CONSULTANCY REPORT

BAMBOO (KENYA) PROJECT

(Centre File: 3-P-86-0244)

P M Ganapathy, PhD

I V Ramanuja Rao, PhD

CONTENTS

INTRODUCTION

BACKGROUND

The Bamboo (Kenya) project was approved for implementation in the Kenya Forestry Research Institute (KEFRI) in March 1987. Although the date of commencement was June 1987, project activities commenced sometime in September 1987. The project period which was to end in June 1990 was extended upto 30 May 1991. The following are the objectives of the project:

General Objective

To evaluate and establish fast growing, adaptable species of bamboo, to meet local demands for the country's village crafts industries.

Specific Objectives

(a) To survey the distribution and availability of suitable Asian and African species for introduction to Kenya;

(b) to develop nursery techniques for the mass propagation of species of African and Asian origin;

(c) to compare the growth of selected species in different agroclimatic zones in the country; and

(d) to investigate the economics of bamboo cultivation, processing and marketing in Kenya.

The project was reviewed in May-June 1988 and the consultant Dr G Dhanarajan made some recommendations. The objective of the present consultancy was to review the progress achieved by the project and assist with the formulation of a Phase II proposal as detailed in the Terms of Reference.

ACKNOWLEDGEMENTS

Meetings had been arranged for us with several persons connected with the project. In addition, we sought and obtained time at short notice for meetings with others for discussions on the Phase II proposal. To all of them, we are grateful for sparing their time. In particular, we wish to thank Dr Jeff A Odera, Director, KEFRI, Mr David M Kamweti (EARO) and Dr Bernard N Kigomo (Project Leader) for their help and assistance. Mr Kamweti, Dr Kigomo and Mr Gordon Sigu stretched their working hours till late evenings and sacrificed their week-ends to remain with us during our stay, including field visits. Our sincere thanks to Dr Paul Vitta, Ms Rita Bowry and Ms Margaret Emoker of EARO for the care with which they arranged the visit. For a very useful briefing, we are beholden to Dr Cherla B Sastry and to Ms Catherine Ndiaye (ASRO) for the backstopping arrangements.

TERMS OF REFERENCE

(a) To travel to Nairobi, Kenya as Team Leader (Dr P M Ganapathy) together with Dr I V Ramanuja Rao (the other consultant) to visit the Centre-supported Bamboo (Kenya) project;

(b) to discuss and review the progress achieved todate with the project personnel and assist with the formulation of a Phase II proposal;

(c) to examine the issue of germplasm transfer, identifying any bottlenecks at both the source and receiving (Kenya) ends and suggest specific measures to overcome constraints;

(d) to evaluate current practices and studies on germination, nursery and field trials and to check if any duplication of studies exist (i.e., from work already undertaken in Asia); recommend specific research studies which are needed and might be carried out within the project; and

(e) to submit a joint report of the work accomplished to the Acting Regional Director, Regional Office for South East and East Asia, IDRC, with a copy to Dr Ron Ayling at our Ottawa Office by March 20, 1991 (this was extended to April 10 at our request).

ITINERARY (also see map on page 5 and Appendix 1)

8.2.91 Left Singapore at 10.00 a.m. and reached Bombay at 12.35 p.m. Left Bombay at 6.30 p.m. and reached Nairobi at 10.15 p.m.

9.2.91 Discussions with project staff

10.2.91 (Sunday) At Nairobi

11.2.91 Meeting in IDRC EARO Office. Briefing session with Project Leader. Left for Muguga. Met Director KEFRI and visited laboratories and extension centre. Visited project experimental sites and returned to Nairobi late in the evening

12.2.91 Left for Karura and visited Wood Science and Technology Division of KEFRI. Proceeded to experimental site near Kinale and thereafter to Forest Industrial Training Centre, Nakuru. Left for Eldoret and halted for the night

13.2.91 Visited Penon (Kaptagat) experimental site and proceeded to Moi University. Visited Department of Forestry, Moi University and proceeded to Kakamega, visiting en route bamboo and rattan experimental sites, natural forest and

Seed Collection Centre. Halt at Kakamega

14.2.91 Left for Yala and visited Siaya experimental site, Agroforestry Centre, Maseno (KEFRI-KARI-ICRAF). Proceeded to Kisumu, visiting Nyabeda experimental site en route. Reached Nairobi late in the evening

15.2.91 At Nairobi. Discussions with Mr Kamweti and Dr Kigomo

16.2.91 Left Nairobi for Mombasa and halted for the night

17.2.91 Proceeded to Malindi and visited forest station and Bamboo/Rattan experimental sites at Gede and Bamboo experimental site at Jilore. Returned to Mombasa. Left for Nairobi by train. In the course of our field visits, we covered about 2500 km by road (PMG + IVR) and 500 km by rail (PMG)

17.2.91 (Sunday) Reached Nairobi. Discussions with Project Leader

18.2.91 Discussions in EARO together with Project Leader

19.2.91 Met Director, KEFRI, together with Mr Kamweti. Discussions with Project Leader. Left Nairobi at 6.30 p.m. Returned to Nairobi because of bird hit. Left Nairobi by relief plane at 00.15 a.m.

20.2.91 Reached Bombay at 8.30 a.m. Left Bombay at 11.30 a.m. Reached Bangalore at 1.00 p.m. (PMG)

(One of us (IVR) had to return earlier due to unforseen circumstances:

15.2.91 Left Nairobi at 11.00 p.m.

16.2.91 Reached Bombay at 7.45 a.m.

17.2.91 Left Bombay at 7.45 a.m. Reached Delhi at 9.45 a.m.)

PERSONS MET

IDRC EARO

Dr Paul Vitta, Deputy Director
Mr David M Kamweti, Consultant
Ms Rita Bowry, Program Administrator
Ms Margaret Emoker, Program Officer
Ms Agnes Ogana, Secretary (Forestry Program)

Bamboo (Kenya) Project

Dr Bernard N Kigomo, Project Leader
Mr Gordon Sigu, Project Assistant
Ms Agnes Babu, Project Secretary

KEFRI

Dr Jeff A Odera, Director
Dr Joe Mwangi, Head, Biotechnology Division
Mr Joseph Magondu, Assistant Research Officer, Biotechnology Division
Ms Alice Kaudia, Training Manager
Mr Mwamburi, Assistant Training Officer
Mr Joseph Kichana, Technologist
Mr Opiyo, Technologist
Mr John Mambo, Technologist
Ms Agnes Ng`ang'a, Technologist

Karura Forest Products Program (KEFRI)

Mr Onchieku James, Wood Physics and Engineering
Mr Moilonti Kavaka, Wood Chemistry
Mr Albert Luvanda, Biomass Energy
Ms Nellie Ndegwa, Wood Composites
Mr George M Muthike, Wood Anatomy and Quality
Mr Meshack Muga, Natural Products/Pulp and Paper
Ms Ezrkiel Kute, Energy Section
Ms Jodam Kagombe, Harvesting
Ms Shiela Mude, Pulp and Paper
Mr E O Kute, Energy

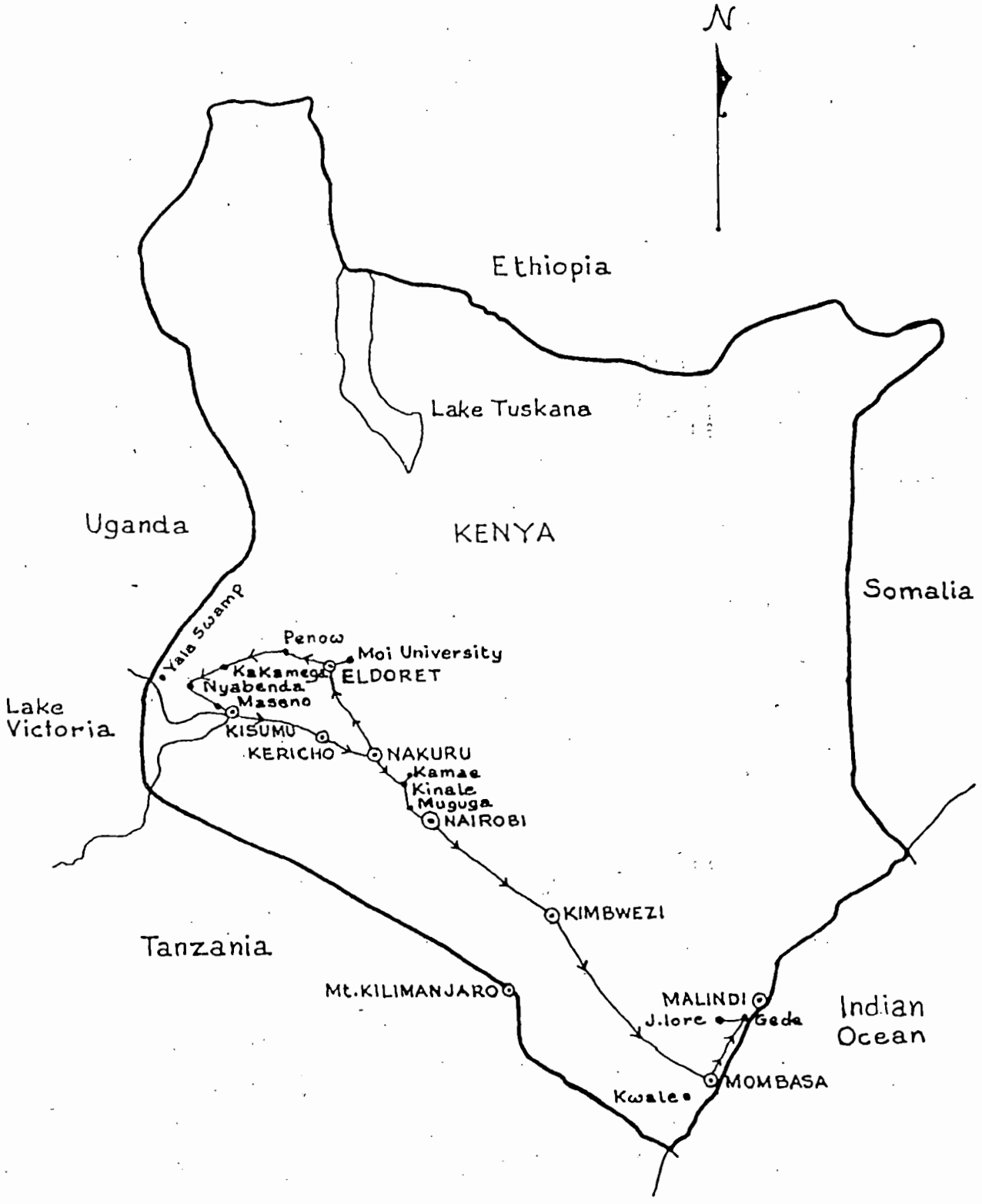
Coast Province

Mr Geoffrey M Kinyanjni, Provincial Forest Officer-Coast
Mr Mibusu Kamau, Station Director, Gede Forest Research Station (KEFRI)
Mr G Mwangi, Forester, Gede Forest Research Station (KEFRI)

Others

Mr Imbugah, Forest Assistant, Kamae Forestry Station, Ministry of Environment and Natural Resources
Mr G H Macharia, Project Manager, Forest Industrial Training Centre
Mr K Tallam, Assistant Project Manager, FITC
Dr Anwar Haq, Dean, Department of Forestry, Moi University
Dr Francis Sang, Head, Department of Forestry, Moi University
Mr Evanson Muriu, Chief Technician, Department of Forestry, Moi University
Mr Ndungu, Technician, Kakamega Seed Collection Centre
Mr Harry Otieno, Research Officer and Centre Director, Maseno Agroforestry Centre

Map of Kenya showing places visited



Not to scale

TECHNICAL REPORT

REVIEW OF IMPLEMENTATION OF PREVIOUS CONSULTANT'S RECOMMENDATIONS

Dr G Dhanarajan (former Network Coordinator) visited the project in May-June 1988 to review the activities, recommend suitable Asian species for introduction and consider aspects connected with their importation and propagation. Our assessment of the work done for implementation of the recommendations is given below.

a) **Recommendation:** Information on the natural bamboo flora of East and South Africa and research conducted thereon should be collected to serve as a background material.

Comments: A KEFRI monograph and three research papers based on the information collected, have been published. These contributions have provided much needed documentation on bamboos of the region, particularly Arundinaria alpina.

b) **Recommendation:** 1 to 1 1/2 years old culms, rhizomes, offsets of Arundinaria alpina should be used for mass propagation.

Comments: Propagation through culm cuttings, rhizomes, offsets, and wildlings has been tried. However, the studies have been confined to the nursery only and no attempt made for mass propagation. Instead of continuing exploratory studies, advantage should be taken of mass propagation techniques worked out and applied elsewhere. As regards propagation by culm cuttings, the Bamboo (India) project at the Kerala Forest Research Institute has worked out a successful technique to which a number of bamboo species have responded satisfactorily. This is published by BIC (India) and a copy has been given to the Project Leader. The application of the culm cutting technique to A. alpina needs to be examined. Mass propagation by macro-proliferation, a technique evolved in India, has also been found to be very successful. Verification trials may be undertaken particularly for A. alpina. Information on this technique is given in Appendix 2.

c) **Recommendation:** Termite infestation is noticed in nursery and field. Treatment with termiticides should be tried.

Comments: Although some chemicals were tried, no evaluation was made. Termites were still noticed, for example, in Muguga and Gede. An effective method of application does not appear to have been tried. The methodology summarized in Appendix 3 may be followed.

d) **Recommendation:** Bambusa vulgaris available locally and in Malawi and Madagascar should be included in mass propagation studies

Comments: Studies on vegetative propagation of B. vulgaris have been carried out including propagation by culm cuttings. Work on mass propagation has not been initiated as techniques still need to be standardized.

e) **Recommendation:** Propagation of A. alpina by seeds and wildlings should be tried.

Comments: Propagation by seed as well as by wildlings has been tried with success. Although propagation has been successfully accomplished, standardization of nursery and out planting practices has not been initiated. This needs to be done before attempting mass propagation.

f) **Recommendation:** One of the sites selected for the field trial was far from the road and water availability was found to be a problem. Hence this site should be excluded.

Comments: This has been done.

g) **Recommendation:** As there will be difficulties and delays in obtaining propagules for vegetative propagation, study-cum-collection trips should be undertaken by the project staff

Comments: Study-cum-collection trips were undertaken in Tanzania, Rwanda, Thailand and India. Most of the material for the project was collected on these trips. Only from Thailand was some material obtained by post.

h) **Recommendation:** Following species (selected after matching ecological conditions) may be tried in species trial studies Arundinaria alpina, A. falcata, Bambusa blumeana, B. arundinacea, B. balcoa, B. polymorpha, B. tulda, B. vulgaris, Dendrocalamus strictus, D. asper, D. hamiltoni, D. membranaceus, Gigantochloa apus, Melocanna baccifera and Thyrsostachys siamensis. For a comparative study of the performance of A. alpina, this species should be planted in all trial sites.

Comments: Seed or other material for propagation of the following species could not be obtained: Arundinaria falcata, Dendrocalamus asper, D. hamiltonii, Gigantochloa aspus, B. balcoa and Melocanna baccifera. The remaining species recommended have been tested. Planting of A. alpina was attempted in trial sites in all the zones. Outside its natural habitat it did not establish anywhere except Muguga. The species which could not be procured earlier and other species (not listed) may now be

obtained for establishing living collections and continuing with the species trial. Only those species which have shown promise in the trials already undertaken in Phase I should be procured for mass propagation and would be adequate for meeting local needs.

REVIEW OF WORK ACCOMPLISHED IN PHASE I

1. Phase I (86-0244) began in June 1987 and will complete in May 1991. The general objective of Phase I was to develop practical methods to evaluate and establish fast-growing, adaptable species of bamboo, to meet the local demands for the country's village crafts industries. The specific achievements were:

Objective a): To identify Asian and African species suitable for introduction to Kenya

Several African species which could adapt to the climatic and soil conditions of Kenya were identified. Some planting material was introduced from Malawi, Tanzania and Rwanda. Besides, several bamboo species were recommended by the consultant for inclusion in the project research and development activities: Arundinaria alpina, A. falcata, Bambusa arundinacea, B. balcoa, B. blumeana, B. polymorpha, B. tulda, B. vulgaris, Dendrocalamus strictus, D. asper, D. hamiltoni, D. membranaceus, Gigantochloa apus, Melocanna baccifera and Thyrsostachys siamensis.

A monograph was published on the distribution and state of bamboo management and development principally in East Africa. Other papers have also been prepared. The publications have updated information on bamboos of the region particularly in respect of A. alpina. A more detailed analysis of research on bamboo in Kenya was published. A technical note on local bamboo species was also prepared.

Comments: Concerted attempts have not been made for introduction of species from other countries of Africa. This is attributed to difficulties involved in obtaining planting material and the implicit preference for Asian species.

Objective b): To develop satisfactory nursery techniques for the mass propagation of species of African and Asian region

A study tour was undertaken in the first year of the project. Some planting material was obtained from Thailand, India and Bangladesh. Information was also collected on the state-of-the-art in nursery techniques for bamboo cultivation, multiplication utilization and marketing of the produce.

The III International Bamboo Workshop held at Cochin, India (1988) afforded a good opportunity for germplasm collection as material was obtained from Indonesia, Thailand and India. Besides, seeds of Phyllostachys pubescens were obtained through the courtesy of JICA. In addition to these, the project procured other Asian germplasm including B. giganteus, B. nutans, B. thorni-cornis, B. vulgaris var. striata, D. brandisii, Gigantochloa atter, G. aspera, Neohouzeana dulloa, Phyllostachys lenosis, Shibatea ruscifolia and Teinostachys lenonis.

Propagation tests in the nursery indicated that the rate of growth of seedlings in shade was comparatively low; survival is influenced by spacing and black polythene tubes encouraged better growth. A comparative trial of B. vulgaris var. striata, A. alpina and O. abyssinica showed that offsets are more successful while cuttings are most difficult to propagate except with B. vulgaris var. striata.

Comments: Achievement is only partial. Out of the seventeen species recommended by the consultant, eleven species have been procured as seed, cuttings and offsets. But as such mass propagation has not been carried out and methods standardized. Trials were conducted mainly from planting material of seed and wildling (in respect of A. alpina) origin. Studies on propagation by culm segments, were confined to one trial and those on rhizomes, to a very small extent. Difficulties in obtaining adequate quantity of planting material, inadequate background on mass propagation techniques and limited resources (as pointed out by the project leader) are the reasons for insufficient progress in this area. But another important reason is that limited attempts have been made in this regard.

Germplasm Transfer

Specific attention was given to this matter to identify bottlenecks both at the supplying and receiving ends.

Import of plants and plant materials to Kenya is not allowed as per provisions of the Plant Protection Act, unless a Plant Importation Permit issued under the above Act is obtained by the importer. (This we were given to understand, is relatively easy especially due to the fact that special emphasis is being given to bamboo in the country. Besides, the Division of Plant Quarantine Services which is under the Kenya Agricultural Research Institute, is located at Muguga itself. The project leader has an excellent rapport with the Division of Plant Quarantine Services). For this purpose, an application needs to be made to the Director, KARI (Division of Plant Quarantine Services, Muguga) furnishing the following information:

- Name of plant proposed to be imported
- Description of plant/plant part (viz. seedling, rhizome, stem, seed, fruit, etc.)
- Quantity
- Country from which import is proposed and full address of supplier
- Declaration that all quarantine conditions relating to import will be strictly observed.

After obtaining the permit, one copy along with a Q label needs to be sent to the supplier together with detailed instructions in conformity to Kenyan quarantine conditions (based on the information gathered, a specimen letter for this purpose is included in Appendix 4).

On receipt of the cargo arrival notice, it should be ensured that the parcel is delivered at the Plant Quarantine Station, not later than one day after reaching Kenya. (If properly labelled, the airport authorities telephonically inform KEFRI/KARI who then immediately collect the material).

If the procedure conforms to the provisions of the Kenya Plant Protection Act and clear instructions are issued to the suppliers in this regard, no bottlenecks on importation of germplasm are foreseen at the receiving end.

The main problem encountered has been in the identification of suppliers of germplasm. As detailed earlier, seeds were sent by Dr Songkram Thammincha from Thailand by post; through JICA from Japan and collected by the Project Leader from participants of the International Bamboo Workshop, Cochin who brought them in response to a request made by Mr G Dhanarajan. A similar request should be made to the participants of the IV International Bamboo Workshop to be held at Chiangmai, Thailand this year. Whereas seeds can be obtained from both near and distant sources, there is a limitation where rhizomes and cuttings are concerned. Thus, although the project received a positive response from Thailand for export of planting material, this was not pursued further in view of the time lag involved in the absence of direct flights. India is a nearer and more direct source but more efforts need to be made to establish supply sources. The only attempt made was to approach the Forest Research Institute, Dehra Dun from where there was no response.

To overcome this problem, the following can be contacted for rhizomes:

- M/s Adush Bamboo Vikas Nigam
  609, 15th Cross, Ist Phase
  J P Nagar, Bangalore 560 078, India
  Tel: (0812) 641534

- Director
  Kerala Forest Research Institute
  Peechi 680 653,
  Kerala, India
  Tel: (0487) 22375

In addition, project staff should be able to carry with them planting material, subject to observing export-import regulations, while returning from project-sponsored travel to India, Thailand and elsewhere.

The imported rhizomes can be multiplied through the macro-multiplication method. As planting out should be done at the break of monsoon and 3-4 months are required for development of planting material from rhizomes, the ideal period to import rhizomes is November-January. Import of seed, on the other hand, can be done as and when sources are identified.

Objective c): To compare the growth of selected species in different agroclimatic zones in the country

Fourteen species (including. A. alpina) were planted in several sites distributed in three regions: coast, lake and highlands. A. alpina did not establish in the coast and lake regions. Assessment of survival, clump size, and stem height and diameter have been made. Based on the results so far, the following species are recommended for planting in the three regions:

Coast region: B. blumeana, B. brandisii, B. tulda, D. membranaceus, D. brandisii, D. strictus, B. arundinacea

Highlands region: Arundinaria alpina (in Muguga if watered), Phyllostachys pubescens, Bambusa arundinacea (Muguga only), B. vulgaris (Muguga only)

Lake region: B. blumeana,B. brandisii, B. tulda, B. vulgaris, B. vulgaris var. striata, B. arundinacea, Dendrocalamus membranaceus, D. strictus, D. brandisii, Phyllostachys pubescens (Kakamega only), T. siamensis

Comments: The project has succeeded in establishing the feasibility of introducing bamboos in different climatic zones in the country (Appendix 5). This is no mean achievement and we were pleased with the results. Growth under Kenyan conditions (especially the lake and coast regions) compares well with that in the plains of India. However, considering that these bamboos are still juvenile and adult culms are produced after three years, it is too early to make a quantitative assessment of growth. Data collected so far is yet to be processed. Firm conclusions based on qualitative assessment are also not possible, as base line parameters are not comparable especially with regard to nature of propagule, time of planting, source of planting material, etc. The assessments of suitable species given above are, therefore, of indicatory value only. Observation on the trial plots should be continued during Phase II.

Acquiring and testing too many species should not be the focus of the project. This is not necessary. In India, for example, Dendrocalamus strictus and Bambusa arundinacea are the most important and widely used bamboos. In Thailand, it is Dendrocalamus strictus, Bambusa arundinacea, Thyrsostachys siamensis and Dendrocalamus asper. In China, Phyllostachys pubescens is predominant. However, because of the varied climatic conditions occurring in different parts of Kenya, the suitability of species for different regions may be different. Emphasis should be on consolidation and extension of results already obtained.

The activity involving hiring of local farmers and villagers at each trial location and instruction in the establishment and tending of the plots has not been attempted so far. This is an activity best suited for Phase II since the project staff were still in the learning phase during Phase I.

Objective d): To investigate the economics of bamboo cultivation, processing and marketing in Kenya

A report on the socio-economic importance of intensifying production of indigenous bamboo by adopting suitable management practices; extending bamboo production to private farms (indigenous and exotic species) and diversifying utilization potential of this material has been produced.

The study indicates that increased production must come from private farms. It, however recommends that information on management in farms, harvesting methods etc will be required before production farming is passed on to the local farmers. It will also be necessary to develop marketing channels, understand farm input needs against resources available at the farm/community level and infrastructure for ensuring efficient supply of planting materials. The current low prices for bamboo from public forests will also need to be adjusted according to the market to attract more farmers to this activity.

Comments: Despite the handicap of inadequacy and sometimes questionable dependability of the data base, a useful report has been produced. This important work will form the basis of future extension activities. Further studies of this nature should await improvement in availability of planting materials, increase in the production base, and availability of improved utilization technology.

There is a ban on cutting of bamboo from public forests by the government except for use by the government departments resulting in a large unsatisfied private demand. This ban is a misinformed one. Bamboo continuously puts out culms and after reaching a certain age (often 5-6 yrs), these dry up and must be removed as these can constitute a serious fire hazard. A bamboo forest continuously renews itself and multiple harvests are possible, and in fact, necessary for its proper management.

GENERAL ASSESSMENT OF PHASE I AND PHASE II DIRECTIONS

Phase I largely achieved its objectives. The project has helped to gain familiarization with bamboo. Importantly, it has generated a great deal of interest in this plant, particularly for its cultivation in forest and farm land. A very important contribution has been the introduction of Asian bamboos which can grow in areas where the native bamboo, Arundinaria alpina, cannot. If the constraints in accessing planting materials and difficulties encountered in starting a new venture are taken into account, the progress achieved in the project is certainly satisfactory.

Phase II should build on this foundation and expand the range of activities with the goal of developing local capability in bamboo research and utilization. The need for quickly making available material for the cottage industries has been another guiding factor in determining the nature of research activities.

Kenya is well endowed with bamboo resource (ca. 150,000 ha or 10% of the forest area), although of only one species, Arundinaria alpina. This natural resource has been neglected and not utilized because of inadequate information. Phase II should lay strong emphasis on study of the growth and silvicultural characteristics and generate information required for the management of this resource on a sustainable basis.

Phase I has established the basic parameters for establishing bamboo plantations both of the indigenous bamboo and the introduced Asian species. Phase II should follow up by evaluating and developing mass propagation methodologies for both the native and exotic species and establish demonstration plots in forest and farmland areas. The planting areas should be related to the main population areas (Rift, Central & Coastal areas) to ensure maximum exposure and benefit to the people.

Observation in the species trials currently being carried out in the three region should be continued. These can form the nucleus of the living collections proposed to be established in Phase II. The program of introduction of new species should be continued and these will be used to add to the living collections through the mechanism of continuing with the field trials. The collections can also be used for training in bamboo taxonomy besides serving as a valuable resource for future research activities.

Rattan are another group of plants widely used in the cottage industries. Suitable areas exist in Kenya where rattans can thrive and successful introductions were carried out during Phase I. There are also reports of the previous occurrence of rattans in the forests of Kenya which were over-exploited. Using imported seeds, a living collection and demonstration plots should be established. These will subsequently serve as seed sources for a more extensive plantation program.

The physical, mechanical and chemical properties of A. alpina are also unknown. This information will be important in determining its utilization. As bamboo is widely used for pulp and paper production, information on the pulping characteristics of A. alpina will need to be collected. Another aspect of A. alpina that merits attention is the potential for production of bamboo shoots, given its prolific growth rate. Studies will need to be carried out to ascertain the nutritive value of the shoot.

In Asia, bamboo and rattan have been a part of the handicraft and cottage industries scene for several centuries. There will be significant socio-economic benefit if these technologies could be transferred to Kenya. A study for evaluation of the various Asian techniques should be undertaken. This can also document suitable techniques and transfer them through training programs. Cultivation techniques could also be documented.

In the third year of Phase II, an African Workshop on Bamboo and Rattan should be organised to pool and exchange available information and provide a forum for African expertise on these two important commodity groups.

Comments: We were struck by the extent and value of the native bamboo resource and puzzled by the little emphasis on it.

Arundinaria alpina is a medium height bamboo. Its most remarkable feature is its fast growth. In comparative trials in its natural habitat, it out-performed other Asian bamboos both in terms of number of culms and height (based on visual evaluation).

The resource (A. alpina) is fairly abundant and is the dominant plant in areas where it occurs. In some areas, Juniperus prosera and Podocarpus melangianus grow together with the bamboo. In higher altitudes, Higenia abyssinica occurs together with it. The area under bamboo forest was reckoned to be about 300,000 ha earlier but much of it was removed for planting softwoods. In 1988, the bamboo forest area was estimated at 156,000 ha. Approximately 6000 ha of this has been cleared for establishing tea zones, leaving 150,000 ha (as compared to the rainforest area of 32,000 ha). The plant is now largely restricted in the central and mountainous regions, with some of it growing in inaccessible areas.

A. alpina largely grows as pure populations (very similar to the monopodials). This is added evidence to its remarkable spreading and rapid growth habit. The bamboo may combine growth characteristics of a sympodial and a monopodial. Whereas in the initial stages clump formation takes place, with culms being closely interspaced, mature stands which have not been subject to any management as such, have culms reasonably distant to each other, such that free passage is possible through the stand. It is only at the edge of the stands that growth is thicker, probably due to greater availability of light. A similar growth habit is seen in the monopodial bamboos, which start as clumps but later develop the spreading habit.

Because of these unique growth characteristics of A. alpina, care should be taken not to directly apply management practises suitable for the tropical Asian bamboos. Besides, the Indian and Thai practices are restricted to clump-forming bamboos which get severely congested if left unmanaged whereas A. alpina is loosely spread. Management practices of monopodial bamboos will also need to be tested before arriving at the appropriate practice. Studies also need to be undertaken on its growth requirements, growth characteristics, phenology, in addition to harvesting cycle, harvesting methodology etc.

A. alpina also appears to be sensitive to moisture stress. Experiments should be carried out to determine the water requirement including the effect of watering on rhizome growth. It also needs to be examined whether it is principally the juvenile stage that is susceptible to water stress in comparison to the mature plants . Most of the plants we saw dried up were young; adult plants were rarely affected.

We were given to understand by the personnel at the Penon station that sporadic seeding takes place every year. Most of the florets are empty. However, sufficient seeds oan be collected and we were given a figure of 10 kg. Considering that the seed size is very small (as we were told), the seed count per kg would be very high and if sown immediately after collection, would ensure the availability of a large amount of planting material.

In A. alpina, propagation through culm cuttings may not be a feasible method (as for the monopodials) because it does not branch at the lower nodes (only in young clumps is branohing observed from the lower nodes). Poorly developed branches are seen from the 7th to 10th node upwards. The weak branches signify the presence of weak axilliary buds in comparison to the Asian bamboos which show strong branching from the base. No shoot buds were seen at the lower nodes. In comparison there is much aerial rooting from these nodes. Rooting was absent from the upper nodes.

In spite of importanoe of the native bamboo as brought out in the foregoing account, the emphasis on exotic bamboos need to be continued. A. alpina for all its advantages, is restricted in its distribution, and does not grow in the lake and coastal regions. In comparison, the Asian bamboos have performed much better in these regions. Besides, more solid and larger diameter bamboos will be required for other end uses including construction. This program with exotic bamboos will need to be continued and strengthened with emphasis on a few species identified on the basis of the trials conducted in Phase I. These species should be mass-propagated and demonstration plots set up at suitable locations, both in forest area and farmlands.

The increase in demand for bamboo as against decrease in its supply is evident from the sharp increase in the price of each pole from 2-3 schillings in 1984 to over 30 schillings at present. This increase in cost brings in the aspect of preservation. One of the principal uses of bamboo in Kenya is as fencing. There are several other uses it is put to including decorative roofing, construction of houses, keeping salt and baskets for tea-picking. No treatments are currently given and fencing is replaced when deteriorated. But with the current high prices, treatment with preservatives will become important and necessary.

Another aspect to be evaluated is whether the craftsmen and cottage industries will accept a material like bamboo. However, bamboo is certainly not new to Kenya. It is perhaps more its nonavailability that has led to a decline in its use. Besides, Kenyan craftsman are certainly adaptable. For example, when the traditional wood of indigenous origin for carving became scarce, they accepted Eucalyptus. Similarly, when supplies of Arundinaria alpina declined, weavers switched over to the thick-stemmed grass, Phragmites communis. Even this material is no longer freely available especially since the swamplands where it grows are rapidly being reclaimed. In other areas, there is no alternative material for weaving. This places the women at a serious disadvantage, since the women mostly do the weaving while the men engage in carving.

Whereas rattan was not specifically mentioned in the Terms of Reference, this has been included in the suggested Phase II proposal because its cultivation on a large-scale in the country could be easily undertaken. The presence of suitable growing areas has been established beyond doubt in the Phase I preliminary trials. This will greatly benefit the handicraft industry.

Several aspects have been discussed above which need attention and research. At the same time, there is the danger of spreading the effort too thin as the local expertise available is limited at present. The suggested Phase II proposal is a package aimed as maximum benefit and impact both from the research and social points of view.

PHASE II OBJECTIVES

The following are suggested as objectives for a Bamboo (Kenya) Phase II project (preferably: Bamboo/Rattan (Kenya) Phase II).

General Objective

To develop and evaluate methods to increase the production and utilization of bamboo and rattan in Kenya, through improved silvicultural management and harvesting of natural bamboo stands, cultivation of the native bamboo and introduced bamboo and rattan species, and introduction of Asian utilization technology for meeting the needs of the village crafts industries and overall socio-economic development.

OR

To develop and evaluate methods to increase the production and utilization of bamboo and rattan in Kenya for meeting the needs of the village crafts industries and overall socio-economic development.

Specific Objectives

(a) To assess the resource base, study the growth and silvicultural characteristics and develop management techniques for the indigenous bamboo, Arundinaria alpina;

(b) to continue development of propagation techniques for indigenous and exotic species of bamboo and establish demonstration plots;

(c) to continue field trials and establish living collections of exotic bamboos,

(d) to establish demonstration plots and a living collection of rattans;

(e) to study the properties and identify potential uses of the indigenous bamboo; and

(f) to evaluate, document and transfer bamboo and rattan cultivation and utilization techniques, and disseminate project findings.

LIKELY RESULTS AND BENEFICIARIES OF THE PROJECT

The research program suggested for Phase II is expected to open up and make efficient use of the natural bamboo resource of the country. The trial results with the tropical Asian bamboos in Phase I will be translated into tangible demonstration plots which will contribute greatly to the spread of bamboo cultivation in areas where this was previously not possible. An important contribution of Phase II will be the establishment of demonstration plots of rattan which will make available in the

future, an excellent raw material for handicrafts and furniture. This will also serve as a seed source for future plantation establishment. Living collections of both bamboos and rattan will be set up for future research use and to serve as the nucleus of future germplasm collections. A major contribution will be the transfer of Asian utilization technology to Africa, one of the recommendations of the III International Bamboo Workshop (Cochin, India). While the study of the physical, mechanical, anatomical and pulping properties of the native A. alpina will permit a more informed and efficient usage of the material, the study of the nutritional properties of the bamboo shoots, if of acceptable standards, will pave the way for a lucrative bamboo shoot industry. The path-breaking African Workshop on Bamboo and Rattan which will be organized in the third year of the project will mark the coming of age of bamboo and rattan research in Africa and firmly establish KEFRI's leadership in this area.

The project should benefit four groups. Expertise in bamboo research will be developed with long term implications. The Forest Department personnel will benefit from the improved management strategies that will be developed. The farmers will benefit by additional income and the women from increased availability of raw material for weaving and other activities.

SUGGESTED METHODOLOGIES

Objective a): Resource base, growth and silvicultural characteristics, and management techniques

Study 1: Assessment of resource base (Division of Ecology and Management)

Existing records with the Forest Department and other sources should be thoroughly researched and the distribution and area of A. alpina determined under two categories: pure stand and admixture with other species. The area will need to be further categorised into the following altitude ranges: (a) 1800 - 1999m, (b) 2000 - 2499 m, and (c) 2500 m and above.

Five plots should be laid in easily approachable sites in each of these categories. The plot size should be determined using the method detailed in Maoyi et al. (1990)*. In each of these plots, the number of culms should be counted. One hundred culms selected at random from each of these plots should be cut and weighed. These should be weighed again after air-drying for 30 days. From the data so gathered, an estimate of the resource in tonnes (green and air-dry condition) can be made.

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*Maoyi, Fu; Jingzhong, Xie; Mingyu, Fang; Xiaojing, Ren & Daiyi, Li (1990). Fertilization studies in bamboo timber stands. In Rao, I.V.R., Gnanaharan, R. & Sastry, C.B. (eds) Bamboos, Current Research. Kerala Forest Research Institute, India & International Development Research Centre, Canada.

Comments: Assessment of forest resource by interpretation of imageries after adequate ground check is a well-established method. Protocols for assessment of bamboo forests by use of remote sensing methods are being worked out by Bamboo (India) II and Bamboo (Thailand)III. Although this method is ideally suited to the Kenyan bamboo forests due to their occurrence largely as pure stands, the previous experience in photo-interpretation and ground checking in KEFRI could not be ascertained.

Study 2: Growth and silvicultural characteristics (Division of Ecology and Management)

In the plots selected for Study 1, the following activities should be conducted and data recorded as noted below:

a) Plots should be visited at the beginning of every month during years 1 and 2 (and if found necessary in year 3) and the date and periods of shooting, shoot production, number of dying-back shoots, number of new culms, leaf shedding, flowering, fruiting and seed fall noted.

b) Fifty shoots should be selected at random in each plot and the height and diameter recorded every 15 days. The rate of growth should be computed from this data. (Where there is clump formation 10 clumps will be selected. In each of the clumps the best five shoots will be monitored. Besides, the number of culms is each of the clumps will be noted and the average number of culms per clump worked out.

c) The condition of the culms should be closely monitored during the project period and observations on insect/fungal attack and natural drying recorded at the beginning of every month.

Study 3: Management of natural stands (Division of Ecology and Management)

Experiments on the method, time and cycle of harvesting will need to be carried out on the natural stands of A. alpina. The effect of different culm density and culm composition on shoot and culm productivity will also need to be studied. In all the above, data should be collected every year on shoot and culm production.

Two consultants, one from India (Dr K A Kushalappa or Dr A C Lakshmana for sympodial bamboos) and one from China (Dr Fu Maoyi for monopodial bamboos) should together visit the project in Year 1 to advise and guide the project staff on the activities in Studies 1-3.

Comments: Data collection on the above studies will need to be continued beyond the project period to provide information for evolving management techniques particularly relating to harvesting cycle, harvesting time, etc. Based on the data it will also be possible to evolve appropriate management prescriptions to regulate yield. Studies on fertilization etc can thereafter be undertaken.

Objective b): Propagation of bamboos and establishment of demonstration plots

Study 4: Seed collection, storage and nursery establishment of *A. alpina* (Division of Seed Technology and Seed Quality Control)

The exact location of the seed sources should be recorded. The seeds should be cleaned and kept in a refrigerator.

Seed characteristics including number of seeds per kg and moisture content should be determined by measuring 50 randomly selected seeds and seed germination percentage determined. A sample of 100 randomly selected seeds should be soaked and placed on moist filter paper in petridishes and the number of germinated seeds counted. Five replications should be made for each species.

Tests should be carried out to determine the most suitable storage conditions for prolonging the viability of the seeds. Germination percentage and plant percentage should be tested after storage at 15, 5, 0 and -20 C for varying durations as such and over silica gel in a desiccator.

The following methods will be used to study seed infection by microorganisms such as fungi and bacteria:

(a) Blotter Method

(b) Agar Plate Method

Pretreatment methods for preventing seed infection will be developed. Studies should be undertaken to determine the quantity of seeds to be sown per standard nursery bed and requirement of pretreatment.

Based on the results a pamphlet on seed storage and nursery raising of seedlings will be brought out.

Study 5: Propagation of native and exotic bamboos (Division of Ecology and Management)

Macroproliferation of wildlings/seedlings of A. alpina (detailed methodology in Appendix 2):

The seeds should first be sown in germination boxes or nursery beds. Light watering should be carried out, taking care to avoid total drying of the soil. When the seedlings reach the 3-5 leaf stage (after approximately 1 to 1 1/2 months), these should be pricked out and planted individually in black polybags (24x18 cm size) already filled with the soil mix (soil + sand + farmyard manure in 1:1:1 ratio) and applied with the first dose of NPK (urea N= 46.4% - 0.05g; super phosphate single P_2O_5 = 16% - 0.59 g; muriate of potash K_2O = 56-60% - 0.04g) . Wildlings collected from the forest floor can be similarly planted in the polybags. After 6-7 months when 3-8 tillers have been produced, the seedlings should be removed from the polybags and each tiller alongwith a part of the rhizome and some roots separated by cutting the rhizome. These are individually planted in polybags, maintained in the nursery and field-planted when one year old.

Propagation of exotic bamboos: Based on the trials conducted during Phase I, the following bamboos are recommended for mass-propagation (the source country is given in parenthesis):

B. arundinacea (India)

B. blumeana (Thailand)

Dendrocalamus strictus (India)

D. membranaceus (Thailand)

Rhizomes or seeds should be obtained from India and Thailand. The rhizomes can be directly planted in black polybags (24x18 cm) whereas the seeds should be sown and seedlings raised in the nursery. Macro-proliferation should be carried out as described above. Field-planting should be done when the plants are one-year old.

Study 6: Propagation of A. alpina through tissue-culture (Biotechnology Division)

Tissue culture techniques should be developed (using embryonic and meristematic tissue) for obtaining somatic embryos. These can then be stimulated to develop roots and shoots through the manipulation of nutrient levels, growth regulators and growth supplements. Culture media will need to be developed for each of the four phases, i.e., initial explant, subculture, plantlet regeneration and plantlet development. Both agar and liquid media should be tested.

Shoot tips and lateral buds excised from the culms and lateral branches should be used as explants for obtaining

micropropagation in vitro. Multiple shoots can be obtained followed by rooting to obtain plantlets. The plantlets should be transferred to different potting mixtures, hardened and percentage survival recorded. These can subsequently be field-planted.

Comments:

1. The Division of Biotechnology (KEFRI) has a tissue culture laboratory and an active tissue culture program is in progress.

2. The protocol described in the IDRC booklet on Propagation of Bamboo and Rattan through Tissue Culture can be tried.

Study 7. Demonstration (forest) plantation of exotic bamboos (Division of Ecology and Management)

A 4 ha demonstration plot may be established in a forest area (Kakamega). One ha each should be planted with Bambusa arundinacea, B. blumeana, Dendrocalamus strictus and D. membranaceus at a spacing of 5 x 5 m.

Field meetings should be organized to demonstrate the recommended techniques and local study tours organized for interested persons

Study 8. Farm plantations of bamboo (KEFRI-KARI-ICRAF Research Station and Social Forestry Department, KEFRI)

Farmers should be invited to raise bamboo on their farmland (B. arundinacea, B. blumeana, D. strictus, D. membranaceus) by following recommended techniques. The project staff should maintain regular contact (visit every six months) with the farmers to monitor the progress, solve local problems and encourage local adoption of the recommended cultivation techniques. At the conclusion of the project, a final assessment should be made by surveying the farmers as to their knowledge and adoption of the recommended practices.

Objective c (Study 9): Living collection of bamboos and field trials (Division of Ecology and Management)

The field trials already underway should be maintained and observations continued. These will form the nucleus of the living collection. Those established at Penon for sub-temperature exotic bamboo species and at Kakamega or Gede for the lowland exotic species should be expanded further for this purpose. Procurement of germplasm, their field testing and maintenance should continue as in Phase I of the project.

The participants to the IV International Bamboo Workshop can be requested to bring seeds/planting materials to the Workshop.

A consultant (Dr Soejatmi Dransfield) will visit the project in Year 2 and conduct a short course on bamboo taxonomy and assist in their identification.

Objective d (Study 10): **Rattan demonstration plot and living collection** (Division of Ecology and Management)

A living collection of rattans should be established at Kakamega in a half hectare plot. Seeds of various species can be obtained from the Network projects in South and South-east Asia (including the Rattan Seed Centre of Rattan (Malaysia) II and SAFODA). The seedlings should be raised in black polybags and transplanted in the plot when one year old. These will be monitored for survival and height growth.

Two demonstration plots of one hectare each should be established at Kakamega. These can be planted with (1) Calamus thwaitesii and (2) Calamus trachycoleus or species with similar site/growing condition requirements.

Objective e (Study 11): Properties and utilization of A. alpina (Division of Forest Products and Wood Science, KEFRI)

Physical properties to be tested should include moisture content, specific gravity and shrinkage. Mechanical property tests will measure the bending strength (MOE & MOR) and compression strength parallel and perpendicular to the grain. These tests can be carried out with the help of the Universal Testing Machine available in the Division. Ten mature culms of each species should be tested both in split and round form. The test specimen should be taken from three parts of the culm: top, middle, and bottom, and dried to reach a moisture content of 12% before testing. The anatomical structure of the culm (vascular bundle and fibre distribution) and fibre morphology should be studied. All data should be analyzed statistically. Properties of the indigenous species should be compared with published data on exotic species being introduced and which perform well under local conditions. These studies will help in efficient use of the material and determining appropriate end uses.

Determination of pulping characteristics should also be carried out (this can be done at the Department of Wood Science and Technology, Moi University). The percentage edible portion of bamboo shoots, food energy and protein, fat and fibre content should be determined for ascertaining its usage as a food. If facilities are not available in Kenya, this can be carried out at the Central Food Technology Research Institute, Mysore, India.

Objective f (Study 12): **Technology transfer and information dissemination** (Division of Ecology and Management; Division of Social Forestry Training and Extension, KEFRI)

An extension officer and an extension technician should visit the States of Kerala and Karnataka (India) and the National School of Design, Ahmedabad (India) to study bamboo and rattan conversion and handicraft techniques. Slide sets and video films of suitable processes and techniques as also of bamboo and rattan cultivation with commentary in Swahili should be made in consultation with the Project Leader. Utilizing these materials, training workshops can be conducted for women engaged in weaving crafts to familiarize them with bamboo handicraft techniques. A consultant (Dr M P Ranjan, National School of Design, Ahmedabad), could visit the project in Year 2 and assist in the training and dissemination of handicraft technology.

An African Workshop on Bamboo and Rattan should be organized in the third year to pool and exchange available information and provide a forum for African expertise on these two important commodity groups.

Besides the above, a library of various publications on bamboo and rattan should be built up and contacts established with the Bamboo Information Centres (India and China) and the Rattan Information Centre (Malaysia).

TRAINING NEEDS

The Project Leader should participate in the 4th International Bamboo Workshop in Thailand (November 1991) and visit India on the way back to acquaint himself with bamboo and rattan plantation and utilization techniques, and for making a lasting arrangement for the continued importation of the Indian and Thai bamboo species. The Project Assistant should also undertake a study tour to India for training in the state-of-art in research, cultivation and utilization of bamboo and rattan.

The training will be organised by the Regional Forestry Coordinator (Asia) at the Andhra Pradesh Agricultural University and the Kerala and Karnataka Forest Departments. They will also visit the Indian Plywood Industries Research Institute, the Kerala Forest Research Institute, the Mysore Paper Mills and the laboratory of the Network Coordinator at the University of Delhi. After their return to KEFRI, they should conduct a short training course for the other rese

Comments: We understand the Project Leader visited China for a Farm Forestry course but do not know whether he was exposed to management practises for monopodial bamboos. If not, then such a visit to the Chinese consultant's Institute is desirable (not included in budget).

INSTITUTIONAL ASPECTS

As in Phase I, the project should be executed by the Kenya Forestry Research Institute (KEFRI) of the Ministry of Research, Science and Technology. The project is of national importance, and has the full support of the Ministry.

In addition to the project staff in Phase I, additional staff will be made available for Phase II. The involvement of the various Departments/Divisions were discussed with the Director, KEFRI, the Project Leader, as well as respective senior staff. In particular, the Departments of Ecology and Management of Natural Forest Resources, Biotechnology, Tree Seed, Forest Products and Social Forestry Training will contribute to the realization of the project objectives. Excellent facilities are available in KEFRI for the proposed studies.

On-station trials and demonstration plantations will be located in the forests with the cooperation of the Forest Department. Participation of the Forest Department staff in the implementation of the field activities of the project will be encouraged and will contribute to the accomplishment of the objectives.

The pulp quality analysis studies will be carried out at Moi University. The lecturers and students of the University will use the project trial and demonstration plots for teaching and learning purposes.

PROJECT ORGANISATION

Project Adviser
Dr Jeff A Odera

Project Leader
Dr B N Kigomo

Study	Study Leader
1. Assessment of resource base	: Dr B N Kigomo*
2. Growth and silvicultural characteristics	: Dr B N Kigomo*
3. Management of natural stands	: Dr B N Kigomo*
4. Seed collection, storage and nursery establishment of *A. alpina*	: Mr J Kichana
5. Macroproliferation of wildlings/ seedlings of *A. alpina*	: Dr B N Kigomo*
6. Propagation of *A. alpina* through tissue culture	: Dr J Mwangi
7. Demonstration (forest) plantation of exotic bamboos	: Dr B N Kigomo*
8. Farm plantations of bamboo	: Mr H Otieno
9. Living collection of bamboos and field trials	: Dr B N Kigomo*
10 Rattan demonstration plot and living collection	: Dr B N Kigomo*
11 Properties and utilization of *A. alpina*	: Mr G M Muthike
12 Technology transfer and information dissemination	: Mr A Kaudia

* Some of these will be undertaken by Mr James Were and Mr Gordon Sigu

SUGGESTED TIME TABLE OF ACTIVITIES
(Summary)

Study	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
1. RESOURCE BASE, GROWTH AND SILVICULTURAL CHARACTERISTICS AND MANAGEMENT TECHNIQUES												
a. Analysis of existing information on distribution and composition of area under *A. alpina*	x	x										
b. Selection and demarcation of study plots, green & air-dry weights		x	x			x	x					
c. Observation on phenology culm number, height, diameter, pests and diseases			x	x	x	x	x	x	x	x		
d. Harvesting techniques; effect of culm density and composition on shoot and culm production			x	x		x		x		x		x
2. PROPAGATION OF BAMBOOS AND ESTABLISHMENT OF DEMONSTRATION PLOTS												
a. Seed viability, storage and nursery techniques	x	x	x	x	x		x		x		x	
b. Macroproliferation	x	x	x	x	x	x	x	x				
c. Tissue culture propagation		x	x	x	x	x	x	x	x	x	x	x
d. Demonstration planting (forest & farm)			x	x	x	x	x	x	x	x	x	x
						x	x	x	x	x	x	x
e. Procurement of rhizome; planting and multiplication	x	x	x	x		x	x			x	x	
3. LIVING COLLECTION OF BAMBOOS AND FIELD TRIALS												
a. Procurement of planting material	x	x	x	x	x	x	x	x	x	x	x	x
b. Planting and maintenance				x	x	x	x	x	x	x	x	x

4. RATTAN DEMONSTRATION PLOTS AND LIVING COLLECTION																				
a. Procurement of planting material	x	x	x	x				x	x	x	x				x	x	x	x		
b. Establishment of demonstration plots								x	x	x	x				x	x	x	x		
5. PROPERTIES AND UTILIZATION																				
a. Structure, properties								x	x	x	x									
b. Determination of pulping characteristics					x			x												
c. Determination of nutritive characteristics		x	x	x				x												
6. TECHNOLOGY TRANSFER AND INFORMATION DISSEMINATION																				
a. Development of audio/video material	x	x																		
b. Extension								x	x	x	x				x	x	x	x		
c. Regional workshop																				x

SUGGESTED BUDGET

	Year 1	Year 2	Year 3	Total
TO BE ADMINISTERED BY THE CENTRE (in CAD)				
1. International Travel				
Project Leader to attend International Bamboo Workshop and visit bamboo plantations and utilization centres in Thailand and India (1 month)	5500			5500
One project assistant to be trained in bamboo plantation techniques in India (1 month)	4200			4200
One Extension Officer and one Technician of Social Forestry Dept. to be trained in India in handicrafts and to develop audio-video aids	8400			8400
2. Consultancy				
a. Taxonomy (1)		4860		4860
b. Silviculture and management (2)	8520			8520
c. Handicrafts (1)		4260		4260
4. Import of planting material	2000	3000	1000	6000
5. Equipment				
a. Vehicle (4-WD Toyota Hilux)	28000			28000
b. PC-AT computer with printer	5000			5000
c. Camera with accessories and lenses	3000			3000
d. Photocopier	5000			5000
	69620	12120	1000	82740

	Year 1	Year 2	Year 3	Total
TO BE ADMINISTERED BY THE RECIPIENT				
A. IDRC Contribution (in CAD: 1 CAD=21.43 K.sh)				
1. Salaries and Allowances (Nursery Technicians and Labour skilled/ unskilled)	12100	14600	12100	38800
2. Research Expenses				
i. Small Tools & Supplies	3000	2500	1500	7000
ii. Chemicals, reagents, glassware	2000	5000	2000	9000
3. Testing fees (pulping, nutritional chara- cteristics)	-	2000	-	2000
4. Fuel and Vehicle maintenance	6000	7000	6000	19000
5. Local Travel	12000	15000	10000	37000
6. Publication	200	1300	2000	3500
7. Extension (including development of audio/ video aids)	-	2000	2500	4500
8. Postage, telephone, telex, etc.	1000	2000	2000	5000
9. Local Consultancy	-	1000	1000	2000
10. Local Training	4000	2000	2000	8000
11. Regional Seminar	-	-	15000	15000
Total (A)	40300	54400	56100	150800

	Year 1	Year 2	Year 3	Total
B. Recipient Contribution (in K.sh.)				
Salaries & Allowances				
Project Leader (60%)	195,900	215,500	237,050	648,450
Project Assistant (100%)	214,060	214,400	216,000	644,460
Project Forester (100%)	178,450	179,000	180,000	537,450
Research Foresters - Field (6x50%)	535,260	537,000	540,000	1,612,260
Technicians (6x50%)	535,260	537,000	540,000	1,612,260
Nursery Forman (100%)	178,400	179,600	181,200	539,200
Extension Officer (20%)	35,685	36,680	38,540	110,905
Handicraft Technician(20%)	35,685	36,680	38,540	110,905
Utilization Officer (10%)	21,450	21,450	21,600	64,500
Seed Officer (5%)	10,725	10,725	10,800	32,250
Driver (100%)	90,500	91,200	92,400	274,100
Total (B)	2,031,375	2,059,235	2,096,130	6,186,740

BUDGET SUMMARY
(CAD)

Centre Contribution	Year 1	Year 2	Year 3	Total
I. CAP	69,620	12,120	1,000	82,740
II. RAP	40,300	54,400	56,100	150,800
Total	109,920	66,520	57,100	233,540
Recipient Contribution (CAD eq.)	94,790	96,090	97,810	288,650
Overall Total				522,230

Kenya Forestry Research Institute (KEFRI), Muguga

KEFRI was established in 1986 as a national statutory scientific research institution under the Kenya Science and Technology Act with the mandate to undertake research and development in forestry and allied natural resources.

Although the Institute is just about five years old, organized forestry research in the country dates back to the early thirties. Research capability was strengthened with the setting up of the East African Agricultural and Forestry Research Organization (EAAFRO) with its head-quarters at Muguga. With independence in 1963, the capability of this organization declined considerably as several scientists left the country. The forest service with a separate research wing looked after research which continued until the collapse of the East African Community in 1977. In 1981, the research wing of the Forest Department, Forestry Division of EAAFRO and the defunct East African Community merged to form the Forest Research Department of Kenya Agricultural Research Institute (KARI). As this did not really take off, KEFRI was established. Thus the Institute has inherited about 50 years of forestry research history, though checquered.

Research, training and extension activities are carried out in the Institute in six Departments, out of which one is exclusively for social forestry including urban and amenity forestry and another to look after resources management (human resources, finance, planning, etc.). The project Bamboo (Kenya) is under implementation in the Silviculture, Tree Improvement and Environmental Sciences Department in which the Project Leader is the Principal Scientific Officer (PSO). Apart from the main complex at Muguga, the Institute has six National Research Centres, six Regional Research Centres, four Sub-Centres and several experimental sites. Field trials connected with the Bamboo project are conducted in these experimental sites with the cooperation of field staff attached thereto.

The Institute has excellent laboratory facilities especially with regard to equipment and can compare well with modern laboratories for biological research. In the main body of this report, utilization of some of the existing facilities in the Phase II program are be discussed and therefore relevant information about the following Divisions/Departments which are proposed to be involved, is given.

Silviculture, Tree Improvement and Environmental Sciences Department

Research is undertaken in five major areas:

- Wetlands Silviculture

  Focus is on medium and long term research for overall improvement of forest practices including industrial plantation in the wetter regions. Research activities cover development of nursery practices, selection of suitable species and provenances for planting in different areas, management of natural forests for optimum yield, etc.

- Forest Genetics and Tree Improvement

  Basic and applied research on tree genetics, including selection of elite trees for breeding programs; establishment of clonal and seed orchards; breeding for resistance to diseases and pests and developing efficient vegetative propagation methods

- Forest Ecology and Management of Natural Forests and Watershed Resources

  Research aimed at developing appropriate technologies and strategies for effective management, conservation and utilization of natural forests on a sustainable basis including regeneration and development of indigenous species in natural and plantation conditions

- Dryland Silviculture

  Research in the arid and semi-arid areas, including site preparation techniques; effect of browsing animals on artificial and natural regeneration; management of irrigated plantations

- Agroforestry

  Systematic study leading to development of agroforestry technologies appropriate to the existing land use practices; identification of potential/promising multipurpose tree and shrub species (MPTS)

Research Support and Development Department

Of the four Divisions in this Department, activities in the area of Biotechnology were of immediate interest to us. In this area, studies are undertaken on nitrogen fixing trees; rhizobia symbiosis studies; tissue culture technology for mass propagation and wood biodegradation studies. Tissue culture raised plantlets and saplings of a few species including Grevillea robusta were shown to us.

Forestry Seed Centre

The Centre, established with support from the German Agency for Technical Cooperation (GTZ) has excellent facilities for studies on seed extraction, viability testing, storage, pretreatment, dormancy determination, germination and nursery behaviour.

Forest Products and Wood Science Department

This Department conducts studies on harvesting and is also involved in developing basic information on wood properties for different end uses. Determination of structure, properties; investigations on durability and preservation; wood energy; methods of charcoal manufacture; development of low cost binders; non-wood products from trees; briquetting of saw dust; saw milling etc., are among the areas of study undertaken. Facilities for anatomical studies and determination of strength characteristics (with a modern Universal Testing Machine) are good and a study on indigenous woods is in progress.

Social Forestry Department

The main activity in the Department is the implementation of KEFRI/Kenya Forest Department Social Forestry project supported by Japan International Cooperation Agency (JICA). An important component of this project is Social Forestry training. It is concerned with development and organization of short intensive courses for participants ranging from grassroot to administrative levels. The other important component is the Pilot Forest Project in which activities such as seedling production, trial plantation, people's plantation, etc., are undertaken for the purpose of extending social forestry practices with specific reference to semi arid areas. Trial plantations have been raised annually with several species, of which Croton megalocarpus, Prosopis juliflora and Acacia polycantha have given promising results. People's plantation program in which local organized groups are given facilities and tenurial rights for planting tree species on Government land, has also gained popularity. The program for seedling production in farm lands and institutions like schools with technical and material assistance from the project are also gaining acceptance.

Forest Industrial Training Centre, Nakuru

This Centre, established with FINNIDA support has three main activities viz: (i) training of personnel deputed from industries and others in harvesting, transport and primary conversion (confined to sawmilling), (ii) commercial production of sawn timber for local market and (iii) manufacturing prefab houses. The Centre has a training sawmill, modern saw doctoring shop, production sawmill and a wood working unit. Vocational courses in various areas of saw doctoring and sawmilling are organized regularly and in each course, upto 12 persons are trained. The main activity however appeared to be production and sale of sawn timber and prefabricated houses.

Faculty of Forest Resources and Wildlife Management, Moi University

This Faculty was established to meet the training and research needs of the country in forest resources and wildlife management. It has three Departments viz: (i) Forestry (ii) Wildlife Management and (iii) Wood Science and Technology.

In the Department of Forestry, besides undergraduate and post graduate programs (in Tropical Forest Biology and Silviculture; Forest Economics and Management; Tropical Forest Soils; Hydrology and Agroforestry), research is undertaken in methods of managing high yielding plantations, high potential community forestry, agroforestry, watershed management, etc.

The Department of Wildlife Management conducts undergraduate courses and research in Wildlife Biology, Management, etc.

The Wood Science and Technology Department caters to the requirements of forest based industries for providing competent and trained manpower especially in optimization of processes in utilization of wood and other lignocellulosic materials. Facilities are available for conducting studies on structure, properties and chemical characteristics of wood and wood products. Qualified staff are in position for undertaking studies on pulping characteristics.

Agroforestry Centre, Maseno

This is a compact unit in which KEFRI, Kenya Agricultural Research Institute (KARI) and International Council for Research in Agroforestry (ICRAF) conduct in collaboration, studies on agroforestry systems and extension. A Research Officer of KEFRI is in charge of the Centre. With technical and material inputs from all these organizations, the Centre is working as a conduit for transferring technologies. The Centre is maintaining a well equipped nursery from which seedlings are supplied to farmers. Plantings in farm and marginal lands are monitored.

APPENDIX 2

METHODOLOGY FOR MACROPROLIFERATION

Step-1. Sow the seeds in germination boxes or nursery beds.

Step-2. After 1-1 1/2 months, young seedlings of 3-5 leaf stage may be pricked out from the germination boxes or nursery beds or collect seedlings from the forest floor (wildlings) and plant them in black polybags (24x18 cm size) already filled with soil-mix (soil + sand + farmyard manure in 1:1:1 ratio) and applied with first dose of NPK (urea N=46.4% - 0.05 gm; superphosphate single P_2O_5 = 16% - 0.59 gm; muriate of potash K_2O=56-60% - 0.04 gm).

Application of NPK - The NPK dose is prepared in piecemeal, at a time for 1000 polybags. This is continuously stirred so that the superphosphate remains uniformly remains distributed in the solution during application of fertilizer in the polybags. 30 ml of NPK solution is poured into a 10-12 cm deep planting hole in each polybag, prior to planting of the young seedlings.

Step-3. One young seedling of 3-5 leaf stage may be planted in each polybag and kept in shade for three days. After all the seedlings planted in polybags have established well, shift them to the open under direct sunlight.

Step-4. The second dose of fertilizer consisting of urea (0.05 gm) muriate of potash (0.12 gm) and water (30 ml per polybag) is applied.

Application of NPK - The NPK dose is prepared as mentioned in step-2 and applied as top dressing of soil in each polybag after a period of one month from the date of application of the first dose.

Step-5. The saplings are maintained by regular watering, weeding and soil working for a period of 6-7 months. Three to eight tillers (averaging 6), will be formed in each polybag.

Step-6. The saplings are carefully removed from the polybags. Each proliferated tiller alongwith some rhizome and a few roots is separated by cutting the rhizome. Each such propagule is separately planted in polybags of 24x18 cm size as mentioned in Step-2.

Step-7. Propagules planted in polybags are handled as in Step 3, the second dose of NPK given as in Step-4 and the plants maintained as in Step-5.

Step-8. Each propagule proliferates on an average into six tillers in each polybag and attains the field plantable stage in one year.

APPENDIX 3

METHODOLOGY FOR CONTROL OF SUBTERRANEAN TERMITES

For effective protection from termite attack, precautionary or preventive measures must be taken before the seedlings are planted out. Small quantities of either of two insecticides, aldrin or heptachlor, when properly applied, will prevent damage. For protection of seedlings in nursery bed, the bed must be treated with insecticide before seeds are sown. For protection of out-planted seedlings, the container seedlings (i.e. seedlings in polythene bags) must be given an insecticide drench before they are planted out.

Materials Required

1. Aldrin 30 EC (30% emulsified concentrate of aldrin), at the rate of 1.02 litres per hectare of plantation

   or

   Heptachlor 20 EC (20% emulsified concentrate of heptachlor), at the rate of 1.53 litres per hectare of plantation

2. A drum of about 200 litres capacity

3. A graduated measuring cylinder of about 50 ml capacity

4. A watering can with a small sprinkler head to give a fine spray

Treatment of Nursery Bed

When to treat: The treatment may be carried out after the bed has been prepared, immediately before or several days in advance of sowing, according to convenience.

Preparation of insecticide solution: Using the measuring cylinder, measure out 20 ml of aldrin 30 EC or 30 ml of heptachlor 20 EC and pour into 125 litres of water in the drum. Mix with a stick.

Method of application: Before sowing the seeds, drench each bed of 12 m x 1.2 m with 125 litres of the diluted insecticide solution using the watering can. To permit ready absorption of the liquid into soil, the drenching should be carried out in two or three consecutive instalments, covering the entire bed each time as uniformly as possible.

Treatment of Container (Polybag) Seedlings

When to treat: The treatment may be carried out any time after the seedlings have become established in the containers.

Preparation of insecticide solution: To 125 litres of water in the drum add 1 litre of aldrin 30 EC or 1.5 litres of heptachlor 20 EC and mix with stick.

Method of application: The following preparatory measures must be taken to ensure proper penetration of the diluted insecticide solution into the container soil.

1. Carry out the treatment on the evening of a sunny day, after skipping the regular watering in the morning. This is done to render the container soil comparatively dry.

2. Ensure that the top edge of the container (polythene bag) projects sufficiently above the soil level to hold the insecticide solution.

3. If the bags are stacked too far apart, bring them closer to reduce the empty space between the bags.

Drench each group of about 2500 seedlings with 125 litres of the insecticide solution using the watering can. The drenching may be done in two or three consecutive instalments, covering the entire group of 2500 seedlings each time as uniformly as possible.

When the insecticide solution is poured over the container seedlings, some spillage between the containers is unavoidable; this has been taken into consideration in deciding the recommended dosage. A fairly large volume of water has been recommended for dilution of the insecticide in order to ensure good penetration of the insecticide into the container soil.

How Crucial Is the Insecticide Dosage?

A somewhat wide variation of the dosage above or below that recommended is permissible, but very high doses are likely to retard the initial growth of seedlings and very low doses will make the treatment ineffective.

Is Pit Treatment Necessary in Addition to Container Treatment?

No. If the container seedlings are treated as recommended above, no treatment of the planting pit is necessary. This is because most termite attacks are confined to the portion 2 to 20 cm below the soil surface, which region is well protected by the treated container soil.

APPENDIX 4

SPECIMEN LETTER TO SUPPLIER OF BAMBOO PROPAGULES

Name: Date:
Address:
Telephone/Telex/Fax No:

The .... (Supplier's name and address)

Sir,

I request you to supply..... numbers of rhizome/culm cuttings/offsets of following species of bamboo:

i.
ii.
iii.

It may please be ensured that the following instructions are strictly followed while packing and forwarding the material:

i. Attached copy of Plant Importation Permit should be placed inside the parcel, duly inserted in a moisture resistant envelope

ii. Attached Q label should be affixed on the parcel

iii. Phytosanitary Certificate (International or equivalent model) should be enclosed

iv. Material should be free from pathogens and insects

v. Soil should be washed off thoroughly from the surface and the material dipped in a fungicide and an insecticide solution before packing. A certificate to this effect should be enclosed. The treatment carried out should be explained

vi. Plant residues such as leaves, straw, etc., should not be used for packing. If unavoidable, such residues should be treated and a certificate indicating method of treatment, should be enclosed

Please ensure that the material is despatched so as to reach Kenya before expiry of the transportation permit 6 months from the date of issue. After despatching the material, the relevant information may please be furnished by telephone/telex/fax.

Payment will be made at the rate and mode, as already agreed.

Yours faithfully

APPENDIX 5

EXPERIMENTAL SITES AND SPECIES PLANTED

The project has established and is maintaining nine experimental sites, three each in the Coast (150 to 450 m above sea level), highland (2100-2550 m) and lake (1500-1675 m) regions to represent the respective agroclimatic zones. All these sites (except Kwale and Kinale) as well as the rattan experimental sites at Gede, Yala and Kakamega were visited during the field trips. Summary information relating to these is given below.

Locality factors relating to the experimental sites

	Locality factors		
Locality	Altitude (m)	Annual rainfall (mm)	Mean annual Temperature, C
Coast			
Gede	150	900 - 1200	28
Jilore	185	450 - 1350	32
Kwale	450	850 - 1700	34
Highland			
Kinale	2550	700 - 1800	20
Muguga	2100	600 - 1500	24
Penon	2500	950 - 1600	20
Lake region			
Kakamega	1675	1100 - 1900	32
Nyabeda	1500	1000 - 1850	29
Maseno	1500	1700 - 2500	30

Species planted in these experimental sites:

Rattan species	Country of origin	Propagule	
1. *Calamus caesius*	Malaysia	Seed	1988
2. *C. trachycoleus*	Malaysia	Seed	1988
3. *Calamus* sp.	Bangladesh	Seed	-
4. *C. huegelianus*	India	Seed	-
5. *C. thwaitesii*	India	About 8 seeds	-
6. *Daemonorops kurzianus*	India	Few Seeds	-

	Bamboo species	Country of origin	Propagule	Year of planting
1	Arundinaria alpina	Kenya	Rhizomes and seedlings	1988
2	Bambusa brandisii	Thailand	Seed	June 1990
3	B. blumeana	Thailand	Rhizome, offsets cuttings	1988 Jilore 1989- Nyabeda 1990 Gede, Kakamega, Muguga
4	B. vulgaris	Kenya Malawi Tanzania	Offsets	June 1988 & 1989
5	B. vulgaris var. striata	Rwanda ex India	Cuttings and rhizomes	1990 (June)
6	B. arundinacea	Thailand	Seed	1989 (Muguga) 1990
7	B. tulda	Thailand	Seed	1990
8	Dendrocalamus membranaceus	Thailand	Seed	1990
9	D. strictus	Thailand	Seed	1990
10	D. brandisii	Thailand	Seed	1990
11	Phyllostachys pubescens	Japan	Seed	1989
12	Thyrsostachys siamensis	Thailand	Seed	1990

"IDRC CONFIDENTIAL"

CONSULTANCY REPORT : PART II
BAMBOO (KENYA)

(Centre File: 3-P-86-0244)

P M Ganapathy, PhD

I V Ramanuja Rao, PhD

RELEVANCE OF THE PROJECT

The Bamboo (Kenya) project has made a notable contribution towards generating interest in bamboo in Kenya where, although it constitutes nearly one tenth of the forest area, hardly any attention was given to its propagation and cultivation.

The project has strong support from the Government of Kenya. The President of Kenya has taken keen personal interest in bamboos and has instructed that bamboos be planted on a large scale. (We were told stories of foresters being fired because of inability to procure and raise bamboos. Part of this was due to the misconception that the propagation of bamboo was as easy as that of sugarcane and that sets could be taken for this purpose.)

The Minister for Research, Science & Technology was also impressed with the progress of the project after visiting trials at Mombasa and West Kenya. The Presidential Commission on Soil & Water Conservation has recognised the efforts of the Bamboo (Kenya) project. The Minister of Agriculture was also converted to the bamboos on a visit to the Philippines. He asked the Director of Agriculture to plant bamboos, who in turn, contacted Dr Kigomo. All this has resulted in Dr Kigomo being recently conferred the national scientific achievement award for his contribution including "pioneering work on introduction, research and development of bamboo". A very good beginning, indeed!

Overall, the Phase I of the project has already established the feasibility of introducing exotic bamboos/rattans in Kenya. The suggested Phase II program will provide KEFRI the methodology for developing the indigenous bamboo resource (almost totally neglected so far) and cultivation of exotic species in forest and farmlands where the indigenous species cannot grow. The living collection to be established will be of lasting value for research and propagation. Utilization techniques will also be introduced from Asia.

INSTITUTIONAL APPRAISAL

Although Bamboo (Kenya) was a KEFRI project, the activities were confined to a small group. There is no evidence of interaction with other scientists and the excellent facilities available in some laboratories of the Institute were not made use of. Involvement of scientists in these laboratories, particularly, Seed Technology, Genetics and the Department of Social Forestry would have helped in achievement of objectives of Phase I to a greater extent. It is essential that for Phase II, the relevent Departments/Divisions of KEFRI are involved.

KEFRI has excellent linkages with the Forest Department and therefore no difficulties are envisaged in carrying out the field studies. In the Phase II, researchers from other Divisions should also be involved in project activities. This will lead to the furthering of multidisciplinary studies which were missing in Phase I.

PROJECT PERSONNEL

The project leader is an experienced scientist, already recognized for his contribution to bamboo research in Kenya. He has implemented Phase I with a fair amount of success. This is no mean achievement considering that the project was operated by a very small group under the leadership of Dr Kigomo. The success of Phase II will depend to a large extent on his continued association with the project. As several new activities are proposed in Phase II in which scientists from other Divisions/Departments of KEFRI are involved, it is desirable that the Director of KEFRI be designated as Project Adviser. While Dr Odera was not in favour being the Project Leader (in which case Dr Kigomo could have been the Coordinator), his assistance will certainly be needed for the smooth running of the project.

Dr Kigomo's relationship with senior scientists in the Institute has been found to be cordial with the exception of perhaps Dr J Mwandi, Head, Biotechnology Division. The involvement with him is in tissue culture studies only which is not critical for the success of Phase II.

Dr Kigomo is definitely motivated and the recent national scientific achievement award has given him a greater sense of involvement with the project. Neverthless he has some way to go before he can qualify to be the 'Bamboo Expert of Africa'. We have no doubt that he certainly will, given his zeal and motivation. But more direction and greater effort will be required to achieve this. At the present stage it would be prudent not to expect too much of him without building up his knowledge base and experience, particularly because his own efforts at self-education seem to be at a premium. Mistakes such as growing rattan in an open field under bananas are pointers in this direction.

CONSULTANCY AND TRAINING

While developing the Phase II proposal, emphasis has been laid on utilizing the available talent to the maximum extent. At the same time, it is necessary to take into account the specific expertise in bamboo and rattan research. While care has been taken to suggest appropriate methodologies, closer guidance during implementation will be necessary. One problem with Dr Kigomo is that he finds it difficult to accept a target specific approach. A generalized approach appeals better to him. The Bamboo (Kenya) II project will thus need close and frequent monitoring particularly in the research aspects. For this, suitable consultants have been identified who can provide the needed backstopping.

The poor manpower base is the weakest link in the project and we have sought to address this by paying attention to training. It is suggested that Dr Kigomo and Mr Sigu be put through an intensive and extensive hands-on training course which should include detailed report-writing on methodologies and experiences.

Dr Kigomo would also benefit from attending a Research/Project Management Course. In conformity with the recommendation of the IIIrd International Bamboo Workshop, an extension team should visit India to evaluate and document utilization techniques for transfering them to Kenya.

ETHICAL CONSIDERATIONS

The nature of the research involves no ethical considerations. However, while promoting plantations in farmland, adequate care should be taken to ensure that the rights and privileges of farmers are not infringed.

RISKS

No scientific, social or other risks are foreseen. However, progress may be affected if key staff go on long-term study programs (Mr Sigu wishes to go abroad for post-graduate study. If this is to take place, another person should be deputed for the suggested training in India).

NOVELTY

Several of the proposed studies are novel in the African context. The project will become a model for others in the region. Rattan will be reintroduced to the country. The African Workshop on Bamboo and Rattan proposed for Year 3 will bring bamboo and rattan to public notice and act as a catalyst for initiation of national research activities in the African countries on these two important plant groups (similar to the fallout of the Singapore meetings on bamboo and rattan in 1979 and 1980).

MGC

The clause stipulating access to bamboo and rattan germplasm (seed or vegetative material), "the development of which is wholly or partly supported by this project..." should be included.

SCIENTIFIC MERIT

While some of the methodologies are based on the results of Phase I, several are the outcome of research conducted in Asia. For the first time, these will be verified and possibly adopted in Africa. If successful, these will become a model for adoption in other countries in Africa.

The overall aim is to achieve maximum progress in the shortest possible period without overreaching, so as to bring the project more or less at par with the Asian projects of the Network. A successful and visible project would also have a domino effect in Africa.