue culture of rattans, cost-benefits seem to favour continued use of seeds despite tissue culture being a step forward in reducing unwanted heterogeneity in plantings and permitting more rapid genetic enhancement.

7. On sustainable management of the anthropogenic stands of bamboo and rattan, the lack of ecological research was highlighted. Strategic research is relevant to degradation and depletion of forest resources, restoration of specific ecosystems, standardisation of extractive economies and conservation of genetic resources.

8. Most management practices are traditional and have been applied locally. Very little enrichment planting has been attempted even when more exotic materials might be much more productive. For both bamboo and rattan almost nothing is known about population structures or how spatial heterogeneity affects population persistence. Closer linkages between research in this area and population genetic theory will help much-needed genetic enhancement.

REPORT

PROPAGATION AND SUPPLY OF PLANTING MATERIALS

9. Presentations concentrated on methods of propagation of bamboo rather than rattan since priority species of the latter are at present adequately propagated through seed. However,

discussions on integrating methods and considerations of better delivery systems included rattans. Specific Working Groups were established to consider recommendations for further strategic research as well as recommendations on other actions which would enhance production.

10. Mrs. A. Zamora (Philippines) provided an overview of micropropagation. This overview included literature reviews and summaries of recent developments (Appendix 4A).

11. For micropropagation, species and methods were summarised. So far, 20 genera and 73 species of bamboos have been researched under *in vitro*. Almost all the genera listed as INBAR priorities were mentioned. Tissue culture methods are still influenced by different responses of clonal tissues, different responses using juvenile or mature plants, or by collection at different seasons. Rooting responses are poor in certain species. It is clear that researchers in this area should concentrate their efforts to bring the existing protocols to the technology level. Recent research has also opened the possibility of creating artificial seeds in an important commercial species, *Dendrocalamus strictus*.

12. Tissue culture derived plantlets tend to be more convenient to transport than traditionally multiplied materials. In bamboo, there is also a tendency for plantlets from tissue culture to show early rhizome development in the nursery, an added advantage; and establishment and growth in the field is faster. In a limited number of species, tissue culture technology is being used for mass propagation. Dr. Dhawan (India) outlined technology currently used for *Bambusa tulda*, and *Dendrocalamus longispathus*. *Bambusa vulgaris* is also under study because although the two other species are available for mass propagation, this species can only be provided on a laboratory scale. She also highlighted the advantages and disadvantages of micropropagation of seed/seedling explants versus adult tissue explants. (Appendix 4B)

13. Miss Ramanakaye (Sri Lanka) outlined tissue culture

research in her country aimed at propagating *Bambusa vulgaris* and *Dendrocalamus giganteus*, the two major species, as also the potential for *Dendrocalamus asper* in view of demand for bamboo shoots by the tourist industry. She vividly pointed out that research in Sri Lanka, and elsewhere, should also be linked to:

- Introduction of good quality exotic species, and
- Rapid multiplication of superior genotypes.

14. Dr. R.L. Banik (Bangladesh) reviewed conventional propagation research in bamboo (Appendix 5). Six vegetative methods:

- Clump divisions
- Whole culm cuttings
- Layering
- Culm-segment cuttings
- Branch cuttings
- Macroproliferation

have been studied in different countries of Asia to develop propagation suitable for important local species. Additionally, propagation through seeds is widely used but there is often unpredictable availability of seeds; as a result, research on optimal methods of seed collecting and seed handling have been neglected.

15. No one conventional method of propagation is universal and effective for all species of bamboo. Each carries its own inherent risks, e.g. sexual propagation could result in death of stands by flowering before products are marketable and vegetative propagules result in a lesser productive period. Hence the development of appropriate strategies must be linked to a number of other considerations:

- Wider availability of materials. Germplasm collections and their representativeness are inadequate.
- More attention should be paid to flowering periodicities, since there is a degree of genetic control.

- Regional genepools need to be developed using a clear set of criteria.

These considerations are important to the development of the INBAR network.

16. With the current state of knowledge, it is possible to summarise research on various methods of vegetative propagation by informing scientists of the most appropriate method for each species. These should be linked to given conditions because they have to be cost-effective and reliable since rural farmers do not divorce technical matters from socio-economic implications.

17. The urgency for effective delivery of planting materials was highlighted by Dr. V.V. Srinivason (India) who stressed that the majority of natural stands of bamboo are overexploited and may show problems of re-establishment after flowering since fires and grazing prevent regeneration. In India, current demand for bamboo stocks are 90-120 million seedlings per annum but this is expected to increase to up to 300 million per annum. The key to success will be cost-effective, simple plant propagation techniques. These considerations are applicable to other countries. (Bamboo makes up 12.8% of India's forest areas).

18. Dr. I.V. Ramanuja Rao (India) focused his presentation on the need for a variety of delivery systems taking into account availability of suitable planting materials and the logistics of producing propagules in a centre and transporting them to planting sites (Appendix 6). Propagation has to produce large numbers in a short time, make these available on site and they must be of field plantable age. The three benchmarks for a successful method are cost-effectiveness, reliability and quality of materials, and delivery on time. Two types of propagation can be considered: mass propagation combining conventional and *in vitro* methods. Mass propagation tends to be slow although relatively inexpensive; rapid propagation is faster but more expensive. Decision-making options, therefore, have to weigh financial, social and environmental considerations as well as the time frame.

19. Although protocols for a limited number of high priority bamboos are at the stage where *in vitro* technology can be commercialised, this will not happen until an organisation like INBAR provides clear information. Past problems of unwillingness of scientists to share details of laboratory methods, lack of ready information on technical experts and almost total lack of research on social and environmental benefits and profits hamper the uptake of rapid propagation technologies by production agencies. Participants were asked to discuss how best INBAR could address these constraints - might be through a small expert group.

20. Dr. Rao also summarised the state of the art on tissue culture of rattan. This is not currently a viable alternative to propagation by seed when it is 100 per cent certain that seed can be obtained, and seed set is often very high. The constraint for rattan is seed storage. However, there is need for continued tissue culture research since it is often difficult to obtain viable research material, unless located near locally seeding material, and also tissue culture is a useful transfer system. For rattans, multiple shoots can be produced from the collar region of the seedling and somatic embryos can be produced; however the sub-culturing process cannot be continued for long and it is necessary to keep going back to seeds. Tissue culture of rattans will become more important as a tool in genetic enhancement.

21. Discussions on delivery systems identified the following as important:

i. Source of materials; quality and quantity of propagules.

ii. Systems should be linked to genetic enhancement, wherever possible.

iii. Systems and products have to have wide acceptability.

iv. Economic options need to be studied.

v. Systems and resultant wider planting have to be linked to conservation.

22. The following emerged during discussion as constraints:

- *Source of materials*
  - Seed collecting methods need upgrading since they lead to loss of viability.
  - Current lack of shared information by national programmes leads to poor knowledge of who holds what meterials.
  - Current lack of shared information on identification of quality planting meterial.
  - Current lack of predictability on availability of materials due to poor storage techniques.
  - Knowledge of appropriate propagation is scattered in the literature.
  - Information on mass/rapid propagation is not readily understood.
- *Links to genetic enhancement*
  - Genetic enhancement and ultimate cultivar development is not widespread.

- *Acceptability of materials*
  - There is some suspicion by foresters of tissue culture derived plantlets.
  - There is a lack of educational tools referring to the availability of appropriate technology information and gaps between scientific work and social/community involvement.
- *Economics*
  - Real costs of planting materials are not available. Forest institutes do not cost realistically (from collection to multiplication, mass propagation and delivery).
  - Employment potentials have not been considered as a result of delivery systems. No modelling on alternative delivery systems has been carried out.

- *Conservation*
  - Outside reserve areas, the involvement of communities in maintaining the resource base is limited.
  - Delivery systems can be geared to increasing and maintaining diversity but this is not currently widespread.

23. The Working Groups were asked to consider these wider aspects related to appropriate propagation and delivery; to identify action which includes strategic research and strategic action appropriate to the region and make such other recommendations as necessary. The following recommendations were adopted after discussion and modification by the whole consultation.

24. Recommendations on Bamboo Planting Materials

With reference to seed propagation

i. In view of the fact that most methods of collecting seeds are sub-optimal for maintenance of viability, it is recommended that a manual is produced on practicable and scientifically optimal methods and also on methods of storing seeds. The latter should be linked to distribution methods to ensure maximum viability, genetic integrity and representation of original population structure.

ii. Quarantine procedures should be made known more widely. (It was noted that INBAR is currently producing up-to-date reviews of pathogens and that IPGRI has offered to develop safe methods for movement of germplasm after the INBAR data are available).

iii. To aid the ready availability of materials, national collections/orchards should be promoted. These should fill a strategic role in storage and distribution.

iv. Seed testing methods for the individual species need to be refined and information gathered together in an INBAR manual. In the first instance, these should be concentrated on priority species.

v. Seed production areas, incidence of flowering and institutes from where seed can be obtained should be fully documented by national programmes, and data should form part of the INBAR Integrated Information System based in the two Information Centres in China and India.

With reference to conventional propagation

Various methods apply to different species. For priority species of INBAR, these should be summarised in a manual, possibly supplemented by audio-visual training kits, and wider training.

With reference to in vitro research

i. Although protocols are not available for all species, they exist for many of the priority species. Rather than continued support to basic research, INBAR is asked to act as a focus, making known the protocols and which institutes have expertise, especially when there are interests in commercialisation.

ii. INBAR should facilitate exchange of information by establishing a small group of experts to focus, in particular, on commercialisation, exchange of materials and for better awareness by the tissue culture community on applied needs for development.

iii. Some strategic research is needed on *in vitro* rooting of minor nodes of bamboos and on the methods of transference to soil.

With reference to all types of propagation

i. It is strongly recommended that a study of cost-benefits be carried out on the alternative methods of propagation (including comparisons across various agencies and localities).

ii. Since supply and demand data for planting materials are not widely available, it is recommended that such data are estimated and analysed (taking into account different user groups) in each country of the region.

With reference to genetic enhancement

i. Methods of selection and criteria for selection as well as identification of superior planting materials require focus. INBAR and IPGRI are asked to study how this can be done.

ii. Cataloguing superior (or plus) genotypes and "biotypes" should be vigorously pursued throughout the INBAR network.

iii. Collecting germplasm of diverse flowering genotypes of some species and pooling them in collections requires INBAR action so that material is readily available for selection, and also to provide continuous seed production stands in the proposed national seed collections.

iv. *In vitro* flowering offers possibilities for genetic improvement. INBAR should explore how strategic research could be implemented in this area.

25. Recommendations on Rattan Planting Materials

1. Planting materials for rattan must be increased due to an increasing demand for cane and to cause change from reliance on continued seed supplies collected from the forest. In this respect:

i. It is recommended that seed orchards are developed at the national level. In addition, a number of subregional orchards should be established to cover production areas and biodiversity in South, Southeast, East Asia and the Pacific.

ii. The preferred planting material should remain the seed, until selection has enhanced genotypes to the level that cloning is necessary.

iii. Seed orchards should be planned to have principle focus on locally available species but exotic material, as identified in the INBAR priority list, should be included.

iv. Exchange of materials should be in the form of seed, either treated or pregerminated in cotton. Further development of tissue culture methods for exchange should not be ruled out but, at present, appear not to be cost-effective.

v. Exchange of planting materials should be on a mutual basis, expecially for research purposes. INBAR is asked to identify institutes willing to provide exchange materials.

vi. It is recommended that strategic research is carried out on the germination process of the INBAR priority species. Knowledge on nursery techniques should be collated for priority species other than the main 3-6 commercial ones.

2. In the case of some priority species, more information is needed on vegetative mulitplication methods.

With reference to variation

i. Little information is available on patterns of genetic variation. More research is required to increase quality and quantity of production and also for application in genetic enhancement.

ii. This type of research should be carried out across genepools rather than on local segments. Both qualitative and quantitative markers are required and a database should be established in the INBAR Information System, including identification of superior genotypes.

TOWARDS SUSTAINABLE MANAGEMENT OF NATURAL STANDS

26. Presentations provided data, information and practices for a range of management interventions for stands of bamboo and rattan. These stands are collectively called "natural stands", representing spontaneous regeneration in a range of sites, including degraded forest areas. Maybe 95% of bamboo is produced in such areas and maybe 98% of rattan. Management for sustained yield of such ecosystems has been normal practice, and, despite research, has remained largely traditional.

27. Mr. A.K. Lakshmana (India) outlined normal management practices for clumping bamboos, including harvesting methods such as horse-shoe and inverted V cutting of clumps and a range of felling periods in relation to the age of the culms

(Appendix 7). Over-cutting and also irregular cutting tend to make the bamboo non-workable, and non-working causes additional congestion, one of the most serious problems in clump management. Irrigation and fertilisation both increase yield but the former showed increased mortality and the latter may not be cost-effective. Protection of regeneration after flowering includes protection from fire and grazing but major efforts are needed to strengthen cooperation with communities and NGOs to provide information, because in some areas protection from grazing is needed for a number of years.

28. Better production would result from the identification of silvi-ecological zones based on rainfall, temperature, soils and other parameters and the selection of the 5 best genotypes for each zone.

29. There is a need to transfer many stands into agroforestry and to adapt methods of social forestry much more for the management of natural stands.

30. Since too much clearing and thinning will motivate fires and poor utilisation results in sub-optimal management, there is a great need to understand the economics of management. This should provide a range of management interventions adapted to natural stand maintenance and also ecosystems conversion methods.

31. More attention needs to be given to management in fragile hill areas. Experience shows the use of fertilisers in such areas has often led to soil erosion. Also, clump management is difficult in many such areas because it is difficult to demarcate clumps.

32. Due to the high percentage of the production coming from natural stands, there is an overriding need to expand production from plantations where fertilisers and other practices can be applied more easily. Planning of land use, clear government agreements and mobilisation of funding are all needed. Failing these, natural stands can be managed better, but they alone cannot meet the supply/demand for bamboo. Much more attention is needed to the use of a wider array of germplasm, both native and exotic.