METHODOLOGIES FOR TRIALS OF BAMBOO AND RATTAN

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FOREWORD

At INBAR's networkshop in Singapore in June 1993, members of the Production Research Working Group recognised the need for INBAR to organise and carry out regional provenance trials of bamboo and rattan.

Regional collaborative provenance trials of bamboo and rattan are long overdue. As a first step, INBAR convened in March this yearanexpertconsultativemeeting toagreeonstandardised methodologies for conducting such trials. Universiti Pertanian Malaysia (UPM) kindly offered to host the meeting, and Dr. Kamis Awang from UPM undertook to prepare standardised methodologies for conducting provenance trials.

As this book goes to press, a pilot regional bamboo provenance trial has been initiated jointly by INBAR and FORTIP (a UNDP/FAO-funded Forest Tree Improvement Project). The bamboo trial involves collaborators from Bangladesh, China, India, Sri Lanka, and Thailand. Rattan provenance trials will be organised at a later date.

Field practitioners from around the network have reviewed and commented on the text of the section on standardised methodologies. Their valuable inputs are noted with thanks.

INBAR will issue the sections on standardised methodologies for bamboo and rattan separately as handbooks that may be used as field guides. We hope that this will encourage the establishment of more provenance trials, both national and regional, of these important non-timber forest products.

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CONTENTS

I. INTRODUCTION

1. A Consultative Meeting on methodology for trials of bamboc and rattan was held 23-25 February 1994 at the Universiti Pertanian Malaysia at Serdang, Selangor, by kind invitation of Dr. Nik Muhamad Majid, Dean of the Faculty of Forestry. The Meeting was organised by the International Network for Bamboo and Rattan (INBAR) operated through IDRC, India, in cooperation with the UNDP/FAO Regional Project on Improved Productivity of Man-Made Forests through Application of Technological Advances in Tree Breeding and Propagation (FORTH'), and with the Forestry/Fuelwood Research and Development Project of Winrock International Institute for Agricultural Development (F/FRED).

2. Apart from the organisations listed above, local technical experts from Malaysia and Singapore attended, as well as a representative for part of the Meeting, of the Center for International Forestry Research (CIFOR) of the Consultative Group on International Agricultural Research. A list of participants is shown in Annex 1.

3. The objectives of the Meeting were to recommend to INBAR 'what can be done to promote the concept of regional trials of species and provenances and to develop a standardised methodology which can be provided to collaborators if regional trials are established, or which can be used by national programmes so that sharing of information in the INBAR network can become more meaningful.

II BACKGROUND

1. BACKGROUND TO TRIALS OF BAMBOO AND RATTAN

J.T. Williams

The agreement by the Production Working Group of INBAR to promote regional provenance trials of bamboo and rattan, as well as a similar recommendation of a specialist consultative meeting on priority species, was prompted by two observations. First, the movement of germplasm across regions has remained relatively slow; much of it has been based on chance introductions. There is, therefore, an urgent need to speed up movement of germplasm in a more targeted and scientific way. Second, production gains will be increased through paying more attention to the genetic potential of particular provenances. However, our knowledge of such potentials is limited and there are massive opportunities for surveying, collecting, testing and selecting specific populations and genotypes.

None of these requirements are new; they are the same for most woody species which are utilised and which have not yet been the subject of scientific plant breeding or have intensive, quality seed production programmes. For bamboo and rattan, scientists have not been overly clear as to whether they require provenance trials, multilocational trials, or species trials. However, the methodologies used can be fairly standard for all these applications.

Constraints to implementing trials

Since the design and implementation of trials for a range of bamboo and rattan species is a vast undertaking, it is important to recognise institutional constraints and also limitations in available funding for trials. Additionally there are about 50 species of bamboo used extensively and about 50 species of rattan used regularly and commercially. To implement research on all these would be impossible in the first instance. However, INBAR has already examined the range of species and prioritised these, and this is a good starting point for trials (Williams and Rao, 1994).

The following two points need to be considered in order to identify the constraints to trials implementation:

1. Within any area or country, trials to evaluate performances of provenances collected over a number of sites should be a responsibility of the relevant local authority. Regional testing has to have objectives well defined, be limited to what can feasibly produce meaningful results valuable to national institutions and the testing needs to be vigorously monitored. The major objective must surely be to determine provenance x site interactions to relate to broad eco-climatic zones or special purpose situations, such as rehabilitation of degraded lands.

2. For many forest or multipurpose trees, it is a question of sampling natural populations and some populations associated with managed areas or interference from people. Whereas this may be the case for rattans, sampling for bamboos poses many constraints because much of the materials, when sampled, are clonal and sampling and distribution of germplasm is by no means as easy as that based on seed collections. Seed is widely used for propagation of some bamboos, but seeding may be so rare that this cannot be relied upon for germplasm collecting. Clonal materials raise all sorts of associated problems, not least having enough material to propagate but also quarantine. Scientifically, for many bamboos the use of tissue culture for mass propagation would avoid such problems but greatly increase the complexity and organisation needed to conduct trials.

Provenance testing

In an ideal situation, provenance testing is carried out in several stages. Initially, patterns of inherent variation are identified. Following this, more detailed work is done to identify provenances having potentially high productivity in specific sites. Hence, soil preference information is very important

(Rao, A.N., see below). The provenance testing methodology is based on sampling between populations, which themselves are usually fairly widely heterogeneous.

Let us look at what is known about bamboos and rattans to see how this methodology can be applied.

BAMBOOS

Very little is known about patterns of genetic variation or about correlations between such patterns and geography, climate, latitude, altitude or local selection by rural people. Of the priority species recently agreed upon, some exhibit different chromosome numbers within the same species (especially some *Bambusa* species and *Dendrocalamus latiflorus*: Tewari, 1992). Some species, therefore, have polyploid series but aneuploids are also available in populations. Apart from cytotypes possibly showing different physiologies, the opportunity is available for hybridisation and production of new vigorous forms - if flowering and seeding can be induced. Until such research is more widespread, the selection of materials for provenance trials will probably have to rely on what has already been done at the national level for selection of "plus" bamboos.

In India, for instance, the simple selection of best phenotypes gives immediate gains of 5-10% increase in productivity. Inclusion of some of these selected accessions, along with collections made from specific agro-climatic zones, is an obvious starting point. This means that sampling for materials to include in provenance trials is likely to be non-random and biased towards genetic enhancement. Random sampling should probably be used to capture as much genetic variation in the provenance as possible when seed is available; however, for clonal materials this is just not manageable. It should be remembered that in seed sampling the plants collected should be distributed across the provenance, represent the whole area, and at least 25, but preferably up to 50 plants, should be sampled so that enough bulk seed is available to provide to all trials cooperators.

Clearly, it would be unwise to include certain provenances simply because they happened to produce seed when needed; unless, of course, the provenance represented a population which appeared to be a highly desirable entry.

It would seem, therefore, that there are several activities which need to be followed to support the wider trials:

1. Gathering of available information on putative superior genotypes, or "plus" genotypes. INBAR, early in 1994, contacted national programmes for information on these in relation to the recently-agreed priority species.

2. Identification of areas to be sampled for materials to be used in regional trials and the bias or non-bias to be used in sampling. It should be noted that only a limited amount of ecological information is available on species preferences and tolerances.

3. Continued local selection at the national programme level, through nursery selection - and understanding why segregation occurs (e.g. Kondas et al, 1973 for *Bambusa bumbos*), or through propagation of mutant forms (e.g. spineless types of a spiney species, or erect forms within spreading types).

4. Multiplication of superior plants through

- micropropagation using vegetative explants since seeds often represent recombinants with no guarantee of reproduction of the superior form.
- Other vegetative methods; culm cuttings are likely to be speedier than offset planting and marcotting.

5. Initiation of regional provenance trials with sharing of information, results and experiences and regular feed-back to the network.

RATTANS

Again, very little is known about patterns of genetic variation and correlations with soils or specific ecologies. Important data are to be found in Dransfield (1979,1984 and 1992) and restriction of species to different climatic zones is known.

Most rattan plantations are established from seed, and plantations act as good sources of seed. Nonetheless, the seed lots are genetically heterogeneous. Planting systems and nursery techniques are fairly well known (Wan Razali et al. 19921. For trials, however, supports and shade are needed and methodology requires rigorous standardisation. Planting in one location in recently logged areas and in another in old secondary forest will not provide the needed comparisons.

Germination of rattan seeds can be a prolonged process ranging from a few weeks to a year, and pre-treatments are needed for experimental trials.

These practical problems are constraints to establishing uniform trials, but more importantly is the need to have available large bulked seed lots to spread the diverse progeny, because most rattans are dioecious and do not breed true.

Decisions will have to be made at an early stage on the objectives for regional trials of rattans, because experimentally, the best results would come from mass propagation of selected types, thereby reducing much of the heterogeneity of the planting material. In practice, scientists are lagging in the identification and propagation of selected types, and in the foreseeable future trials will still be based on seed lots.

Timing

Trials for both bamboo and rattan will, depending on the species, need to include felling cycles well defined in terms of years. For instance, Dendrocalamus *strictus* can be cyclically cut 2-3 years in mesic conditions but only 3-4 in drier conditions. For *Bambusa bambos,* cutting periods can range from 3 to 12 years. Rattans can be harvested after about 6 years, but there is a wide range in timing and some rattans can take very much longer before materials can be usefully harvested.

Standardisation

Trials include a series of operations ranging from germplasm origins to planting, experimental design, management and data recording. The better the standardisation, the better will be the interpretation of the results.

Almost certainly trials will be limited to a handful of species. In the first instance, I would advise to keep the number of provenances as small as possible and to identify the test sites in relation to development criteria, rather than to include all those that would be of interest scientifically. The more applied the trials, the better downstreaming we can expect and the quicker we can see increased productivity over wide areas.

REFERENCES

Dransfield, J. 1979. A Manual of the Rattans of the Malay Peninsula. Malayan Forest Records No. 26, Kuala Lumpur.

Dransfield, J. 1984. The Rattans of Sabah. Sabah Forest Records No. 13, Forest Dept., Sabah.

Dransfield, J. 1992. The ecology and natural history of rattans. In, Wan Razali Wan Mohd., J. Dransfield and N. Manokaran (eds.). A Guide to the Cultivation of Rattan, Malayan Forest Record No. 35, Kuala Lumpur:27-31.

Kondas, S., Shree Rangaswamy, S.R. and Jambulingam, R. 1973. Seeding segregation in *Bambusa arundinaria* Retz. Madras Agricultural Journal, 60:1914-16.

Tewari, D.N. 1992. A Monograph on Bamboo. International Book Distributors, Dehra Dun.

Wan Razali Wan Mohd., Dransfield, J. and Manokaran, N. (eds.) 1992. A Guide to the Cultivation of Bamboo. Malayan Forest Record No. 35, Kuala Lumpur.

Williams, J.T. and Rao, V. Ramanatha (eds.) 1994. Priority Species of Bamboo and Rattan. INBAR, New Delhi/ IBPGR, Singapore.

2. ECOLOGICAL REQUIREMENTS OF BAMBOO AND RATTAN

A.N. Rao

INTRODUCTION

To conduct successful provenance trials of bamboo and rattan, it is useful to have reliable data on both the species concerned and their climatic and edaphic tolerances. Accordingly, the literature available to scientists likely to conduct the trials was reviewed to abstract relevant information.

Such information is also necessary for effective conservation programmes, which are much-needed due to the over-extraction of, resources by people, depletion of stocks as a result of clearing of forests and other changes in land use.

Scientific information about the taxonomy, morphology, ecology and genetics of bamboo and rattan are limited, very much in the same order. However, periodic meetings of scientists have provided new knowledge (see for instance: Rao, etal., 1987,1991; Rao, I.V.R. et al., 1990,199l; Wong and Manokaran, 1985).

It is generally assumed, and to some extent believed, that bamboos of one kind or another can grow anywhere, even in poor or marginal soils, or even under semiarid conditions. Likewise, it is also assumed that the humid, lowland forests of the equatorial zone are suitable for rattan growth, and hence, their cultivation in plantations.

Information provided below shows a great lack of data on soil tolerances of the species of interest. There will be a need, in the immediate future, to upgrade this information, especially in relation to the priority species identified recently by INBAR (Williams and Rao, 1994).

GENERAL ECOLOGY OF BAMBOO

Ideally, there is a need for information on soil types, levels of soil fertility and drainage relationships, as well as data on annual rainfall and the number of rainy days in a year, since soil and water availability are the key determinants for bamboo growth.

Information was abstracted from Banik, 1994; Bennett and Gaur, 1990; Iyuppu, 1965; Sen et *al.,* 1987; Tewari, 1992; and Yadav, 1965. The information shows that bamboos exhibit high growth rates in areas of high rainfall, usually in the range of 1270-6350 mm. Growth rates are reduced under semi-dry conditions of 762-1016 mm precipitation. However, such broad ranges need to be interpreted in relation to specific soil structures, soil drainage, soil moisture relations, altitude and physiography, all of which play important roles in bamboo growth patterns. Many species appear to have specific growth niches and good adaptibility only in some rather specific habitats.

Data on Priority Species

Table 1 shows data that are available for a number of high priority bamboos. It can be seen that there are many gaps; also in many cases, data derive from only one country. Nonetheless, Table 1 provides a general indication of overall ecological tolerances for over half the priority species.

Data on more narrow ecologies

Tewari (1992) provided information on some rather narrow ecologies. The following examples will illustrate this.

Dendrocalamus longispathus: along ravines.

D. sikkimensis: above 1200m.

D. patellaris: 1200-2000m.

Drepanostachyum hookerianum: 600-1600m.

Schizostachyum helferi: moist humid valleys inevergreen forests.

S. capitatum, S. polymorphum, S. dullooa: 1200 - 2000m.

High altitude species: *Sinobambusa elegans, Drepanostachyum polystachyum, D. khasianum, Chimonobambusa griffithiana,*

Table 1. *Ecological information for some high priority bamboos.*

Species	Soil type	Soil fertility	Soil drainage	Rainfall pa mm	Number of rainy days pa	Other ecological notes
Bambusa bambos	Prefers acid soils (1) Prefers moderately fine clayey soils (2) Avoids dry coarse grained slils(2) Sandy looms also suitable Otacko & Jayaraman, 1990)	Rich to poor (I) Prefers rich (2)	Poor to good (2) Tolerates some waterlogging (Thomas, 1990)	700-2300 (2)		Occurs in low level areas and canal banks. Best development in moist areas (2)
B. Blumena		Rich to poor (1)				
B. polymorpha	Loam and riverine alluvium (2) Brown Piedmont (3)	Rich to poor (3) Rich to medium (1) Rich (1)	Good (2)	2500-4500 (3)	95-115	Low hill slopes and along valleys (2)
B. textilis		Moderately rich (1)				
B. tulda	Alluvial soils (2) Sandy loams (3) Brown piedmont soils (3) Brown to red hills soils (3)					
B. vulgaris	Grey fld plain soils (3) Alluvial sandy loams (2) Range of soils (1)	Rich to medium (3)	Good (2) Good (2)	2500-3000 dry and wei areas (2)	85-135	On moist soils, especially agricultural margins, along creek also in foot hills (2)

Cephalostachyum pergracile	Range of soils (1) Loam (2)	Rich (1)		semi-dry areas (1)	
Dendrocalamus asper		Rich (1)			
D. giganteus		Rich (1)			
D. latiflorus		Rich (1) Poor (2)	Good (2)	low rainfall (1, 2) dry and wet areas (2) mean 848 (Patil and Patil, 1990)	Hill slopes and flat areas (2); semi-dry and dry zones along plains and hill tracts to 100 m (2)
D. Strictus	Stony soils (2, 4) Avoids moist heavy clay soils (2) clay loams (oxisols) (Patil & Patil, 1990)	Rich (1)			
Gigantochlo apus		Rich (1)			
G. levis		Rich to medium (1)	Good	1300-4000	Temperature 21-26" less than 11" limiting (Londono, 1992)
Guadua angustifolia	Volcanic alluvial soils rich in organic matter (Assanoussi, 1992)	Rich (2) Rich to medium (3)	Good (2, 3)		Mid-range altitude plains and valleys (2) Along streams, in most park of upper mixed forest (3)

Table 1. *Continued... . .*

Species	Soil type	Soil fertility	Soil drainage	Rainfall pa mm	Number of rainy days pa	Other ecological notes
B. tulda	Alluvial soils (2) Sandy loams (3) Brown piedmont soils (3) Brown to red hill soils (3)					
Melconna baccifera	Loams (2) Brown to red piedmont soils (3) Sandy clay loams (3)	Rich (2) Medium (3)	Good (2, 3)	2500-5500 (3)	110-125	Low to highland (2) Moist hill slopes and clearings (2, 3) and large tracts of pure stands (3)
Ochlandra	Acidic soils (2) Loamy soils (1)	Rich (2)	Good (2)	1300-3000 (2)		
Phyllostachys pubescens	Red loams (4) Silt and clay loams (4)			1500-1870		
Thyrsostachys siamensis	Piedmont soils (3)	Rich (1)	Good (3)	2500-5000	38-1000	

C. callosa, Arundinaria hirsuta, Phyllostachys bambusoides, Schizostachyum capitatum.

Although such species with narrower ecologies are only likely to be used locally, there is always the possibility that one of them might become important in, for example, mountain development. This being the case, it would be helpful to have much more ecological information than that which is current in the literature.

General inferences

It is generally assumed that both lowland and upland species show adaptation to a wide variety of soils and Tewarisummarised this by stating that bamboos as a group of species are not exacting in their requirements, nor indeed in their climatic requirements. Hence, some species of bamboos will grow practically on all types of soil, provided there is good drainage. Waterlogged conditions and heavy soils, which are almost pure clay, or soils with high lime content, may not be very suitable for bamboo cultivation.

With the above generalisations, it becomes obvious that in bamboos we are dealing with a group of plants with great versatility in their potential adaptation to conditions. Nonetheless, in order to initiate good provenance studies we need a better understanding of the soil preferences of those accorded priority by INBAR. Such knowledge also has to be applied to effective genepool conservation, genetic enhancement and the more effective utilisation of materials on a sustainable basis.

The data in Table 1 focus on soil type, soil quality and drainage, and also on annual rainfall and other parameters. Soil quality is recognised in terms of fertility and moisture content (Smitinand and Ramayarangsi, 1980). However, of all the enviromental parameters, rainfall appears to be the most important for distribution and growth.

The following examples from the literature illustrate the uneven approaches taken to defining specific ecological characteristics.

1. *Bambusa blumeana, B. vulgar-is, Schizostuchyum lumumpuo* and *S. lima* grow best on well-drained, sandy loam to clay loam soils. Swampy places are not suitable. Soil favourable for bamboo growth varies in colour from yellow, through reddish, to brown yellow. High humidity and fertile soil promotes increased height. and diameter in bamboo growth (Bumarlong and Tamolang, 1980).

2. Conglomerates with sand rock and stones support growth of *Dendrocalamus strictus* in Nepal where annual rainfall is 1300-2200 mm (Prasad, 1990).

3. Clay loam soil with high organic content is suitable for *Giguntochlou hasskarliana* in Thailand and annual rainfall is over 2500 mm (Suwannapinunt, 1990).

4. *Bumbusa bumbos* grows well on acidic, noncalcareous soils and prefers humid conditions. It tolerates waterlogging. Growth is much better on rich organic soils with high mineral contents. Acidic sandy soil rich in sesquioxides and poor in nutrient content was also used and application of NPK improved growth (Thomas, 1990).

5. *Phyllostuchys heteroclada* grows well on sandy soils with clay loam in Suhclung county where annual precipitation is 1400 mm (Tienren, *et* al., 1987). However, Sun and Ye (1992) recorded that sandy soil, with a very shallow top layer and low fertility was not suitable for rhizome extension.

6. Soils with loess structure and high organic content are suitable for rapid growth of rhizomes of *Phyllostuchys pubescens* (Xiao, 1992). Experimental data for growth on a range of red loams showed the effects of organic matter % (0.2 - 4.6) Nitrogen % (0.5 - 0.22) Phosphorus 205% (0.06 - 0.1) when pH range was between 5.49 and 5.73. As a result, fertiliser application could be assessed to increase culm production (Fu *et al.,* 1990,1992).

7. Variations in distribution of bamboo species in north China was attributed to rainfall and temperature variants only, and hence, soil types and factors were not considered (Guoging, **1985).**

Phytosociology of Bamboos

Very few papers have been published on the phytosociology of bamboos. This is because there are very few ecologists in the bamboo growing areas actually working on the ecosystems which support the bamboo species. Although the bamboos are both homogenous and a divergent group, each species has its own ecological requirements and variations (Brandis, 1899). Even less is known about growth behaviour of species under natural and artificial conditions.

In recent years, there has been a wider interest in the growth, reproductive biology, ecology and genetics of tropical forest plants, but bamboos are not included in existing studies. There is an urgent need to apply much of the research to bamboo species.

GENERAL ECOLOGY OF RATTANS

The information which exists is provided in monographs on the species (Dransfield, 1979,1984) as well as in ongoing research in this area and also in Dransfield (1992), and specific papers (e.g. Balagopalan and Sankar, 1993) and Renuka (1994). A useful set of notes on priority species may be seen in Table 2 from Williams and Rao (1994).

Ecological parameters controlling distribution of rattan species differ somewhat from those for bamboos because in addition to soil conditions, rainfall and altitude, temperature and sunlight are also important. The relative influence of each needs further study (Xu, 1989). Pending such detailed studies, we are left with fragmentary information such as *Calamus truchycoleus* grows well in Bukit Garam, Sabah, on "good sites" with an average rainfall of 3090 mm (Shim, 1989).

Table 2. *Soils and ecology of priority rattan species.*

Species	Soil type
Calamus manan	Well-drained soils. Not on waterlogged soils. 200-1000 m above sea level.
C. caesius	Rich alluvial soils. Variety of soils. Lowland to 900 m.
C. trachycoleus	Withstands flooding. Flooded alluvial soil. Acidic clay, waterlogged soil, not suitable for agriculture. Low elevation.
Calamus Sect. *Podocephalus*	Mangrove soil, freshwater swamps, not peat swamps, coral limestones, ultramafic soils. Lowlands - 1800 m.
C. subinervis	Dry coastal soils, drained soils, mildly acidic rocks, soils from coral limestones.
C. palustris	Fertile soils. O-700 m. Can grow on limestone soil.
C. tetradactylus	Northern rattan, 20-30 ° C. More than 1300 mm rainfall. Survives rare frosts.
C. deerratus	Freshwater swamps. Alluvial soils.
C. hollrungii and relatives	Low elevations, rich soils.

SOIL CONDITIONS FOR RATTAN GROWTH

Details regarding soil types for natural growth and also growth under cultivation are generally lacking. Soils suitable for major crop plants or woody crops like rubber and oil palm in Malaysia are identified and some details published (Law and Tan, 1975; Leamy and Panton, 1966). Rattans are mostly restricted to wet soils and soil conditions in the tropical swamps, and extend up to 1000 m above sea level. Seedlings planted in coastal swampy soils showed better growth than those planted on hill slopes (Manokaran, 1982). In Sarawak, alluvial soils supported good growth of *Calamus javensis*, *C. cuesius, C. scipionum* and *Korthulsia hispida*-all useful in making furniture and different kinds of products (Mohamad, A. *et al.,* 1985). Swamp forest area was chosen to establish plantations of different rattans in Thailand (Bhodhipuks and Ramyarangsi, 1989). Medium loam, light clay and sandy loam with medium to high humus (1.2 - 4.9%) are the different types of soils that promote rattan growth in China. The pH ranged from 4.5 to 6.0 and annual rainfall was 1300 mm. Seventeen species of *Calamus* and *Daemonorops margaritue* are the local rattans that grow from sea level to 1600 m elevation.

Calamus manan planted on steep hill slopes in the secondary forest area with fertile soil showed good growth when the surrounding trees were cut and the canopy was opened up, allowing more light to penetrate. The relative growth rates were recorded for 9 years (Nur and Wan, 1989).

From this brief survey, it becomes clear that our knowledge of soil relationships of rattans is limited. More studies are required to determine:

- the quality of soil that promotes rattan in different geographic areas
- the influence of soil water on rattan, and
- the selection of suitable soils and fertilisers for the development of plantations

The dependence of forestry on the soil is well known but how the individual groups of plants are affected by soil, and how to match the soil type and vegetation have to be worked out. Plant vegetation relationships to edaphic conditions of the tropics have also to be worked out to conserve usefu! species, improve the genepool, and use them on a sustainable basis (Fanning and Fanning, 1989; Bridges, 1978; Whitmore, 1984).

CONCLUSIONS

Soil plant species relationships are yet to be well studied in the tropics. Some of the soil characters are well analysed but how they affect plant growth are not mentioned in detail.

The data presented in this paper show how incomplete our knowledge is on bamboo and rattan. Scientists in the INBAR network could speedily obtain and collate meaningful data which would be invaluable to provenance testing.

REFERENCES

Assanoussi, M.I. 1992. The role of *Guadua angustifolia* in Ecuador. In, S.Z. Zhu et al. (eds.), Proceedings of the International *Symposium* on Bamboo and *its* Use, ITTO/CAF: 3740.

Balagopalan, M. and Sankar, S. 1993. Ecological conditions of rattan (cane) growing areas with special reference to soil properties. In, S. Chand Basha and K.M. Bhat feds.), *Rattan Management and Utilisation,* KFRI/IDRC: 118-124.

Banik, R.L. 1994. Personal Communication.

Basu, K.S. 1989. Reproductive ecology of tropical forest plants. Biol. Intl., IUBS: 7-56.

Bennett, S.S.R. and Gaur, R.C., 1990. *Thirty Seven Bamboos Growing in India.* FRI, Dehra Dun.

Bhodthipuks, P. and Ramurangsi, S. 1989. Past and present prospects of rattan in Thailand. In, A.N. Rao et al. (eds.), Recent *Research on Ruttuns,* Kasetsart Univ./IDRC: 11-12.

Brandis, D. 1899. Biological notes on Indian bamboos. Indian For., 25: l-25.

Bridges, E.M. 1976. World Soils. Cambridge Univ. Press, Cambridge.

Bumarlong, A.A. and Tamolang, F.N., 1980. Country report on the Philippines. In, G. Lessard and A. Chouinard (eds.), *Bamboo Research in Asia,* IDRC: 69-80.

Chacko, KC. and Jayaraman, M.S. 1990. Effect of container size on growth of *Bumbusa arundinacea.* In, I.V.R. Rao et al. (eds.), *Bamboos: Current Research,* KFRI/IDRC: 96-98.

Dransfield, J. 1979. *A Manual of the Ruttuns of the Malay Peninsula.* Malayan Forest Record No. 26, FRIM, Kuala Lumpur.

Dransfield, J. 1984. *The Ruttuns of Sabah.* Sabah Forest Records, No. 13, Forest Dept., Sabah.

Dransfield, J. 1992. The ecology and natural history of rattans. In, Wan Razali Wan Mohd., J. Dransfield and N. Manokoran (eds.), *A Guide to the Cultivation of Rattan,* Malayan Forest Record No. 35, FRIM, Kuala Lumpur.

Fanning, D.S. and Fanning, M.C.B. 1989. Soil. John Wiley and Sons, New York.

Fu Maoyi, Xie Jingzhong, Fang Mingyu, Ren Xiaoling and Li Daiyi. 1990. Eertilisationstudies in bamboo timber stands. In, I.V.R. *Rao et al.* (eds.), *Bamboos: Current Research,* KFRI/IDRC: 121-127.

Fu, Maoyi, *et al.* 1992. Studies on fertiliser application in bamboo stands for timber production. In, S.C. Zhu *et al.* (eds.) *Proceedings of the International Symposium on Bamboo and its* Use, ITTO/CAF: 202-210.

Guoging, L. 1985. Improved cultivation techniques of bamboos in north China. In, A.N. Rao, et *al.* (eds.), Recent *Research* on *Bamboos,* CAF/IDRC: 71-78.

Iyuppu, A.I. 1965. The silviculture and management of bamboos and reeds in Kerala State. All-India Bamboo Study Tour and Symposium, FRI, Dehra Dun: 36-41.

Kondas, S., Shree Rangaswamy, S.R. and Jambulingam, R. 1973. Performance of *Bambusa Arundinacea* Retz. seedlings in nursery. Madras Agricultural Journal, 60: 1719-26.

Law, W.M. and Tan, M.H. 1975. Range in properties of Peninsular Malaysian soils, Paper presented at Third ASEAN Soil Conference, Kuala Lumpur.

Leamy, M.L. and Panton, W.P. *1966. Soil Survey Manual for Malayan* Conditions, Division of Agriculture, Bull. No. 119, Min. Agric. and Coop., Malaysia.

Londono, X. 1992. Growth development of *Guadua angustifolia.* In, S.L. Zhu et *al.* (eds.), Proceedings *of the International Symposium* on *Bamboo and its* Use, ITTO/CAF: 80-86.

Manokaran, N. 1982. Survival and growth of rattan saga, *Calamus caesius.* Malay. For., 45: 36- 48,193-202.

Mohamad, A. 1985. Performances of some rattan species in growth trials in Peninsular Malaysia. In, K.M. Wang and N. Manokaran feds.), Proceedins of Rattan *Seminar,* FRIM: 49-56.

Mohamad, A. et *al.* 1985. Country report on Malaysia. In, K.M. Wong and N. Manokaran (eds.), Proceedings of *Rattan Seminar,* FRIM: 221-229.

Nainggolan, P.H.J. 1985. Preliminary observations on the effect -of different canopy and soil moisture conditions on the growth of *Calamus manan.* In, K.M. Wong and N. Manokaran (eds.), Proceedings of *Rattan Seminar,* FRIM: 73-76.

Nur, S.M. and Wan, R.M. 1989. The growth and yield of a one year old rattan plantation. In,A.N. Rao et *al.* (eds.), *Recent Research* on *Rattans,* Kasetsart Univ./IDRC: 62-67.

Patil, V.C. and Patil, S.V. 1990. Performance of bamboo under varying spacing and fertility levels. In, I.V.R. Rao et *al.* (eds.) *Bamboos: Current Research,* KFRI/IDRC: 107-111.

Prasad, S.N. 1990. Bamboo resources of the outer Himalayas. In, I.V.R. Rao et *al.* (eds.), *Bamboos: Current Research,* KFRI/IDRC: 34-38.

Rao, A.N., Dhanarajan, G. and Sastry, C.B. (eds.) 1987. *Recent Research* on *Bamboos,* CAF/IDRC.

Rao, A.N. and Vongkaluang, I. (eds.) 1989. *Recent Research on Rattans,* Kasetsart Univ./IDRC.

Rao, A.N., Zhang, X.P. and Zhu, S.L. (eds.) 1991. Selected *Papers on Recent Bamboo Research in China,* CAF.

Rao, I.V.R.,Gnanaharan, R. andSastry,C.B. (eds.) 1990. *Bamboos: Current Research,* KFRI/IDRC.

Renuka, C. 1994. Personal Communication.

Sen, Q.T. et *al.* 1987. Study on the application of chemical fertiliser to the timber and paper pulp stands of *Phyllostachys pubescens.* In, A.N. Rao et *al.* (eds.), *Recent Research on Bamboos,* CFA/IDRC: 87-90.

Shim, P.S. 1989. Some cane characteristics on *Calamus trachycoleus.* In, A.N. *Rao et al.* (eds.), *Recent Research on Rattans,* Kasetsart Univ./IDRC: 5153.

Smitinad, T. and Ramayarangsi, R. 1980. Country report on Thailand. In, G. Lessard and A. Chouinard (eds.), *Bamboo Research in Asia,* IDRC: 85-95.

Sun, T.R. and Ye, S.C. 1992. Relationship between soil available nutrients and rhizome distribution of *Phyllostachys heterocladu.* In, S.L. Zhu *et al.* (eds.), *Proceedings of the International Symposium on Bamboo and its Use, ITTO/* CAF: 166-176.

Suwannapinunt, W. 1990. Horseshoe harvesting trials innatural *Gigantochloa hasskarliana* stands. In,I.V.R. Rao et al. (eds.), *Bamboos: Current Research,* KFRI/IDRC: 83-86.

Tewari, D.N. 1992. *A Monograph* on *Bamboo.* International Book Pub., Dehra Dun, India.

Thomas, T.P. 1990. Effect of N,P and K on growth of *Bumbusa arundinacea.* Seedlings in pots. In, I.V.R. Rao et al. (eds.), *Recent Research* on *Bamboos,* CAF/IDRC: 79-86.

Tienren,S. et *al.* 1987. Biomass *structure* of *Phyllostachys heteroclada.* In, A.N. *Raoef al.* (eds.), *Recent Research on Bamboos,* CAF/ IDRC: 79-86.

Whitmore, T.C. 1984. *Tropical Ruin Forests.* Cloncluda Press, Oxford.

Williams, J.T. and Rao, V.R. (eds.) 1994. *Priority Species of Bamboo and Rattan,* INBAR- IDRC/IBPGR.

Wong, K.M. and Manokoran, *N.* (eds.) 1985. *Proceedings of Rattan Seminar,* FRIM.

Xiao, J.H. 1992. A survey of subterranean system on monopodial bamboo stand. In, S.L. Zhu *et al.* (eds.), Proceedings *of the International Symposium on Bamboo and ifs Use,* ITTO/ CAF: 154-165.

Xu, H. 1989. Rattan research in China. In, A.N. Rao *et al.* (eds.), *Recent Research on Rattans,* Kasetsart Univ./IDRC: 13-18.

Yadav, J.S.P. 1965. Site and soil characteristics of bamboo. All India Bamboo Study Tour and Symposium, FRI, Dehra Dun: l-16.

III. REPORT

1. The Consultative Meeting, in both plenary and working group sessions, addressed the objectives outlined in the Introduction and noted the recent INBAR consultation, which had listed priority species of bamboo and rattans. Agreement was reached on what trials INBAR and FORTIP should promote and on the methodology to be used, in view of the urgent need to increase production in cultivation.

2. From the outset, it was agreed that the methodology of F/FRED over its 9-year history, using a networking approach, was, with suitable modification, entirely suitable for the approach INBAR intends to take. In this respect, INBAR has been urged by its Working Group on Production to initiate and/or support wider provenance testing of economic species and to develop trials for bamboos on degraded lands. The consultation on priority species had urged the identification of superior types of bamboos at the national programme level and development of standard methodologies for trials of both bamboo and rattan. The report that follows directly addresses these proposals to INBAR.

PROPOSED TRIALS

3. The Meeting noted the wide diversity in national capabilities for conducting trials. These range from bamboos in large coordinated trials of Phyllostochys pubescens to piece-meal national testing of high priority species such as *Dendrocalamus strictus,* as well as experimentation on species of local interest for utilisation. For rattans, interest has been focused on national provenance testing of the most important economic species, but not in all countries where rattan, is produced. In no case has there been cooperative regional trials, either of species or of provenances of a species.

4. The current situation is largely due to two reasons. First, only in the past decade or so has research priority been accorded

to these commodities by national programmes. This is a result, in large part, of the foresight of IDRC, which supports such research and has provided the basis on which INBAR is building. Second, scientific plant breeding has not yet occurred along with resultant delivery systems of planting materials. The availability of superior genotypes has remained largely localised. Although plant introduction has moved some germplasm from area to area, scientifically-based movement has been extremely limited. In some cases, as in rattan, there are political constraints which limit the movement of materials, and constraints due to quarantine (requirements to protect other economic palms) virtually stop the movement since seeds of rattans survive for only short periods.

5. Even with focus on priority species, the planning, establishment and data gathering of regional trials can be extremely costly. Since any regional trial would be path-breaking, INBAR and FORTIP are asked to initiate the following:

- A pilot demonstration provenance trial of 2 bamboo species in 3-4 countries.
- Promote species and provenance testing at the national programme level of three more high priority bamboos.
- Gather information on the possibility of sharing germplasm for a regional provenance trial of rattans.
- Support national programmes which have not yet initiated provenance trials on the major rattans, but which have major economic interest in them.

BAMBOO

6. For bamboo, it was agreed that initial focus should be on tropical species because they are of interest to more countries than the temperate species. Additionally, emphasis should be on their cultivation on marginal lands, rather than on more robust agricultural lands, and sites should span a range of conditions from wetlands to drylands. The demonstration trial should,

therefore, illustrate the potential gains in productivity for testing provenances without irrigation and fertilisation.

7. The two highest priority bamboo species recommended for the demonstration trial are Dendrocalamus asper (for bamboo shoot production and culm production) and D. strictus (for culm production). Other species to be promoted initially in national trials include Bambusa bumbos, B. *vulgaris,* and *Giguntochloa apus,* All have high potential for environmental reclamation. *Dendrocalamus* was selected for the demonstration trial, because, apart from *Phyllustuchys pubescens* which is temperate, thereexist good experimental information in a number of countries which would be helpful in ensuring a successful project.

8. A trial comprising sites representing the major agro-ecologies of the species, in Bangladesh, India, Sri Lanka and Thailand, is recommended in the first instance. Planting materials will be standardised though the use of culm cuttings for D. *asper* and seed for *D. strictus.*

RATTAN

9. Initial support to enhance the national capacity for rattan provenance testing in Thailand is recommended. This would result in a wider knowledge base for species such as Calamus *cuesius* and C. *manan.*

10. The Section *Podocephulus* of the genus *Culumus* contains a number of closely-related species which are distributed eastwards from India to the Philippines and Papua New Guinea. Species trials by national programmes could usefully be promoted by INBAR/FORTIP in view of their local uses, semi-domesticated status, potential value to rural people and the very limited exchange and testing to date. This promotion should also include introduction and testing in countries where materials are not indigenous.

11. Further support by INBAR on rattan trials would not be justified in the foreseeable future since the over-riding priority research should be on sustainable management of natural stands.

Provision by INBAR of standard methodology for trials to national programmes will be helpful in monitoring how such programmes accept the need for trials and accord them support.

12. Implementation of the action proposed in paragraphs 3-9 above will serve the following objectives:

- To enhance knowledge on growth and site requirements of priority species to meet the needs of small-scale farmers and others for a range of products.
- To improve research through the standardisation of research methodology.
- To act as a demonstration for the INBAR and FORTH' networks.

13. For each country where INBAR/FORTIP trials are initiated, research collaborators, who are scientists, will be identified, and they will actively carry out the trials. Participants at the Meeting agreed that in a number of cases non-governmental organisations might be involved. Coordination will be through the INBAR network, which will convene meetings of the collaborators initially, and thereafter, when necessary. As far as possible, selection of collaborators will take into account previous bamboo and rattan networking, and also trials collaborators of FORSPA and F/FRED.

A GUIDE FOR STANDARDISED PROVENANCE TRIALS OF BAMBOOS

Kimis Awang

P. Venkateswarlu

PREFACE

Multilocation trials represent an important step towards co-ordinated research on bamboos. This manual provides guidelines for multilocational network trials to evaluate provenances of bamboo species such as *Dendrocalamus asper* and *D. strictus*.

The range of diversity of these species has not been fully exploited owing to limited movement of materials in a regional context. Better testing of performance of provenances would lead to accelerated emphasis on better germplasm for use as planting materials.

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CONTENTS

Figure and Appendices

1. INTRODUCTION

As a pilot study, INBAR is planning to evaluate two species of bamboo, *Dendrocalamus asper* and *D. strictus*, collected from different countries. The trials will incorporate the following features:

- common design and standardised methodology
- common minimum data set to be collected
- common germplasm
- thoroughly described soils and climate at each site
- data exchange and professional interaction among participants
- inter-site combined analysis of data

The trials are designed to serve the following broad objectives:

- to increase knowledge of growth and site requirements of different provenances of *Dendrocalamus asper* and *D. strictus*
- to provide a focus for network cooperation and expansion
- to help improve and standardise forestry and agroforestry research methodology

Guidelines are provided below for research collaborators participating in the network trials. These include designing the experiment, standard procedures to follow, minimum data set to be collected, and maintenance practices applicable to the experimental trials.

2. EXPERIMENT DESCRIPTION

2.1. Specific objective

To evaluate provenance performances over a number of sites, and to determine provenance x site interactions.

2.2. Experimental design

The experimental design is a randomised complete block with 4 replications using a factorial arrangement of 2 Species x 5 Provenances. The treatment factors are labelled as Factor A (Species) and Factor B (Provenances/Species). Provenances will be selected by INBAR, in consultation with national programme collaborators.

2.3. Layout

Provenances are randomly assigned in complete blocks of 10 plots each. A sample block layout is shown in Figure 1.

Clump spacing is 3 m x 3 m. Each plot is uniquely numbered serially and consists of 4 rows spaced 4 m apart. Each row contains 4 plants, also 4 m apart; 4 rows x 4 trees = 16 plants /plot x 40 plots = 640 plants/site. For each provenance, the total number for planting is 16 x 4 = 64. An extra 20% should be reserved for replacement of dead seedlings.

Plot size is 12 m x 12 m = 144 m^2 per plot x 40 plots = 5,760 m^2 (0.58 ha) per site.

Clumps are numbered beginning at the northwest comer and proceeding east, from 1 to 4, following a typewriter system. The first bamboo plant in the second and succeeding rows is directly below tree number 1 in the plot layout. All the 16 clumps are to be used as sample clumps.

slpl	s2p2
slp5	s2p3
s2pl	slp2
slp3	s2p4
s2p5	slp4

slp2	s2p4
s2p5	slp4
slpl	s2p3
slp5	s2pl
s2p2	slp3

Figure 1. Example of block layout. The provenances are randomly assigned for each block.

It is suggested that two rows of *Acacia auriculiformis* seedlings be planted at a spacing of 2 m x 2 m as buffer zones around the blocks.

3. NURSERY SEEDLING PRODUCTION

For the trial, stems will be used to propagate *D. asper* vegetatively, and seed will be used to raise *D. strictus* seedlings.

3.1. Dendrocalamus strictus

3.1.1. *Seed storage*

Bamboo seeds can lose their viability rapidly under field conditions. To ensure higher viability, the seed should be stored in a relatively lower humidity condition, with the moisture content of the seed maintained at 8-10%. This can be achieved by initially drying the seed to 8-10% moisture content and storing in air-tight plastic containers.

3.1.1. *Presowing treatment*

No special treatment is necessary. Soaking the seed in water overnight before sowing is usually sufficient.

3.1.2. Sowing seed

It is recommended that the seeds be sown in seedbeds made of fine river sand. Germination occurs in 1-3 weeks. Once the hypocotyl is erect, the seedlings should be transplanted into containers.

Sow seeds 3-4 months before the planting date.

3.1.3. *Potting mix*

The potting mix should comprise the following mixture.

50% sandy loam (by volume)
40% river sand (by volume)
10% compost (by volume)

Add chemical fertiliser (12:24:12) (N:P:K) at 30-50 g (3-4 tablespoons) per 10 litre of potting mixture. Mix fertiliser thoroughly in the potting mixture before filling potting containers. The pH should be maintained between 6.0 and 7.5.

3.1.4. *Potting containers*

Use plastic bags (15 cm x 23 cm in size while flat; 0.075-0.1 mm in thickness) with 8 to 12 perforations as potting containers. If the bag does not come with holes, punch 8 holes extending to the base of the bag (office paper-puncher will suffice) before filling with potting mixture.

Ideally, all containers should be elevated 10 cm above ground or placed on a black plastic sheet to prevent roots from penetrating into the soil below.

3.2. Dendrocalamus asper

3.2.1. *Stem storage*

For D. asper, transport the stems to the nursery site as quickly as possible upon receiving them. Maximum care should be taken to prevent drying. This can be done either by wrapping in moist gunny bags or embedding in boxes containing moist sawdust.

3.2.2. Preparation of cuttings

Prepare two-noded cuttings (a cutting with two nodes leaving about 5-7 cm on either side of the nodes) using a sharp knife or saw. Make an opening (about 2 cm in length and 1 cm in width) or drill.

3.2.3. Hormonal treatmentfor root inductioin cuttings

Dissolve 10 g of NAA (I-Naphthalene acetic acid) BDH, Loba them or E. Merck, in 250ml of ethyl alcohol (90%) in a container by stirring the solution gently.

Pour this solution to a clean container and add water to make up 100 lib-es. Mix the solution thoroughly by stirring. The final concentration of NAA will be 100 mg/l of water or equivalent to 100 ppm. This solution is sufficient to treat 1000 cuttings.

Pour about 100 ml of the solution to the stem cavity. Close the hole by wrapping and tying with a polythene strip (60 cm x 6 cm). Ensure that the polythene wrapping is tight so that the solution does not leak out. Keep the cuttings horizontal with the opening facing upwards.

3.2.4. Preparation of nursey and planting

Prepare raised nursery beds of 10 m x 1 m and fill with a mixture of soil and sand (3:l).

One week prior to planting, drench the nursery bed separately with any insecticide (e.g. Aldrin) and fungicide (e.g. Bavistin) to prevent termite and fungal attack. For each bed, use 40 litres of 0.015% (a.i.) Aldrin prepared by adding 0.5 ml of Aldrex30EC per litre of water, and 301itres of 0.05% (a.i.) Bavistin prepared by adding 1 g of Bavistin 50wp per litre of water.

Place the cuttings horizontally (the opening facing upwards) across the nursery bed. About 50-60 cuttings may be conveniently planted on a raised nursery bed of 10 m x 1 m. Cover the cuttings with a thin layer (2-3 cm) of soil.

3.3. Care of seedlings

Shade

Seedlings should receive about 50% shade. For the last 2-3 weeks prior to planting, seedlings should be exposed to full sunlight.

Watering

Water well in the morning if the upper part of seedling containers is dry. For D. *asper* cuttings, the beds should be watered regularly in the morning and evening with 30 to 40 litres of water per bed at each watering. Take due care to avoid water logging. Always water seedlings with a fine spray, particularly when seedlings are small. As a means of "hardening off", watering should be reduced a week or so before the plants are transported to site.

Weeding

Keep seedlings free from weed competition at all stages of development. Careful manual weeding is better than the use of herbicides.

Grading of beds

To prevent larger seedlings in pots from shading smaller ones, the beds should be graded by placing the larger seedlings at one end and the smaller seedlings at the other end. Grading may need to be repeated, depending on the length of time the seedlings are kept in the nursery.

Root pruning

If seedling beds are raised above ground or placed on plastic sheets, root pruning of potted seedlings should not be necessary. If seedlings stand on bare soil, however, it is necessary to prune the roots regularly. Do this by cutting the roots that emerge from drainage holes. Roots may be pruned at the time when seedlings are graded.

Pest andfungus control

Control damping off and root rot with fungicides, if necessary. Either Blitox (a blue coloured powder), Dithane M-45 (a yellow coloured powder), or Bavistin can serve this purpose. Similarly, spray pesticides if needed, but exercise great care. Insecticides containing methyl parathion, such as as Metacid and Paramar, are usually effective against defoliators.

Manuring

For D. asper, it may be necessary to apply farmyard manure to increase the vigour of the sprouts from the cuttings.

4. FIELD ESTABLISHMENT AND MAINTENANCE

4.1. Laying out the trial

Site selection

The trial site should be representative of the area where the species is likely to be planted. The site must be easily accessible in all seasons to facilitate future maintenance and assessments. It is also preferable to select a site for which meteorological data are available.

Site preparation

Clear the site of all vegetation. It should then be tilled adequately. Whenever possible, the site should be disc-ploughed twice in two directions, perpendicular to each other; otherwise, prepare according to local management practices.

Block shape and positioning

The block layout depends on plot shape, soil variability, and practical field considerations. Choose the block shape to minimise the variability within the block. All obvious site variation should be carefully evaluated when laying out the trial. If the site is uniform, blocks with the shape shown in Figure 1, for example, can be laid freely. Where a dominant soil gradient in a particular direction is known (e.g. sloping land), a more rectangular block layout positioned across the slope is a better choice to minimise variability. Blocks do not have to be contiguous or always of regular shape.

Marking out

Three different sizes of marking stakes will be used:

1. Large posts, made of concrete, wood, or PVC pipes to mark block corners.
2. Large pegs, small posts, or small PVC plastic pipes (but easily visible) to mark plot lines.
3. Small pegs to mark each planting position.

Mapping trial layout

Prepare a map showing trial layout for each trial site. The map should include the following details:

1. Name of the trial
2. Location of the trial site
3. Date of planting
4. Trial design
5. Illustration of field layout

4.2. Planting

Selecting seedlings

From each provenance in the nursery, select 64 healthy seedlings of uniform height. These seedlings should be around 30 cm in height. They should be "hardened off" 1-2 weeks before they are transported to the site. This can be done by gradually reducing the watering and removing shade. If cuttings are sprouted and rooted at both the nodes, cut carefully at the middle of the cutting to get two plants.

Transport of seedlings

The seedlings should be well watered before transportation. They should be packed in wooden or plastic boxes to avoid damage during transportation. Ensure that the seedlings are not packed loosely. Avoid wind damage during transport by erecting appropriate screens on the truck.

After arriving at the planting site, place the seedlings in a protected, shaded area until planting. Water them thoroughly daily.

Planting seedlings

Planting holes should be 25 x 25 x 25 cm. In addition, cultivate topsoil within 15 cm of the hole.

Planting should be done in the morning and/or evening, not in the heat of the day. Slit the potting bag with a sharp knife or razor blade and carefully remove the plastic bag without breaking the soil or damaging the roots. Set the seedling in the hole, with its root collar level with ground surface. Fill in the soil around the roots of the seedling and firm the soil well down around the seedling to avoid large air pockets in the soil. Do not stamp with the foot and do not press with a heel. Mulch with dry grass.

Replace dead seedlings with new ones within 2 months after planting.

4.3. Post-planting maintenance

Weeding

The seedlings should be kept free from weed competition during the initial stages of development, until weeds are outgrown. Frequency and method of weed control will depend upon particular site conditions.

Every 2-3 months during the first year, pull all weeds within 50 cm of each seedling, and cut all those in the remainder of the experimental area to prevent competition. For succeeding years, weed as necessary.

If chemicals are used, take care to avoid damaging the bamboo seedlings and to ensure workers' safety.

Fire protection

Conduct regular weeding and removal to ensure that dead plant material does not accumulate within the experimental area, especially during the dry season. Prepare a firebreak, 8 - 12m wide, around the experimental area before the beginning of the dry season. Cut and remove vegetation or plough within the firebreak regularly during the dry season.

Fencing

The experimental area should be fenced to prevent damage, particularly damage caused by animals. To help prevent human damage to trees, communicate to all neighbours the study objective and long-term importance of the results to the local population. This will help to ensure protection by the local community.

Pest and disease control

Monitor pests and diseases, especially ants, crickets, or other insects. Appropriate control measures should be taken as necessary up to the age of 1 year. After that, taking effective measures may be difficult and costly.

5. MINIMUM DATA SET TO BE COLLECTED

There are two kinds of data that all cooperators must provide: one-time information, and measurements taken periodically in the field.

5.1. One-time information

The following information will be required at the beginning of the trial.

Site description (See examples in Appendices 1,2 and 3)

Name and address of principal investigator and institution

Site name, state, country

Latitude, longitude, and elevation of experiment site

Climate (maximum and minimum temperatures, precipitation)

Previous vegetation (including existing land use) and method of clearing

General relief: (flat, rolling, hilly, or mountainous)

Site relief: (flat, concave, convex, or ridge)

Position: (upper slope, mid-slope, lower slope, terrace, or valley)

Slope percentage, aspect

Method of soil cultivation

Farmgate prices for bamboo shoots and poles.

Nearest weather station (see example in Appendix 2)

Name, straight-line distance from site

Latitude, longitude, and elevation of weather station

Mean monthly precipitation, maximum and minimum temperatures and relative hun idity for the past 10 years.

The number of rainy days per year.

Soil characterisation

If possible, try to get the following information on soil:

Topsoil and subsoil texture, pH, colour, drainage

Soil family, moisture regime, temperature regime

Depth to impermeable layer or water table

Parent material, bulk density, stoniness, salinity

Soil fertility

5.2. Field measurement and recording procedure

The information described,in this section must be recorded periodically during the experiment. Note the frequency of each record where it is mentioned.

Plant measurements

Survival

Count all clumps in each plot and record them.

Number of culms

Count the number of culms at each clump every time.

Height

Measure the total tree height of three dominant culms at each clump. Mark the culms and measure the tree from ground level to the top of its highest apical bud. If the stems are bent over, straighten them if possible, so that the actual length of the stem is measured.

Use a height stick or some type of marked, rigid pole to take this measurement.

Regularity of measurement

Clump survival, number of culms and height of three dominant culms are to be measured every 2 weeks until the 12 culm stage is reached. Note the age when this stage is reached. Thereafter, only continue with recording the number of culms; do this **monthly** until the age of 4 years.

Shoot measurements

Number of shoots

Starting from the 12 culm stage, count the number of hoots produced from each clump (original "tree"), every 3 months until the age of 4 years. (Note: Shoots sprout at the outset of rainy season).

'Shoot weight

Starting from the 12 culm stage, harvest the shoots produced for sampling every 3 months until the age of 4 years. Only those shoots that are greater than 60 cm are to be sampled. The harvest is to be done only from 8 clumps (original "trees"); the other 8 are to be left untouched until the final harvest. The sampled shoots are weighed fresh, and then dried to obtain the dry weight.

Additional measurements at final harvest

At 4 years, the following measurements will be made from the 16 clumps (original "trees"):

Number of culms.
Number of shoots.
Shoot weights.
And for every culm, measure :

- The total length,
- The number of internodes,
- The diameter of the 8th internode taken at the mid-position, with a diameter tape or vernier caliper.
- The thickness of the 8th internode taken at the mid-position, with a vernier caliper.

Weather information

This information must be obtained with instruments located at the site. Weekly records of maximum and minimum temperatures, precipitation, and relative humidity will be taken for the whole duration of the trials (4 years). For sites that do not already have a weather station in place, the cooperator must install thermohydrograph and rain gauge.

5.3. Log of experiment operation and monitoring

Keep records of the dates and management operations done. Operations include anything carried out during the trials that may influence growth of the bamboos (for example, the date of weeding, the type of weeding, or drainage construction).

The trials should also be regularly monitored for other incidences such as wind damage, pest infestation, flooding or diseases.

6. DATA STORAGE AND EXCHANGE

One of the main features of these network trials is data exchange for multi-site analysis. To facilitate this, the data should be recorded and stored in a standard way.

7. TRIAL CHECKLIST

Use the following checklist to ensure that you schedule important activities in the trial correctly.

Preplanting Period

1. Finalise all the necessary arrangements for participation in the network trials with INBAR Secretariat or responsible institute as designated by the Secretariat.
2. Send information on site and weather station to Network Secretariat.
3. Receive all seeds/culms from Network Secretariat.
4. Receive trial guidelines from Network Secretariat.
5. Raise sufficient seedlings for the trial.
6. Prepare the site in time for planting during the rainy season.

Post-planting Period

1. Within 2 months after planting, replace dead seedlings with new ones.
2. Weed every 2-3 months during the first year, and as necessary for subsequent years.
3. Every 2 weeks, measure plant survival, number of culms, and height of 3 dominant culms up to the 12 culm stage. Thereafter, record only the number of culms monthly.
4. After the 12 culm stage, record the number of shoots produced and sample shoots greater than 60 cm in length for wet and dry weights from 8 clumps (original "trees") every 3 months.
5. At the final harvest (4 years), measure the number of culms, number of shoots, wet and dry shoot weights, total length of every culm, number of internodes of every culn, and diameter and thickness of the 8th internode of every culm.
6. Bend data to INBAR Secretariat for combined inter-site data analysis and exchange.

REFERENCES

Banik, Ratan Lal. 1980. Propagation of bamboos by clonal methods and by seed. In, G. Lessard and A. Chouinard (eds.), *Bamboo* Research in *Asia,* IDRC Canada: 139-150.

Banik, Ratan Lal. 1985. Techniques of bamboo propagation with special reference to prerooted and prerhizomed branch cuttings and tissue culture. In, A. N. Rao et al (eds.), *Recent Research in Bamboos,* CAF and IDRC: 160-169.

Anantachote, Anan. 1985. Flowering and seed characteristics of bamboos in Thailand. In, A. N. Rao et al (eds.), *Recent Research in Bamboos,* CAF and IDRC: 136-145.

Ramyarangsi, Sakonsak. 1988. Techniques for seed storage of *Thyrosostuchus siumensis.* In, I. V. Ramanuja Rao et al feds.), *Bamboos: Current Research,* KFRI and IDRC: 133-135.

Vongvijitra, Rungnapar. 1988. Traditional vegetative propagation and tissue culture of some Thai bamboos. In, I.V. Ramanuja Rao *et al* feds.), *Bamboos: Current Research,* KFRI and IDRC: 148-150.

EXAMPLE OF SAMPLE SITE DESCRIPTION

Form C: Trial Site Information Experiment ID;TK-01

Trial Site Name	: Lad Krating Plantation
Site ID	: 'LKT-01
Elevation	: 150 m Aspect (degrees from North)
Latitude	: 13 degrees 30 minutes N
Longitude	: 101 degrees 32 minutes E
TrialSite Topography	
Slope Gradient	: 3%
Slope Position	: Middle
General Topography	
Slope Gradient	: 3%
Length of Slope	: 100 m to 500 m

EXAMPLE OF SAMPLE SITE DESCRIPTION - CLIMATE

Form E: Site Descriptor - Climate Experiment ID: TK-01

Climate Station Name	: Sanam Chai Khet
Climate Station ID: 423006	
Years of Records	: 79
Latitude	: 13 degrees 30 minutes N
Longitude	: 101 degrees 32 minutes E
Elevation	: 150m
Distance of Experiment Site	: 5.0 km

Month	*Maximum Temp (°C)*	*Minimum Temp (°O*	*Precipitation (mm)*
January	**32.1**	**21.8**	**143**
February	**33.1**	**22.3**	**188**
March	**33.3**	**22.6**	**229**
April	**33.4**	**22.2**	**214**
May	**33.5**	**22.5**	**215**
June	**33.1**	**22.1**	**127**
July	**32.5**	**21.6**	**138**
August	**32.9**	**21.6**	**88**
September	**32.7**	**21.4**	**150**
October	**32.5**	**22.1**	**198**
November	**32.4**	**22.1**	**277**
December	**32.2**	**21.8**	**174**
Mean	**32.8**	**22.0**	
Total	**2141**		

EXAMPLE OF SAMPLE SITE DESCRIPTION - SITE PREPARATION

Form G: Experiment Site Preparation Experiment ID: TK-01

Existing Vegetation

Plantation of *Melia* azedurach was burned previously and poor growing stock remain.

Method of Clearing

Big trees were cut down with chainsaw, all stumps were removed with bulldozer, and land was cleared afterward.

Residue : Removed

Percentage of surface free of residues after preparation: 40%

Method of Soil Cultivation

Ploughing with tractor was done 3 times prior to the planting, to the depth of 50 cm.

SAMPLE FIELD MEASUREMENT FORM (PERIODIC)

Block : .... Date (Age) : ....

Plot No.	Clump No.	Survival	No. of Culms	Height of 3 Dominant Culms (m)		
				1	2	3

SAMPLE FIELD MEASUREMENT FORM (FINAL)

Block ....

Date (Age) : . . . .(4 Yrs.)

Plot No. ....

Clump No. ....

No. of Clums ....

Culm	Total length	No. of	Culm Measurements: Diameter of (cm)	Culm Measurements: Thickness of 8th Internode (cm)

SAMPLE FIELD MEASUREMENT FORM FOR SHOOTS

Block .... Date (Age) : ....

Plot No. .... Clump No. ....

No. of Shoots	Shoot Measurement	
	Fresh Wt. (kg)	Dry Wt. (kg)

A GUIDE FOR STANDARDISED SPECIES AND PROVENANCE TRIALS OF RATTAN

Kamis Awang

PREFACE

Rattans have numerous uses, but are particularly important in sustaining and further developing furniture and handicraft industries in many countries of Asia. As rattans are at present mainly collected from the wild, their natural supply has been over-utilised. Interest is now growing for better management of natural stands, including renewal through planting and the development of plantations. Research on the variability, selection and use of specific genetic resources and appropriate silviculture are becoming more prominent than hitherto.

Sharing of information and exchange of genetic resources are prerequisites for sustained and expanded production. However, knowledge on the performance of species and provenances over environmental ranges is limited, and so is the movement of germplasm across political boundaries. INBAR stresses the mutual benefits to be gained by minimising a number of such constraints and for research to lead, in the foreseeable future, to the identification of improved genetic materials.

In order to promote more intensive in-country research, to facilitate better information exchange and eventually greater regional co-operation, this manual has been prepared to provide guidelines to researchers involved in conducting species and provenance trials, preferably on multiple sites.

In the past, comparisons between performance trials have not always been possible owing to inadequate attention being given to the correct taxonomic identity of the materials used. At the outset, this must be remedied with correct identity and maintenance of voucher specimens; at all costs, vernacular names for identity should be avoided.

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Dean, Faculty of Foresty, UPM

CONTENTS

Appendices

1. INTRODUCTION

Evaluation data of species and provenances of rattans are generally limited. This is particularly so where multiple sites are involved and standardised methods used.

New trials should incorporate the following features:

- common design and standardised methodology
- common minimum data set to be collected
- common germplasm
- thoroughly described soils and climate at each site
- data exchange and professional interaction among collaborators (in-country network)
- inter-site combined analysis of data

The trials should preferably be designed to serve the following broad objectives

- to increase knowledge of growth and site requirements of different species/provenances of rattans
- to provide a focus for cooperation among researchers, both nationally and regionally
- to help improve and standardise forestry and agroforestry research methodology

Guidelines are provided below on designing the experiment, standard procedures to follow, minimum data set to be collected, and maintenance practices applicable to the experimental trials.

2. EXPERIMENT DESCRIPTION

2.1. Specific objective

To evaluate species and provenance performances over a number of sites, and to determine any provenance x site interactions.

2.2. Experimental design

The experimental design is a randomised complete block with 4 replications using a factorial arrangement of X Species x Y Provenances. The treatment factors are labelled as Factor A (Species) and Factor B (Provenances/Species). A researcher can determine his own number of species and provenances to evaluate, based on the resources available to him. As an illustration, let us assume the number of species used is 2 (X=2), and for each species 5 provenances (Y=5) are selected.

2.3. Layout

Provenances are randomly assigned in complete blocks of 10 plots each. A single row plot is the most appropriate, and is recommended for use.

Spacing is 6 m between rows and 3 m within rows for large diameter rattans (solitary species), and 6 x 6 m, respectively, for small diameter rattans (clustering species). Each plot is a row containing 15 plants. The experiment requires 15x10x4 = 600 seedlings. For each provenance, the total number of plants required is 15 x 4 = 80. An extra 20% should be reserved for replacement of dead seedlings.

For large diameter rattans, the experiment would require an area of 1.08 ha per site (block size is 60 x 45 m = 2700 m^2 per block x 4 blocks = 10,800 m^2). The area required for small diameter rattans would be 2.16 ha (block size 60 x 90 m = 5400 m^2 per block x 4 blocks = 21,600 m^2).

Plants are numbered beginning at the northwest corner and proceeding along the row. All the 15 plants are to be used as sample plants.

3. NURSERY SEEDLING PRO DUCTION

3.1. Fruit collection and processing

Fruits are collected in order to produce the planting materials. In some cases, plantations act as seed sources; in many cases, natural stands act as seed sources. Seed sources need to be documented to provide accession data normally recorded for an accession/provenance of a genetic resource. Accession data formats are available from the relevant national genetic resources programme, or any other agency such as the forest department.

The fruit ripening time must be first ascertained so that collecting can be carefully planned. After cutting the fruit-bearing branches (infructescences) from the rattan palm, fruits should be separated from the branches and packed in sacks made from locally available materials such as *Pandanus* sp. or *Lepironia articulata*. In order to maintain seed viability, fruits should be kept cool and moist at all times. The sacks can be kept moist by watering.

At the nursery, the fruits should be spread out on gunny sacks laid flat on the ground under shelter in a cool place. Before sowing, the fruit scales (pericarp) and the fleshy sarcostesta, the outer seed-coat, are removed. This can be done manually by first crushing the pericarp, and then rubbing the sarcotesta by hand against a gunny sack laid flat before being washed off with water. The rubbing and washing can be repeated until all the sarcotesta is removed.

The processed seeds should be immediately sown. If this is not possible, the seeds should be spread out on gunny sacks laid flat, and kept moist and cool as is done for fruits before processing.

3.2. Seed storage

Freshly harvested mature seeds of rattans normally display a high rate of germination, However, rattan seeds are very sensitive to dehydration. One of the most serious problems in storage is the level of seed moisture. For effective temporary storage, it is essential to keep the moisture content the lowest possible in order to reduce infestation of micro-organisms, but not so low as to kill the seeds. For example, seeds of *Calamus manan* can be air dried at room temperature for a night so that the moisture level is 30-35 % (fresh weight basis) before being put in plastic bags. They are then stored at a temperature of 14°-16°C.

3.3. Presowing treatment

Seeds should be treated with fungicide (e.g. 1 g fungicide to 300 g of seeds) before sowing, to minimise fungal attack on germinating seeds and developing seedlings. For seeds which have been stored temporarily, soaking in water overnight before treatment with fungicide is usually advisable.

3.4. Sowing seed

It is recommended that seeds are sown in seedbeds made of a layer 'of sandy loam 7-10 cm in thickness overlaid by a 3 cm thick layer of sawdust, the whole surrounded by planks to maintain the height of the bed. Shelter needs to be built over the seedbed to protect the seeds from heavy rain and direct sunlight.

For small diameter rattans, the seeds can be broadcast over the seedbed, and then spread out by hand to be about 2 to 3 cm apart. For larger seeds like C. *manan, they* can be sown in rows 4 cm apart with 2 cm distance within the rows. The seeds should be covered with l-2 cm of soil and subsequently covered with about 3 cm of seasoned sawdust.

Germination occurs in 3-4 weeks. Once the first seedling leaves are fully expanded, the seedlings are ready to be transplanted into containers.

Sow seeds 12 months before the planting date.

3.5. Potting mix

The potting mix should comprise the following mixture.

50% sandy loam (by volume)
40% river sand (by volume)
10% compost (by volume)

Add chemical fertiliser (12:24:12) (N:P:K) at 30-50 g (3-4 tablespoons) per 10 litres of potting mixture. Mix fertiliser thoroughly in the potting mixture before filling potting containers. The pH should be maintained between 6.0 and 7.5.

3.6. Potting containers

Use plastic bags (3 cm x 6 cm to 40 x 50 cm in size while flat; 0.075-0.1 mm in thickness) with 8 to 12 perforations as potting containers. The small bags are for small diameter rattans and the large bags are for large diameter rattans. If the bag does not come with holes, punch 8 holes extending to the base of the bag (office paper-puncher will suffice) before filling with potting mixture.

Ideally, all containers should be elevated 10 cm above ground or placed on a black plastic sheet to prevent roots from penetrating into the soils below.

3.7. Care of seedlings

Shade

Seedlings should receive about 50% shade. For the last 2-3 weeks prior to planting, seedlings should be exposed to full sunlight.

Watering

Water well in the morning if the upper part of seedling containers is dry. Always water seedlings with fine spray, particularly when seedlings are small. As a means of “hardening off”, watering should be reduced a week or so before the plants are transported to site.

Weeding

Keep seedlings free from weed competition at all stages of development. Careful manual weeding is better than the use of herbicides.

Grading of beds

To prevent larger seedlings from shading smaller ones, the beds should be graded by placing the larger seedlings at one end and the smaller seedlings at the other end. Grading may need to be repeated depending on the length of time the seedlings are kept in the nursery.

Root pruning

If seedling beds are raised above ground or placed on plastic sheets, root pruning should not be necessary. However, if seedlings stand on bare soil, it is necessary to prune the roots regularly. Do this by cutting the roots that emerge from drainage holes. Roots may be pruned at the time when the seedlings are graded.

Pest and fungus control

Control damping off and root rot with fungicides, if necessary. Either Blitox (a blue coloured powder) or Dithane M-45 (a yellow coloured powder) can serve this purpose,. Similarly, spray pesticides if needed, but exercise great care. Insecticides containing methyl parathion, such as as Metacid and Paramar, are usually effective against defoliators.

4. FIELD ESTABLISHMENT AND MAINTENANCE

4.1. Laying out the trial

Site selection

The trial site should be representative of the area where the species is likely to be planted. If it is to be planted by farmers on marginal lands, a first quality site would not be representative. The site must be easily accessible in all seasons to facilitate future maintenance and assessments. It is also preferable to select a site for which meteorological data are available.

Rattans are climbers which need support trees to grow well. In the early stage, they also need some shading. Generally, 50-60 % light appears optimum for growth. These two needs can be met by planting rattan provenance trials under logged-over natural forests or in plantations such as rubber.

Site preparation

Lines of at least a metre width should be cleared along the borders of a block. These lines can also serve as fire-belts. In areas where fire is common, the lines should be 20-50 m wide.

All the undergrowth, saplings, seedlings, bushes and non-commercially important trees along the planting lines should be slashed. The optimal width of the planting lines is 1.8-2.0 m.

Block shape and positioning

The block layout depends on plot shape, soil variability, and practical field considerations. Choose the block shape to minimise the variability within the block. All obvious site variation should be carefully evaluated when laying out the trial. If the site is uniform, square shaped blocks, for example, can be laid freely. Where a dominant soil gradient in a particular direction is known (e.g. sloping land), a more rectangular block layout positioned across the slope gives a better choice to minimise variability. Blocks do not have to be contiguous or always of regular shape.

Marking out

Three different sizes of marking stakes will be used:

- Large posts, made of concrete, wood, or PVC pipes to mark block corners.
- Large pegs, small posts, or small PVC plastic pipes (but easily visible) to mark plot lines.
- Small pegs to mark each planting position.

Mapping trial layout

Prepare a map showing trial layout for each trial site. The map should include the following details:

1. Name of the trial
2. Location of the trial site
3. Date of planting
4. Trial design
5. Illustration of field layout

4.2. Planting

Selecting seedlings

From each provenance in the nursery, select the required number of healthy seedlings which appear as uniform as possible. These seedlings should be around 30-40 cm in height. They should be "hardened off" 1-2 weeks before they are transported to the site. This can be done by gradually reducing the watering and removing shade.

Transport of seedlings

The seedlings should be well watered before transportation. They should be packed in wooden or plastic boxes to avoid damage during transportation. Ensure that the seedlings are not packed loosely. Avoid wind damage during transport by erecting appropriate screens on the truck.

After arrival at the planting site, place the seedlings in a protected, shaded area until planting. Water them thoroughly daily.

Planting seedlings

Planting should be done at the onset of rainy season. The size of planting holes should be at least twice the diameter of the polybag. The depth of the hole should be a few centimetres deeper than the height of the polybag. Place 100-150 g of Christmas Island Rock Phosphate in the bottom of the hole and cover with soil.

Planting should be done in the morning and/or evening, not in the heat of the day. Slit the potting bag with a sharp knife or razor blade and carefully remove the plastic bag without breaking the soil or damaging the roots. Set the seedling in the hole, with its root collar level with ground surface. Fill in the soil around the roots of the seedling and firm the soil well down around the seedling to avoid large air pockets in the soil. Do not stamp with the foot and do not press with a heel. Mulch with dry grass.

Replace dead seedlings with new ones within 2 months after planting.

4.3. Post-planting maintenance

Weeding and pest control

The seedlings should be kept free from weed competition during the initial stages of development, until weeds are outgrown. Frequency and method of weed control will depend upon particular site conditions.

The borders and planting lines usually need to be cleaned 3-4 times a year for the first three years. A strip of area encompassing 1 m distance on both sides of the planting line is cleared. For succeeding years, weed as necessary.

Monitor pests and diseases, especially termites, cricket, mealy bugs, or other insects. Appropriate control measures should be taken as necessary up to age 1 year. After that, taking effective measures may be difficult and costly.

If chemicals are used, take care to avoid damaging the rattan seedlings and to ensure workers' safety.

Fire protection

Conduct regular weeding and removal to ensure that dead plant material does not accumulate within the experimental area, especially during the dry season. Prepare a firebreak, 8 - 12 m wide, around the experimental area before the beginning of the dry season. Cut and remove vegetation or plough within the firebreak regularly during the dry season.

Fencing

The experimental area should be fenced to prevent damage, particularly damage caused by animals. To help prevent human damage to trees, communicate to all neighbours the study objective and long-term importance of the results to the local population. This should assist in a degree of protection by the local community.

5. MINIMUM DATA SET TO BE COLLECTED

There are two kinds of data that all researchers must attempt to acquire: one-time information, and measurements taken periodically in the field.

5.1. One-time information

The following information is required at the beginning of the trial.

Site description (See examples in Appendices 1,2 and 3,

Name and address of principal investigator and institution

Site name, state, country

Latitude, longitude, and elevation of experiment site

Climate (maximum and minimum temperatures, precipitation)

Previous vegetation (including existing land use) and method of clearing

General relief: (flat, rolling, hilly, or mountainous)

Site relief: (flat, concave, convex, or ridge)

Position: (upper slope, mid-slope, lower slope, terrace, or valley)

Slope percentage, aspect

Method of soil cultivation

Farmgate prices for cane, rattan fruit, and rattan shoots.

Nearest weather station (see example in Appendix 2)

Name, straight-line distance from site

Latitude, longitude, and elevation of weather station

Mean monthly precipitation, maximum and minimum temperatures and relative humidity for the past 10 years.

Soil characterisation

If possible, try to get the following information on soil:

Topsoil and subsoil texture, pH, colour, drainage

Soil family, moisture regime, temperature regime

Depth to impermeable layer or water table

Parent material, bulk density, stoniness, salinity

Soil fertility

5.2. Field measurement and recording procedure

The information described in this section must be recorded periodically during the experiment. Note the frequency of each record where it is mentioned.

Plant measurements

Survival

Count all the palms in each plot and record them.

Stem length

Measure the total stem length. For clustering rattan, record the number of stems and measure the length of the dominant stem. Measure from the ground level along the stem, to the base of the petiole of the youngest leaf on the shoot.

Use a height stick or some type of marked, rigid pole to take this measurement or measuring tape when the rattan gets bigger.

Measure all the rattans in the plot. For the first 2 years, measurements are made at 3-month intervals. beyond 2 years, measurements are made at 6-month intervals. The measurement should be reduced to once a year after the rattans have reached the canopy level of the forest/plantation.

Number of leaves

When the stem length is measured every 3 months for the first 2 years, count and record the number of leaves produced.

Diameter at 1 -m level

Every time the stem length is measured, the stem diameter, at a level of 1 m above the ground (whenever possible), is also measured, using a caliper.

Flowering andfruiting

Record the first flowering and fruiting dates, if any.

Final measurements

The trial should last at least 4-5 years. At the end of the experiment, in addition to the stem length, diameter at l-m level and number of stems, also record the number of internodes up to the 3-m length (standard commercial cane length).

5.3. Log of experiment operation and monitoring

Keep records of the dates and management operations done. Operations include anything carried out during the trials that may influence growth of the rattans (for example, the date of weeding and the type of weeding).

The trials should also be regularly monitored for other incidences such as fire damage, flooding, pest infestation, or diseases.

EXAMPLE OF SAMPLE SITE DESCRIPTION

Form C: Trial Site Information Experiment ID: TK-01

Trial Site Name	: Lad Krating Plantation
Site ID	: LKT-01
Elevation	: 150m
Aspect (degrees from North):	
Latitude	: 13 degrees 30 minutes N
Longitude	: 101 degrees 32 minutes E
Trial Site Topography:	
Slope Gradient	: 3%
Slope Position	: Middle
General Topography:	
Slope Gradient	: 3%
Length of Slope	: 100 m to 500 m

EXAMPLE OF SAMPLE SITE DESCRIPT ,N - CLIMATE

Form E: Site Descriptor - Climate   Experiment ID: TK-OI

Climate Station Name : Sanam Chai Khet
Climate Station ID : 423006
Years of Records : 79
Latitude 13 degrees 30 minutes N
Longitude 101 degrees 32 minutes E
Elevation 150 m
Distance of Experiment
Site 5.0 km

Month	*Maximum Temp (°C)*	*Minimum Temp (°C)*	*Precipitation (mm)*
January	32.1	21.8	143
February	33.1	22.3	188
March	33.3	22.6	229
April	33.4	22.2	214
May	33.5	22.5	215
June	33.1	22.1	127
July	32.5	21.6	138
August	32.9	21.6	88
September	32.7	21.4	150
October	32.5	22.1	198
November	32.4	22.1	277
December	32.2	21.8	174
Mean	32.8	22.0	
Total	2141		

EXAMPLE OF SAMPLE SITE DESCRIPTION - SITE PREPARATION

Form G: Experiment Site Preparation Experiment ID: TK-01

Existing Vegetation

Plantation of *Melia azedarach* was burned previously and poor growing stock remain.

Method of Clearing

Big trees were cut down with chainsaw, all stumps were removed with bulldozer, and land was cleared afterward.

Residue: Removed

Percentage of surface free of residues after preparation: 40%

Method of Soil Cultivation

Ploughing with tractor was done 3 times prior to the planting, to the depth of 50 cm.

APPENDIX 2.4

SAMPLE FIELD MEASUREMENT FORM

Block : ....   **Date (Age)** : ....

Plot No.	Plant No.	Survival	No. of Stems	Length of Dominant Stem (m)	No. of Leaves	Diameter at 1 m Level (cm)	Flow-ering Time	Fruiting Time	No. of Internodes up to 3 m

Note: For flowering and fruiting, record the time when first one takes place for each stem.

ANNEX 1

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