Field performance of micro- and macro propagated planting stock of selected five commercially important bamboo species

A project proposal

Submitted to

Department of Biotechnology,
Government of India

Kerala Forest Research Institute, Peechi, Thrissur, Kerala (KSCSTE)&
Attappady Hills Area Development Society, Attappady,Kerala

Institute of Forest Genetics &Tree Breeding, Coimbatore (ICFRE)

Institute of Wood Science &Technology, Bangalore (ICFRE)

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March 2004

DEPARTMENT OF BIOTECHNOLOGY
PROFORMA FOR SUBMISSION OF R&D PROJECTS

PART I: GENERAL INFORMATION

1. Name of the Institute/University / Organization submitting the Project Proposal	1.Kerala Forest Research Institute, Peechi, Thrissur, Kerala, 2.Institute of Forest Genetics & Tree Breeding, Coimbatore, 3.Institute of Wood Science & Technology, Bangalore
2. State	Kerala / Tamilnadu/ Karnataka
3. Status of the Institutions	KFRI is an Institution of Kerala State Council for Science, Technology & Environment (KSCSTE), and Govt.of Kerala. IFGTB, Coimbatore and IWST, Bangalore are Institutions under ICFRE.
4 Name and designation of the Executive Authority of the University forwarding the application	(1) Dr. J.K. Sharma, Director, KFRI (2) Dr. K. Gurumurthi, Director, IFGTB (3) Dr. K. S. Rao, Director, IWST
5. Project Title	Field performance of micro- and macro-propagated planting stock of selected five commercially important bamboo species
6. Category of the Project	R &D
7. Specific Area	Agriculture & Allied fields
8. Duration	3 years
9. Total cost	Rs 1,01.155 Lakhs
10. Is the project Single Institutional or Multiple-Institutional (S/M)	Multi - Institutional
11. If the Project is multi-institutional, please furnish the following	
(i) Name of the Project Coordinator	Dr. JK Sharma
(ii) Affiliation	Kerala Forest Research Institute, Peechi
(iii) Address	Director, Kerala Forest research Institute Peechi- Trichur, Kerala, 680653 Phone: 0487-2699064 FAX:0487- 2699249 Email: jksharma@ kfri.org

12. Project Summary

This multi-institutional project is aimed at evaluating the field performance of planting stock raised by micro and macro propagation of selected five species of bamboo viz., *Bambusa bambos, Dendrocalamus strictus, Pseudoxytenanthera stocksii, Ochlandra travancorica* and *Dendrocalamus asper*, which are commercially important. The collaborating Institutions are Institute of Forest Genetics & Tree Breeding, Coimbatore (IFGTB), Institute of Wood Science & Technology, Bangalore (IWST) and the Kerala Forest Research Institute, Peechi (KFRI). The project envisages establishment of field demonstration plots for testing the performance of micro- and macro- propagated planting stock of the five species of bamboos mentioned above. The planting stock will be produced by the three collaborating institutes and planted out in demonstration plots of 30 ha in Kerala (25 ha at Attappady in two locations: Pattimalom (20 ha) and Jellippara (5 ha), 5 ha at IFGTB Field Centre, Panampally), 5 ha in Tamil Nadu (at Maruthumalai foothills, Coimbatore), 3 ha in Karnataka (Nallal, Bangalore) and 2 ha in Andhra Pradesh (Hyderabad). Four species, *Bambusa bambos, Dendrocalamus strictus, Pseudoxytenanthera stocksii,* and *Dendrocalamus asper* will be planted in five locations, Pattimalom, Coimbatore, Panampally, Nallal and Hyderabad. Ochlandra *travancorica* will be planted only at one location Jellippara. Thirty two hectares (20 ha at Attappady, 4 ha at Coimbatore and 4 ha at Panampally, 2.4 ha at Karnataka and 1.6 ha at Andhra Pradesh) will be planted with micropropagated planting stock and 8 ha (4 ha at Pattimalom (Attappady), 1 ha at Jellippara (Attappady), 1 ha at Coimbatore, 1ha at Panampally, 0.6 ha in Nallal, Bangalore, and 0.4 ha in Hyderabad with macropropagated planting stock. Planting will be carried out in two phases during 2004 and 2005 using the planting stock produced each year by the three collaborating Institutions. KFRI, IFGTB, IWST will establish the demonstration plots of 25 ha (Attappady), 10 ha (Coimbatore and Panampally) and 5ha (Bangalore and Hyderabad) respectively. The performance of planting stock in terms of survival, rate of culm production, growth and yield will be monitored and evaluated jointly by the scientists of all the three institutions. Overall coordination of the project will be carried out by KFRI.

PART II: PARTICULARS OF INVESTIGATORS

13.1 Kerala Forest Research Institute, Peechi

1	Name	Dr. J.K Sharma
	Indicate whether Principal Investigator/Co-Investigator	Project Co-ordinator
	Designation	Director
	Department	-
	Institute/University	Kerala Forest Research Institute, Peechi
	Address	Kerala Forest Research Institute Peechi-680 653, Trichur, Kerala Phone:0487-2699037 FAX:0487 2699249 Email: jksharma@kfri.org
	No. of Projects being handled at present	Project leader for a number of multi-disciplinary projects in KFRI

2	Name	Dr. U.N Nandakumar
	Indicate whether Principal Investigator/Co-Investigator	Principal Investigator
	Designation	Scientist E1
	Department	Sustainable Natural and Plantation Management Division (Silviculture discipline)
	Institute/University	Kerala Forest Research Institute, Peechi
	Address	Kerala Forest Research Institute Peechi-680 653, Trichur, Kerala Phone:0487-2699037 FAX:0487 2699249 Email: nandan@kfri.org
	No. of Projects being handled at present	Two

3	Name	Dr. E. M Muralidharan
	Indicate whether Principal Investigator/Co-Investigator	Investigator
	Designation	Scientist C
	Department	Sustainable Natural and Plantation Management Division (Biotechnology discipline)
	Institute/University	Kerala Forest Research Institute, Peechi
	Address	Kerala Forest Research Institute Peechi-680 653, Trichur, Kerala PH: 0487-2699037 FAX: 0487 2699249 Email: emmurali@kfri.org
	No. of Projects being handled at present	Three

4	Name	Dr. K.K. Seethalakshmi
	Indicate whether Principal Investigator/Co-Investigator	Investigator
	Designation	Scientist E1
	Department	Sustainable Natural and Plantation Management Division (Plant Physiology discipline)
	Institute/University	Kerala Forest Research Institute, Peechi
	Address	Kerala Forest Research Institute Peechi-680 653, Trichur, Kerala PH:0487-2699037 FAX:0487 2699249 Email: seetha@kfri.org
	No. of Projects being handled at present	Three

5	Name	Dr. Pradeep Raj Karat, IFS
	Indicate whether Principal Investigator/Co-Investigator	Investigator
	Designation	Joint Project Director
	Department	-
	Institute/University	AHADS, Attappady
	Address	Attappady Hills Area Development Society, Agaly (PO), Palakkad District, Kerala State, Pin-678 581 Phone:0492-454517 E mail: prkarat @ rediffmail.com
	No. of Projects being handled at present	Afforestation works in Attappady with the support of Japanese Government.

13. 2. Institute of Forest Genetics & Tree Breeding, Coimbatore

1	Name	Dr. K. Gurumurthi
	Indicate whether Principal Investigator/Co-Investigator	Project Coordinator- IFGTB
	Designation	Director
	Department	-
	Institute/University	Institute of Forest Genetics and Tree Breeding
	Address	Post Box No, 1061, Coimbatore – 641002 Phone:0422-2431942 Fax : 0422- 2430549 Email. ifgtb@ifgtb.res.in
	No. of Projects being handled at present	Two

2	Name	Ms.R. Yasodha
	Indicate whether Principal Investigator/Co-Investigator	Principal Investigator
	Designation	Scientist D
	Department	Division of Plant Biotechnology
	Institute/University	Institute of Forest Genetics and Tree Breeding
	Address	Post Box No, 1061, Coimbatore – 641002 Phone:0422-2431942 Fax : 0422- 2430549 Email. yasodha@ifgtb.res.in
	No. of Projects being handled at present	Three

3	Name	Dr. Santan Barthwal
	Indicate whether Principal Investigator/Co-Investigator	Investigator
	Designation	Scientist C
	Department	Division of Plant Biotechnology
	Institute/University	Institute of Forest Genetics and Tree Breeding
	Address	Post Box No, 1061, Coimbatore – 641002 Phone:0422-2431942 Fax : 0422- 2430549 Email. barthwals@ifgtb.res.in
	No. of Projects being handled at present	One

13.3.Institute of Wood Science & Technology, Bangalore

1	Name	Dr. K.S. Rao
	Indicate whether Principal Investigator/Co-Investigator	Co-ordinator - IWST
	Designation	Director
	Department	-
	Institute/University	Institute of Wood science and Technology
	Address	IWST, Malleswaram, Bangalore-560 003 Phone: 080-3346811 Fax- 080-3340529 E-mail- ksrao@iwst.res.in
	No. of Projects being handled at present	Project leader for a number of multidisciplinary projects of IWST

2	Name	Dr. T. S. Rathore
	Indicate whether Principal Investigator/Co-Investigator	Principal Investigator
	Designation	Scientist E
	Department	Tree Improvement and Propagation Division
	Institute/University	Institute of Wood Science & Technology
	Address	IWST, Malleswaram, Bangalore-560 003 Phone: 080-3346811 Fax- 080-3340529 E-mail- tsrathore@iwst.res.in
	No. of Projects being handled at present	Two

3	Name	Dr. S. Viswanath
	Indicate whether Principal Investigator/Co-Investigator	Investigator
	Designation	Scientist D
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	Institute/University	Institute of Wood Science &Technology
	Address	IWST, Malleswaram, Bangalore-560 003 Phone: 080-3346811 Fax: 080-3340529 E-mail: sviswanath@iwst.res.in
	No. of Projects being handled at present	One

PART III: TECHNICAL DETAILS OF PROJECT

14. Introduction

In India, during the late 1990s, the need for overall development of bamboo sector was recognized. Important initiatives like launching of Bamboo Development Programme by the Prime Minister on June 5, 1999 (World Environment Day) were taken up to reenergize the bamboo sector to help the rural people whose livelihood depended on it. Subsequently National Mission on Bamboo Technology and Trade Development was launched to promote bamboo sector in an integrated manner. Resource enhancement is one of the major requirements for the development of bamboo sector. Promoting cultivation of bamboo in forest as well as non-forest areas is an important task required for this purpose. One of the main bottlenecks for organized cultivation of bamboo is availability of planting stock of selected species in required quantity. Concerted efforts are required to develop technology for large-scale production of quality planting stock through appropriate macro and micro propagation methods. There is also need to evaluate planting stock produced by these methods through plantation trials laid out based on sound silvicultural principles.

14.1 Origin of the proposal

The efforts for organized cultivation need to be focused on easily cultivable, economically important, selected priority species having multiple end uses. The National Mission on Bamboo has identified about 13 species for large-scale plantation. Of these, five species (*Bambusa bambos, Dendrocalamus strictus, Pseudoxytenanthera stocksii, Ochlandra travancorica* and *Dendrocalamus asper*) are considered for production of planting stock through micro- and macro- propagation techniques and evaluation by field planting. Though micro- and macro- propagation techniques are available for these species at laboratory scale, scaling up of the technology to meet large-scale planting needs further investigations. Also the performance of planting stock of same species from different locations produced through different methods needs to be evaluated.

14.2 Definition of the problem

Propagation of bamboo has been successful using different techniques such as seedlings, rooted culm and branch cuttings, offset planting, layering and tissue culture methods. The simple and dependable method for regeneration is through seedlings but other methods need to be standardized, as seed supply in most of the bamboo species is erratic due to long intervals of flowering. In the absence of seeds, vegetative propagation through culm cuttings provides an alternative but it is not practical when planting stock is required for large scale planting programs. Several reports have shown the promise of producing planting stock of bamboos in large scale from selected genotypes through micropropagation. However, information on the field performance of the micro- and macro propagated planting stock is wanting. The objective of this proposal is to carry out a field trial with propagules of five species of bamboo viz., *Bambusa bambos, Dendrocalamus strictus, Dendrocalamus asper, Pseudoxytenanthera stocksii* and *Ochlandra travancorica* raised through micro- and macro propagation and assess their growth performance.

14.3 Objective

To evaluate the field performance of micro- and macro propagated planting stock of five commercially important species of bamboo viz., *Bambusa bambos, Dendrocalamus strictus, Dendrocalamus asper, Pseudoxytenanthera stocksii* and *Ochlandra travancorica* in multilocational demonstration plots to be established in Kerala, Tamil Nadu, Karnataka and Andhra Pradesh

15. Review of current status of R &D development in the subject

15.1 International status

Macro- and micro-propagation of various bamboo species has been carried out in different countries (see reviews by Banik, 1994; Zamora, 1994 and Wu, 1999). Methods of macro-propagation of bamboo include, in addition to production of seedlings, offset and rhizome planting, whole culm cuttings, layering, culm or stem cuttings, branch cuttings and macro-proliferation of seedlings. Methods for micro-propagation include those using seed and seedling tissues and explants from mature plants. However, evaluation of the comparative field performance of planting stock produced by different methods is scanty (Gonzales and Quimuio, 1998; Duria, 1991).

15.2. National Status

A large share of the research work in propagation of bamboos is done in India. In tissue culture, the earliest instances of success from institutes in the country were first reports of somatic embryogenesis, *in vitro* flowering and micropropagation of mature bamboo. The technique of macroproliferation was also developed in the country (Adarsh Kumar *et al.*, 1992). KFRI has developed a simple technique for rooting of culm cutting for 22 species (KFRI, 1990). Using this technology several farmers have been trained to set up nurseries in different parts of the State and in the northeast India. The field performance of tissue-cultured plants was assessed by Mascarenhas *et al.* (1989). Culm formation occurred within 30 months in tissue culture raised plants as compared to four years in seed raised plants. The height of the main culm, the number of culms per plant, the number of nodes of the main culm and the girth of the second internode were nearly double of those in the controls at 52 months. However, data from sufficient field trials based on sound silvicultural principles, comparative performance of tissue culture and vegetative propagated planting stocks are lacking.

15.3. Importance of the proposed project in the context of current status

The project will provide information on the field performance of macro and micro propagated planting stock of five commercially important bamboo species viz., *Bambusa bambos, Dendrocalamus strictus, Pseudoxytenanthera stocksii, Ochlandra travancorica* and *Dendrocalamus asper.* The information will be useful for selecting appropriate technology for production of planting stock. The data on growth performance of the five species will provide baseline information about the suitability of these species for large-scale cultivation.

15.4. Anticipated products and processes of practical/technological utility expected to be evolved by pursuing the project

Field-tested planting stock production technology for the five species viz.,. *Bambusa bambos, Dendrocalamus strictus, Pseudoxytenanthera stocksii, Ochlandra travancorica* and *Dendrocalamus asper* developed will be useful for taking up large-scale production of planting stock for these species.

Information generated through field trials will also help in devising appropriate package of practices for these species, which will help the farmers and people to take up bamboo cultivation in private lands.

15.5. Expertise available with the proposed investigating group in the subject of the project

Kerala Forest Research Institute, Peechi:

During the past two decades, KFRI has conducted research in various aspects of bamboo cultivation and utilization. This has not only generated a strong database but also enhanced the capabilities of scientists in this field. Work on bamboo was initiated in a big way during the late 1980s with a two phased multidisciplinary programme sponsored by the International Development Research Centre (IDRC), which continued until 1995. Several other programmes were also taken up with the assistance of various states, national and international organizations. KFRI has a bambusetum consisting of about 65

species of bamboos belonging to 18 genera, one of the largest in India. Technology for production of planting stock using seeds of *Bambusa bambos*, *D. strictus*, *O. travancorica* and vegetative propagation techniques for 22 commercial bamboo species using rooting of culm cuttings (Surendran and Seethalakshmi, 1985, Pandalai *et al.*, 2002) has been standardized. Micropropagation techniques have been standardized for important bamboo species like *Bambusa bambos* var. *gigantea*, *D. hamiltonii*, *D. strictus*, *Ochlandra travancorica* and *Thyrsostachys oliveri* (Muralidharan, 1992; 2002). Studies were also made to characterize the inter and intra specific variation in the genus *Ochlandra* using molecular markers (RAPD). The Institute has mother stock of commercial bamboo species in bambusetum in two localities in Kerala, viz., Palappilly and Nilambur. Facilities for carrying out micropropagation and nursery and mist chamber facilities for macro propagation are also available. KFRI, during the last three years, through an extension project viz., Resource Enhancement and Processing of Cane and Bamboo species suitable for Handicrafts, addressed promotion of organized cultivation in private lands and transfer of necessary technologies. Systematic training in nursery and cultivation of bamboo was provided to about 1000 farmers and about one lakh seedlings were distributed for planting. Technical support was provided for establishment of 10 bamboo nurseries to farmers in the state. Technical support and training was also provided to RFRI, Jorhat (ICFRI Institute) and SFRI, Arunachal Pradesh for developing expertise in bamboo cultivation. Besides the training workshops and technology transfer, to address some of the key issues which emerged during promotion of organized cultivation, a National workshop on policy and legal issues in cultivation and utilization of bamboo, rattan and forest trees in private and community lands, one Workshop on self help and community mobilization into community based enterprise and an Interaction Workshop on Bamboo resource development and utilization in Kerala were organized in Kerala.

The Investigators:

Dr. JK Sharma has more than 35 years of experience in forestry research, and research management. He is actively involved as expert member in various National and International Agencies and organizations and is currently Director of KFRI.

Dr. UN Nandakumar has more than 20 years of research experience in forestry and he has handled different research projects and extension activities involving bamboo silviculture. Currently he is involved in projects on standardizing cultivation practices for bamboos for homesteads of Kerala and also in monitoring the forestry operations in Bamboo forests in the state being taken up by the Karla Forest Department under the scheme on Restoration of reed, rattan and bamboo areas (RRB) of the World bank aided Kerala Forestry Projects.

Dr. EM Muralidharan has about 18 years of research experience in the field of Plant Tissue Culture. He is currently involved in developing *in vitro* protocols for bamboos, rattans, medicinal plants and forest trees.

Dr. KK Seethalakshmi has 24 years of experience in the field of bamboo propagation, especially macro-propagation techniques, establishment and management of bamboo plantations. Currently she is involved in a project on Development of bamboo sector in Kerala: Resource enhancement and macro-propagation of commercial bamboo species.

Dr. Pradeep Raj Karat, IFS is a forest officer of Indian Forest Service, Orissa cadre since 1992. He is on deputation to AHADS and is currently the Joint Project Director. He is involved in Afforestation activities of Attappady hills. He holds a PhD in Genetics and has experience in forest & wildlife management during the last five years.

Institute of Forest Genetics and Tree Breeding, Coimbatore

The Institute has developed micropropagation protocols for six different bamboo species namely, *Bambusa bambos, B. bambos var. gigantea, Dendrocalamus strictus, Bambusa nutans, Dendrocalamus membranaceous* and *Pseudoxytenanthera stocksii.* The institute has filed a patent application for the process developed for the multiplication of *Oxytenanthera stocksii* with the financial assistance from National Research Development Council, New Delhi (Patent number PAT/FA/99108).

Scientists from different disciplines such as biotechnology, tree improvement, clonal propagation trained in different countries viz., U.S.A., Australia, U.K., Sweden, Brazil are involved in bamboo research. The Institute is internationally recognized in the field of clonal technologies and tree improvement. The institute has been assisting industries like West Coast Paper Mills for the *in vitro* multiplication of high yielding clones of *Eucalyptus* and *Acacia.* Under the DBT funded project on fingerprinting of economically important clones of casuarina and eucalyptus, genetic fidelity of micro propagated plants of *E. tereticornis* has been determined using RAPD and AFLP markers.

The Investigators:

Dr.K. Gurumurthi has more than 35 years of experience and is an internationally known scientist in plant biotechnology. He has worked extensively on bamboo propagation and has served as consultant to various National and International agencies. He is currently Director, IFGTB.

Ms. R.Yasodha has more than 14 years of experience in plant Biotechnology and has worked extensively on bamboo tissue culture. She has received advanced training in Forest Genetics from University of Melbourne, Australia.

Institute of Wood Science and Technology, Bangalore

The Institute of Wood science and Technology, Bangalore has been involved in the bamboo propagation and improvement work for the past 10 years. Under UNDP project, vegetative propagation of three important bamboo species was carried out and several hundred plants were distributed to the farmers in Karnataka. Under ICFRE World Bank project, Rhizome Bank of *Pseudoxytenanthera stocksii, Dendrocalamus strictus* and *Bambusa vulgaris* was established in 1999 at Jarakabande, near Bangalore in collaboration with Karnataka State Forest Department, Bangalore as a source material for vegetative propagation and field trials. Under ICFRE supported project studies are being carried out for development of modern nursery protocols for production of quality

planting material stock of *Dendrocalamus strictus* and *Bambusa bambos*. This project deals with studies on type and size of containers, potting medium ingredients and their per proportion and biofertilisers (VAM and N_2 fixing bacteria).

The Institute developed vegetative propagation technique from leafy (culm) stem branch cutting of *Guadua angustifolia*, an exotic and fast growing multipurpose bamboo species having high potential for agroforestry and social forestry. The Institute has developed protocol for micropropagation of *Pseudoxytenanthera stocksii* through axillary shoot proliferation from the mature plants. Work has also been carried out on the micropropagation of *Dendrocalamus strictus* and *Bambusa bambos* from the seedling material. Micropropagated plants of *Guadua angustifolia* and root trainer raised seedlings of *B. bambos* and *D. strictus* were provided to end users (as quality planting stock) for plantation.

The Institute has a well equipped Plant Tissue Culture laboratory to carry out micropropagation work, green house and mist chambers for *ex vitro* rooting and macropropagation and shade house for hardening of macro and micropropagated plants in IWST campus. Apart from these, the Institute also has modern nursery near Bangalore for mass scale production of quality seedling/planting stock.

The IWST, Bangalore has expertise in plant tissue culture, plant physiology, silviculture, tree improvement and agroforestry. Expertise available at the Institute will address the objectives and work plan of the proposed collaborative project.

The Investigators:

Dr. K.S.Rao has more than 35 years of experience in forestry research and research management and co-ordination. He is involved as expert member in various National and International Agencies and Wood related organizations and is currently Director of IWST.

Dr. T. S. Rathore has 23 years of research experience in plant biotechnology with special emphasis on plant tissue culture. He has handled half a dozen projects on micropropagation / *in vitro* regeneration of important tree species, medicinal plants, orchids and threatened species. Apart from these, he has worked on micropropagation of

Dendrocalamus strictus, *Pseudoxytenanthera stocksii* and vegetative propagation of *Guadua angustifolia*. Presently he is involved in DBT funded project on, "Refinement of protocols for rapid clonal propagation of Sandal and Redsanders: Demonstration of field performance and evaluation of genetic fidelity", in addition to his other research activities.

Dr. S. Viswanath has 13 years of research experience in forestry with special emphasis on agroforestry. He has handled 6 projects at various places like TFRI, Jabalpur; IFGTB, Coimbatore and IWST, Bangalore. Currently he is involved in agro forestry and silviculture projects.

16.1. Methodology

16.1.1. Site Identification for field trials

A total area of 40 ha has been identified in 6 locations: Pattimalom (Attappady, Kerala)-20 ha; Jellippara (Attappady, Kerala)–5 ha; Maruthumalai foothills, Coimbatore,(Tamilnadu)-5 ha; Panampilly, Kerala (IFGTB Field Centre)-5 ha; Nallal, Bangalore, Karnataka – 3 ha and Hyderabad ,Andhra Pradesh-2 ha . Details regarding extent of area proposed to be planted for each species with micro- and macropropagated planting stock in each site are given below. Out of the total area of 40 ha, 32 ha will be with micro propagated and the remaining eight ha with macro propagated planting stock.

Activities for establishing the demonstration plots in three locations (Pattimalom, Jellippara and Coimbatore) covering an extent of 30 ha will be taken up in 2004 whereas the works for remaining three demonstration plots of 10 ha in Panampilly, Nallal and Hyderabad will be taken up during 2005. Planting will be carried out in two phases in 2004 and 2005 with the planting stock produced by the three institutions each year.

Species wise extent of area (ha) proposed to be planted at each site with micro- and macropropagated Planting stock.

Species	KFRI				IFGTB				IWST				Total		
	Pattimalom (Kerala)		Jellippara (Kerala)		Panampilly (Kerala)		Coimbatore (Tamil NAlladu)		Nallal, Bangalore Karnataka		Hyderabad Andhra Pradesh				
	micro	macro	micro	macro	micro	macro	micro	macro	micro	macro	micro	macro	micro	macro	Total
B. bambos	4	1	-	-	1.5	0.25	1.5	0.25	0.60	0.15	0.40	0.10	8	1.75	9.75
D. asper	4	1	-	-	0.5	0.25	0.5	0.25	0.60	0.15	0.40	0.10	6	1.75	7.75
D.strictus	4	1	-	-	1.5	0.25	1.5	0.25	0.60	0.15	0.40	0.10	8	1.75	9.75
P. stocksii	4	1	-	-	0.5	0.25	0.5	0.25	0.60	0.15	0.40	0.10	6	1.75	7.75
O. travancorica	-	-	4	1	-	-	-	-	-	-	-	-	4	1.00	5.00
Total Area (ha)	16	4	4	1	4.0	1.0	4.0	1.0	2.40	0.60	1.60	0.40	32	8.00	40.00
	25				**10**				**5**				**40**		

16.1.2 Production of planting stock

All the collaborative institutions will produce micro-and macro propagated planting stock. The following two tables provide the details on total requirements of all the five bamboo species as well as institutional commitment of the collaborating institutions in the production of planting stock in respect of each species.

Species-wise total planting stock requirements for all the planting areas.

Bamboo species	Area (ha)* & Spacing	Plants/ ha needed for planting **	Planting stock requirement					
			Micro propagated			Macro propagated		
			Actual	Casualty replace-ment	Total	Actual	Casuality replace-ment	Total
B. bambos	8 (1.75) 6 x 6m	240	1920	770	2690	420	170	590
D. asper	6 (1.75) 6 x 6m	240	1440	580	2020	420	170	590
D. strictus	8 (1.75) 5 x 5m	380	3040	1070	4010	665	265	930
P. stocksii	6 (1.75) 5 x 5m	380	2280	910	3190	665	265	930
O. travancorica	4 (1) 4 x 4m	600	2400	960	3360	600	240	840

- Area required for macro propagated plants in parentheses * * after excluding inspection path

Planting stock production (number of propagules) for planting in June/July 2004 and 2005 by the participating institutions

Species	2004				2005			
	Macro	Micro			Macro	Micro		
	KFRI	KFRI	IFGTB	IWST	KFRI	KFRI	IFGTB	IWST
B. bambos	590	200	200	0	-	1000	1000	290
D. asper	-	0	0	0	590	0	1010	1010
D. strictus	930	300	200	0	-	500	500	2510
P. stocksii	930	0	0	500	-	0	670	2020
O. travancorica	-	0	0	0	840	3360	0	0
Total	2450	500	400	500	1430	4860	3180	5830
	3850				15300			

16.1.3 Propagation methods for planting stock production

Micro propagation

Planting stock of *B. bambos*, D. *strictus* and *O. travancorica* will be raised through micropropagation using seedlings as explants. Planting stock of micropropagated *D. asper and P. stocksii* will be supplied by IFGTB and IWST. Micropropagation will be carried out in all the selected species using standard tissue culture procedures through enhanced axillary proliferation from nodal explants taken from *in vitro* seedlings . Shoot multiplication will be carried out in a liquid medium for 4-8 passages. Plantlets will be produced by *in vitro* or *ex vitro* rooting of shoots. Plantlets will be transferred to soil and hardened in the mist propagation chamber. Hardened plantlets will be transferred to the nursery for further hardening prior to planting out.

Macropropagation

The method of vegetative propagation using culm cuttings standardised by KFRI (KFRI, 1990) will be used for production of planting stock. This involves treatment of two nodded culm cuttings with growth regulating substances for inducing root formation. Naphthyl acetic acid (NAA) at a concentration of 250 mg/l will be used and treatment will be given by cavity method for *B. bambos, D. asper* and *O. travancorica* and by dip method for *D. strictus* and *P. stocksii*

16.1.4 Field nursery

Planting stock produced by different participating institutions by micro- and macro-propagation methods will be transferred to a field nursery for hardening before out planting in the field.

16.1.5 Statistical design

As suggested by DBT, the statistical design for demonstration trial prepared by the Bamboo Development Board Uttaranchal, with appropriate modification, if any required, will be adopted for the field trials.

16.1. 6 Site preparation

To ensure protection to the plants fencing will be provided wherever required. In areas susceptible to elephant attack, elephant proof trenches or other protection measures required would be provided in addition to the fence to ensure protection to the plants. To ensure adequate moisture availability and protection to topsoil adequate soil and water conservation measures will be carried out in addition to irrigation depending on requirement. Measures such as contour trenches and inwardly tilted trench –cum-mound pits; terraces etc will be employed sufficiently in advance depending on requirement. Other site preparation activities such as weeding, application of suitable combination of organic manures such as farmyard manure, compost, bone meal, ground nut / neem cake and inorganic fertilizers will be carried out as per requirement.

16.1.7 Planting

Planting will be carried out at the onset of monsoon in pits of 60 cm x 60 cm x 60 cm size uniformly to micro- and macro propagated planting stock to provide optimal growth condition. Base manuring as per requirement will be provided at the time of planting. Planting in entire area 40 ha of all the demonstration plots will be completed by 2005 as in 2004 due to shortage of adequate planting stock planting will be restricted to the quantity of stock produced.

16.1.8 Post planting care and maintenance of plots

Various post planting operations such as weeding, soil working, mulching, manurial application, different soil and moisture conservation methods, irrigation, plant protection from pest, diseases, other biotic and abiotic factors will be carried out during the entire project period depending on requirement in consultation with specialists available in all the collaborating Institutes to ensure optimal growth. Casuality replacement will be made as per standard procedures.

16.1. 9 Observations

For collection of data, as suggested by DBT, the standard format to be prepared by Dr. LMS Palni, Senior Scientific Advisor, Govt. of Uttaranchal will be adopted with suitable modifications, if required. Field observations will be recorded jointly by the investigators from all three participating institutions.

16.2 Organisation of work elements

1. Production of planting stock of all the species by three participating institutions - by KFRI, IFGTB and IWST.
2. Establishment of germplasm garden of the material chosen for planting stock in all the three Institutes ,KFRI,IFGTB and IWST
3. Assembling of planting stock from the different institutions and maintenance at nursery sites for out planting in different trial plots.
4. Site preparation, alignment, staking, pitting and planting by respective institutes.
5. Plantation maintenance activities such as weeding, soil working, mulching, other soil and moisture conservation activities, irrigation depending on requirements.
6. Evaluation of performance of different treatments (type of propagules and source of planting stock) by monitoring parameters such as survival, culm production, growth and yield by the three institutions.
7. Data analysis and preparation of Project Report – by KFRI, IFGTB & IWST.
8. Compilation of all the three reports, synthesis of the results and submission of final report -KFRI

16.3 Suggested plan of action for utilization of research outcome expected from the project

Using the information on the performance of the different bamboo species and types of planting stock in the field, appropriate technology for large-scale cultivation of the chosen species will be recommended. Any further need for improvement in the technology will be identified. A manual on package of practices of all the five bamboo species will be prepared. The germ plasm of the material used for demonstration plot will help in making available the planting stocks of the type later.

16.4. Work Plan and Time schedule of activities giving milestones

S. No.	Name of milestone	Expected starting date	Expected completion date
1	Preparation of planting stock (2004) (KFRI, IFGTB, IWST)	February/March 2004	May 2004
2	Preparation of planting stock (2005) (KFRI, IFGTB&IWST)	February/March 2004	May 2005
3	Establishment and maintenance of germplasm garden of the elite material used for planting stock production at the three participating institutes- (KFRI,IFGTB &IWST)	July 2004	January 2007
3	Assembling and hardening /maintenance in the Nursery (2004 planting) – (KFRI, IFGTB &IWST)	May 2004	Oct/Nov 2004
4	Assembling and hardening/maintenance in the Nursery (2005 planting) -(KFRI, IFGTB &IWST)	May 2004	June/July 2005
5	Preparation of land (2004 planting)- fencing, soil and moisture conservation work , site clearance and weeding etc -(KFRI, IFGTB &IWST)	February 2004	June 2004
6	Preparation of land (2005 planting))- fencing, soil and moisture conservation work , site clearance, weeding etc- (KFRI,IFGTB &IWST)	February 2004	June 2005
7	Planting (2004) including causality replacement -(KFRI, IFGTB &IWST)	June/July 2004	October 2004
8	Planting (2005)including casualty replacement -(KFRI,IFGTB &IWST)	June/July 2005	October 2005
9	Maintenance of demonstration plots and observations -(KFRI,IFGTB &IWST)	August 2004	January 2007
10	Data Analysis and Preparation of final individual report by the three institutions- (KFRI, IFGTB &IWST)	January2007	February 2007
11	Consolidation and preparation of final combined project report by KFRI	February2007	March 2007

16.5 Project implementing agency

Name of agency	Address	Proposed Research	Proposed Cost Sharing
Kerala Forest Research Institute, Peechi	Peechi-680653, Thrissur Kerala	(i) Overall coordination and implementation of the project (ii)Identification of planting sites for (iii)Macro propagation of planting stock of all the bamboo species (iv) Micropropagation of 3 species *B. bambos, D.strictus, O .travancorica* (v) Establishment & maintenance of demonstration plots at Attappadi (25 ha) (vii) Observations (viii) Analysis of data (ix)Preparation of consolidated report with synthesis of results.	**Rs.53.23lakhs**
Institute of Forest Genetics &Tree Breeding, Coimbatore.	Post Box No, 1061, Coimbatore – 641002 Fax : 0422-430549 Email. ifgtb@ifgtb. Coimbatore	(i) Micropropagation of four species and supply of planting stock (ii) Establishment and main demonstration plots at Panampilly & (10 ha) (ii) Observations and analysis of data iii) Report preparation	**Rs. 27.56 lakhs**
Institute of Wood Science Technology, Bangalore	Malleswaram, Bangalore-560 003 Phone:080-346811 Fax: 080-3340529	(i)Micropropagation of three species and supply of planting stock (ii) Establishment and main demonstration plots at Bangalore and ha) (ii) Observations &analysis of data (iii) Report preparation	**Rs. 20.36 lakhs**

PART IV: BUDGET PARTICULARS

18. BUDGET

1.Kerala Forest Research Institute, Peechi

Particulars	Year-1	Year- 2	Year-3	Total
A. Nonrecurring expenses				
Upgradation of Nursery(nursery shed, agroshade nets, root trainers and stand, up gradation of mist/nursery hardening chamber, sprinkler irrigation facilities etc)	1,00,000	50,000	0	**1,50,000**
B. Recurring				
1. Manpower				
Research Fellow 8000 +5% HRA	1,00,800	1,00,800	1,00,800	**3,02,400**
Technical Assistant 6000 + 5%HRA	75,600	75,600	75,600	**2,26,800**
Nursery Man &Watch and ward at field site (Two) 3000+5%HRA	75,600	75,600	75,600	**2,26,800**
2. Consumables				
Chemicals	60,000	70,000	50,000	**1,80,000**
Glassware	25,000	20,000	30,000	**75,000**
Nursery items	15,000	10,000	20,000	**45,000**
3. Travel				
Vehicle charges, TA/DA	50,000	50,000	50,000	**1,50,000**
4. Contingency				
Stationery, communication, etc.	50,000	50,000	50,000	**1,50,000**
5.Establishment & maintenance of Germplasm Garden at KFRI	50,000	30,000	20,000	**1,00,000**
6.Demonstration plots (20 ha first year &25 ha second and third year@ Rs.40,000/- per year)	8, 00,000	10,00,000	10,00,000	**28,00,000**
Analysis of data and report Preparation			30,000	**30,000**
Total	**14,02,000**	**15,32,000**	**15, 02, 000**	**44,36,000**
Overhead @ 20%	2,80,400	3,06,400	3,00,400	**8,87,200**
Grand total	**16,82,400**	**18,38,400**	**18,02,400**	**53,23,200**

2. Institute of Forest Genetics & Tree Breeding, Coimbatore.

Particulars	Year-1	Year-2	Year-3	Total
A. Nonrecurring expences				
Upgradation of Nursery(Agro shade net,root trainers and stand, FRP Sheet, missting nozzlesand pipes, cooling pads,exhaust fan etc)	1,00,000	--	--	**1,00,000**
B. Recurring				
1. Manpower				
Technical Assistant 6000 +15% HRA (2persons)	1,65,600	1,65,600	1,65,600	**4,96,800**
2. Consumables				
Chemicals	60,000	70,000	50,000	**1.80,000**
Glassware	25,000	20,000	30,000	**75,000**
Nursery Items	15,000	10,000	20,000	**45,000**
3.Travel	50,000	50,000	50,000	**1,50,000**
4. Contingency	50,000	50,000	50,000	**1,50,000**
5. Demonstration plots (10.0 ha)	2,00,000	4,00,000	4,00,000	**10,00,000**
6. Germplasm garden establishment	50,000	30,000	20,000	**1,00,000**
Total	**7,15,600**	**7,95,600**	**7,85,600**	**22,96,800**
Overheads (20%)	1,43,120	1,59,120	1,57,120	**4,59,360**
Grand Total	**8,58,720**	**9,54,720**	**9,42,720**	**27,56,160**

3.Institute of Wood Science and Technology

Particulars	Year I	Year II	Year III	Total
A. Non recurring expenses				
Up gradation of mist chamber + accessories	1,00,000	0	0	**1,00,000**
B. Recurring				
Technical Assistant 6000 + HRA @ 15% p.m. (2 No.)	1,65,600	1,65,600	1,65,600	**4,96,800**
2. Consumables (chemicals, glasswares, etc)	1,00,000	1,00,000	1,00,000	3,00,000
3. Travels Vehicle charges TA/DA	50,000	50,000	50,000	**1,50,000**
4. Germ plasm garden Establishment and Maintanance	50,000	30,000	20,000	**1,00,000**
***4. Field expenses (for 5 ha @ Rs. 40,000/ha/year)**	-NIL-	2,00,000	2,00,000	**4,00,000**
5. Contingency (Stationary, communication, mainatenance of equipments, books, report preparation etc.)	50,000	50,000	50,000	**1,50,000**
Total	5,15,600	5,95,600	5,85,600	**16,96,800**
Overhead @20%	1,03,120	1,19,120	1,17,120	**3,39,360**
Grand total	6,18,720	7,14, 720	7,02,720	**20,36,160**

19.Consolidated Budget for the three Participating Institutions

Consolidated budget	KFRI	IFGTB	IWST	Total
A. Nonrecurring	1,50,000	1,00,000	1,00,000	**3,50,000**
B. Recurring				
1. Manpower	7,56,000	4,96,800	4,96,800	**17,49,600**
2. Consumables	3,00,000	3,00,000	3,00,000	**9,00,000**
3. Travel	1,50,000	1,50,000	1,50,000	**4,50,000**
4. Contingencies	1,50,000	1,50,000	1,50,000	**4,50,000**
5.Germplasm garden	1,00,000	1,00,000	1,00,000	**3,00,000**
6. Demonstration plots (40 ha)	28,00,000	10,00,000	4,00,000	**42,00,000**
7. Final report Preparation	30,000	-	-	**30,000**
Total	**44,36,000**	**22,96,800**	**16,96,800**	**84,29,600**
Overheads	8,87,200	4,59,360	3,39,360	**16,85,920**
Grand total	**53,23,200**	**27,56,160**	**20,36,160**	**1,01,15,520**

PART V: EXISTING FACILITIES

20. **Available equipment and accessories to be utilized for the Project:**

A. KFRI, Peechi

	Item	Make	Funding Agency	Year
1	Tissue culture lab with Laminar flow benches-(4) and Tissue culture racks	Klenzaids etc.	DBT, UNDP	1992-2000
2	Autoclaves-2	Natsteel, Medequip	DBT, UNDP	''
3	Deep freezer	Vestfrost	UNDP	2000
4	Shaker- 2 Nos	Remi, Certomat	DBT, UNDP	1992, 1996
5	Plant growth chamber	Sanyo	DBT	1996
6	Stereozoom microscope	Leica	DBT	1995
7	Electronic balance	Sartorius	DBT	2000
8	Quartz distillation units	Bhanu Scientific	KFD	1993

B. Institute of Forest Genetics &Tree Breeding, Coimbatore

	Item	Make	Funding Agency	Year
1	Laminar flow benches-4	Klenzaids, Yorco etc.	WB, ICFRE	1992-2000
2	Autoclaves-2	Avalon	WB, ICFRE	''
3	Deep freezer	Kelvinator	ICFRE	1992
4	Shaker- 2 Nos	Certomat	ICFRE	1992
5	Plant growth chamber	Sanyo	WB	2000
6	Electronic balance - 2	Afcoset	WB, ICFRE	1992, 2000
8	Quartz distillation units	Bhanu Scientific	ICFRE	1993

C. Institute of Wood Science and Technology.

Sl. No.	Name of equipment/accessories	Funding agency	Year of procure-ment
1	Air conditioners (4 No.s)	World Bank	1998
2	Air curtain	World Bank	1998
3	Autoclave Horizontal	World Bank	1996
4	Autoclave Vertical	World Bank	1996
5	BOD incubator	World Bank	1997
6	Culture racks with timer (20 No.s)	World Bank	1997
7	Deep freezer	DBT	2003
8	Electronic Balance	World Bank	1999
9	Electrophoresis unit with power supply	World Bank	1997
10	Freezer	World Bank	1997
11	Gel Documentation system	DBT	2003
12	Glass bead sterilizers (2 No.s)	World Bank	1997
13	Growth chamber	World Bank	1998
14	Laminar Air Flow	World Bank	1998
15	Lux meter	World Bank	1997
16	Magnetic shaker	World Bank	1997
17	Magnetic stirrer	World Bank	1998
18	Microcentrifuge	DBT	2003
19	Oven	World Bank	1998
20	pH meter	World Bank	1998
21	Phase contrast microscope with photographic attachment	World Bank	1996
22	PCR machine	DBT	2003
23	Refrigerated centrifuge	World Bank	2000
24	Single and double distillation units	World Bank	1998
25	Stereo-zoom microscope	World Bank	1996
26	Temperature Controller Unit (2 No.s)	World Bank	1998
27	Ultrafiltration unit with vacuum pump	World Bank	1999

PART VI: DECLARATION / CERTIFICATION

It is certified that

(a) The research work proposed in the scheme/project does not in any way duplicate the work already done or being carried out elsewhere on the subject.

(b) The same project has not been submitted any other agency/ies for financial support

(c) The emoluments for the manpower proposed are those admissible to persons of corresponding status employed in the institute/university or as per the Ministry of Science & Technology guidelines.

(d) Necessary provision for the scheme/project will be made in the Institute/ University/State budget in anticipation of the sanction of the scheme/project.

(e) If the project involves the utilization of genetically engineered organism, it is agreed by us that we will ensure that an application will be submitted through our Institutional Biosafety Committee and we will declare that while conducting experiments the Biosafety Guidelines of the Department of Biotechnology would be followed in toto.

(f) If the project involves field trials/experiments/exchange of specimens, etc., we will ensure that ethical clearances would be taken from concerned ethical Committees/Competent authorities and the same would be conveyed to the Department of Biotechnology before implementing the project.

(g) We agree to accept the Terms and Conditions as enclosed as Annexure-III

Dr. J.K. Sharma.
DIRECTOR, KFRI

Dr. K. Gurumurthi
DIRECTOR, IFGTB

Dr K. S. Rao
DIRECTOR, IWST

Signature of Principal Investigators/ Co-Investigators:

KFRI

Dr. U.N Nandakumar
: Principal Investigator

Dr. E. M Muralidharan
Co- Investigator1

Dr K.K. Seethalakshmi
Co- Investigator 2

IFGT&B:

Ms.R. Yasodha
Principal Investigator
R. YASODHA
SCIENTIST SD
INSTITUTE OF FOREST GENETICS & TREE BREEDING
COIMBATORE-641 002

Dr. Santan Barthwal
Co-Investigator
SANTAN BARTHWAL
Scientist 'SD'
Division of Plant Biotechnology
Institute of Forest Genetics and
Tree Breeding,
P.B. No. 1061, Forest Campus, R.S.

IWS&T

Dr. T. S. Rathore
Principal Investigator
Dr. T. S. Rathore, M.Sc., Ph.D.
Scientist - E
Tree Improvement & Propagation Divn.
IWST, 18th Cross, Malleswaram,
Bangalore - 560 003.

Dr. S. Viswanath
Co- Investigator
Dr. S. Viswanath
Scientist D
Tree Improvement & Propagation Division
Institute of Wood Science & Technology
18th Cross, Malleswaram
Bangalore-560 003

PART IV: BIODATA

Bio-data of Project Coordinator & Investigators

A. Kerala Forest Research Institute, Peechi

1. Project Coordinator

Name	:	Dr.J.K. Sharma
Sex	:	Male
Designation	:	Director
Address	:	Kerala Forest Research Institute Peechi, Thrissur.680 653
Date of birth	:	February 2, 1948
Telephone	:	0487-2699037 0487-2354262 (R)
Fax	:	0487-2699249
Email	:	jksharma@ kfri.org

Educational qualification (Post Graduation onwards)

Sl. No	*Institution/ Place*	Degree Awarded	Year	Award/Prize
1.	Agra University, Agra	M.Sc. (Botany)	1966	1st Division
2.	Agra University, Agra	Ph.D. (Botany-Plant Pathology)	1971	-

Professional Experience

1. Lecturer, Botany Department, Agra College, Agra, India, December, 1967 - June, 1974. (Seven and half years teaching and research experience in Botany)
2. Four and half years teaching and research experience as Postdoctoral Fellow/Visiting Fellow, Department of Forestry, Australian National University, Canberra, July 1974 - November, 1978. (Multi-disciplinary Forestry Research in Tree Physiology, Silviculture, Tree Improvement and Extension). Scientist-in-Charge, Division of Forest Pathology, Kerala Forest Research Institute, Peechi, Kerala, India, November 1978 - March, 1997 (Twenty years experience in Division administration, Identification of research areas, preparation and implementation of research projects. Published 10 research reports as Principal

Investigator, 4 research reports as Co-investigator. Guided 6 Ph.D. students for the award of Ph.D. Degree of Cochin University of Science and Technology and FRI Deemed University, Dehra Dun.)

3. Research Coordinator (Scientist F), Research Monitoring and Evaluation Unit, Kerala Forest Research Institute, Peechi, Kerala, India, April 1997-July 199. (Held discussions with scientists either individually or in groups on matters relating to formulation, implementation and finalisation of project reports and issue necessary instructions).
4. Director, Kerala Forest Research Institute, Peechi, Kerala, India, (July 1999 - continuing.) (Has successfully guided a number of projects of National and International importance. These include a multi Institutional UNDP funded project on bamboo and AICAR, Australia supported project on Eucalypts .)

Publications

Has over 100 publications of National and International repute as research papers, articles, chapters in books, etc .

2 - **Principal Investigator**

Name	:	Dr. UN Nandakumar
Sex	:	Male
Designation	:	Silviculturist.E1
Address	:	Division of Silviculture, Kerala Forest Research Institute Peechi, Thrissur.680 653
Date of birth	:	28.11.1957
Telephone	:	0487-2699037, 2699400(R)
Fax	:	0487-2699249
Email	:	nandan@kfri.org

Educational Qualifications

1. Ph. D. (Forestry) FRI Deemed University, Dehra Dun.2001
2. Diploma in Forestry, State Forest Service College, Coimbatore, Govt.of India, 1988
3. M. Sc. (Mathematics), First Class, University of Calicut in 1981
4. B. Sc (Mathematics) First Class, University of Calicut, 1979

Training received

1. Attended a two year in-service residential training programme in Forestry for the Assistant Conservators of Forests at State Forest Service College, Coimbatore, Tamilnadu, Ministry of Environment & Forests, Govt. of India, Jan 1987 - Dec1988
2. Attended a 4 week training program on Geographic Information Systems for Natural Resources Management, Centre of Studies in Resources Engineering, IIT, Bombay, during October - November, 1993.
3. Attended a 10 week Training course in Remote Sensing Technology and Applications through Visual Interpretation & Digital Analysis at NRSA, Hyderabad, April 4 to June 10,1994.

4. Attended a 1week Training program in "Environmental Impact Assessment of Water Resources Projects "CWRDM Subcentre, Neyyattingara, Thiruvananthapuram, Nov 20-25, 1995.
5. Attended a 10 month Training program in Remote Sensing and GIS application in Forestry at Indian Institute of Remote Sensing, Dehra Dun, Aug 2000 to July 2001.

Important assignments attended

1. Associated in preparing a document on forestry research support for the World Bank aided Kerala Forestry Project in 1995

2. Principal Investigator for a Consultancy Project on "Survey and Establishment of a monitoring system for degraded forests of Kerala" for the World Bank supported Kerala forestry project preparatory facility.

3. Member, Monitoring Committee, Monitoring weeding operations of Kerala Forestry Project as per directive of Hon. High Court of Kerala.

4. Forestry Expert to accompany the advocate commission monitoring KFD activities on natural forests and plantations under Kerala Forestry project as per directive of Hon. High Court of Kerala.

5. Convener, Thematic group " Education, Awareness, Research and Training" for "State Biodiversity Strategy and Action Plan for Kerala State".

Important publications

1. Nandakumar, UN. 1996. Evaluation of alternative material as containers for raising forest planting stock. KFRI Research Report 103,86p.

2. Nandakumar, UN and Menon, ARR.1990. Resource Survey of rattans: problems and prospects. in Rattan Management and Utilisation 86-103pp.

3. Nandakumar, UN and Menon, ARR. 1993. Application of remote sensing for rattan resource survey. Int. Jour. of Remote Sensing.14(17):3137-3143

4. Nair, KSS, Nandakumar, UN, Menon, ARR and Sankar, S 1997. Survey and establishment of a monitoring system for degraded forests of Kerala. (Consultancy report KFRI 251/96) 94p.

5. Nandakumar, UN. 2000. Demonstration cum research on multi-tier forestry through Operations Research. KFRI Research Report 186, 94p

6. Nandakumar, UN. 2002. Information Management for Forest Plantations. (Report on ICFRE sponsored KFRI Research Project KFRI 259/96)109p.

7. Sharma, JK, Nair, KKN, Ramachandran, KKR , Jayson, EA ; Nandakumar, UN , Nair PV. 2002. Studies on Biodiversity of New Amarambalam of Nilgiri Biosphere Reserve. KFRI Report No.247, 230p.

R&D PROJECTS BEING PURSUED/CARRIED OUT BY INVESTIGATOR

No.	Project title	Funding Agency	Duration	
			From	To
1.	Standardization of cultivation practices for bamboo for homesteads in Kerala	Kerala State Council for Science, Technology & Environment	2003	2008

Highlights

Survey of households in Kerala to understand the problems and prospects of bamboo cultivation Study of published and unpublished data, interaction with farmers, scientists and forest officials; Studies on suitable types bamboo species for different types of homesteads, Identification of set of cultivation practices suited to different households and bamboo species; Studies on nursery techniques, sites suitability, planting techniques, post planting care, clump management, harvesting, Establishment of demonstration plots in representative households on aspects such as mixed planting, block planting, border planting, etc.

3. Investigator

Name	:	Dr. E.M. Muralidharan
Sex	:	Male
Designation	:	Scientist C
Address	:	Division of Genetics, Kerala Forest Research Institute, Peechi, 680 653 Trichur District, Kerala, India
Date of birth	:	January 12th, 1961
Telephone	:	+91- (0)487- 2699037, 2699061-64
Fax	:	+91- (0)487- 2699249
Email	:	emmurali@kfri.org emmurali@sancharnet.in

Educational Qualifications

1. M.Sc. (Botany) with First Rank from University of Calicut in 1982
2. Ph.D (Biochemistry) awarded by University of Poona for work on Biochemical studies in Plant Tissue Culture carried out at the National Chemical Laboratory, Pune in 1991
3. Diploma in Bamboo technology from the China National Bamboo Research Centre, Hangzhou, PR China, 2002

Training received:

1. Attended a Training Course on Yeast Genetic Manipulation and Molecular Markers at the MS Swaminathan Research Foundation, Madras from November 27-Decemeber 11, 1995.
2. Underwent training in Molecular Approaches in Plant Population Genetics and Systematics at the Genetics Laboratory of Forest Research Institute of Malaysia, Kepong, Malaysia during 13-24 January. 1997

Research Experience in various Institutions

1. CSIR Junior and Senior Research Fellow at the National Chemical Laboratory, Pune from 1984 to 1989. Worked on the Tissue Culture of some forest trees e.g. eucalyptus, acacia, mango and neem. Also worked on isolation and culture of plant protoplasts and the estimation of secondary metabolites of neem callus cultures.
2. Project Fellow in NABARD sponsored project on "Technology transfer Biotechnological evaluation and clonal multiplication of Eucalyptus, Bamboo and Salvadora" at the National Chemical Laboratory, Pune from 1989 to 1990.
3. Senior Scientific Assistant in the Department of Biotechnology sponsored "Tissue Culture Pilot Plant Facility on Eucalyptus, Bamboo and Teak." at NCL, Pune, from 1990 to 1991. Worked on large-scale micropropagation of trees and their transfer to field.
4. Scientist at Genetics Division, Kerala Forest Research Institute, from May 1991. Initially worked on establishing a tissue culture facility in the Institute and initiating research on micropropagation of medicinal plants, bamboo and rattan and other forestry species. Currently working on tissue culture, isozyme analysis of forest trees and medicinal plants.

Publications: Project Reports - 7; Chapters in Books- 7; Research Papers – 11

List of publications (Recent publications only)

Project Reports

1. Propagation of Medicinal Plants, Bamboo and Rattan by tissue culture methods. Muralidharan, E.M., KFRI Research Report No. **87**. 1996.

2. Micropropagation of teak , rosewood and sandalwood., Muralidharan, E.M., KFRI Research Report No. **119**, 1997.

3. Micropropagation of selected medicinal plants, Muralidharan, E.M., KFRI Research Report No. **123**. 1997.

4. Genetic Diversity and Conservation of certain species of Rattans in Andaman and Nicobar Islands and Southern India . Renuka, C., Indira, E.P. and Muralidharan. E.M., KFRI Research Report No. **157**. 1998

5. Development and dissemination of low-cost techniques for micropropagation of *Kaempferia galanga* (Kacholam), Muralidharan, E.M., KFRI Research Report No. **159**. 1998.

6. Assessment of field performance of micropropagated teak and eucalypts, Muralidharan, E.M. and R.C. Pandalai, KFRI Research Report No **211**, 2001
7. Resource enhancement and processing of cane and bamboo species suitable for handicrafts Component 7 : Setting Up of Tissue Culture and Plant Multiplication Nurseries, Muralidharan, E.M. KFRI Report (In Press), 2002

Handbook

1. Muralidharan, E.M. (2002) Micropropagation of Bamboo and Rattan, KFRI Handbook No. 15, KFRI, UNDP and DC (Handicrafts). 20 p.

Chapters in Books

1. Mascarenhas, A.F. and E. M. Muralidharan (1993) Clonal Forestry with Tropical Hardwoods. In: Ahuja, M.R. and W.J. Libby (Eds.), Clonal Forestry II: Conservation and Application. Springer Verlag. pp 169-187.

2. Muralidharan, E.M. and A.F. Mascarenhas (1995) Somatic Embryogenesis in Eucalyptus. In : Somatic Embryogenesis in Woody Plants, Vol. 2, Mohan Jain, S., P.K. Gupta and R.J. Newton (Eds.) Kluwer Academic Publishers, Netherlands. pp 23-40.

3. Renuka, C., Indira, E.P. and Muralidharan, E.M. (1995) Genetic Diversity and conservation of certain species of rattans in Andaman and Nicobar Islands and Southern India. In: Bamboo and Rattan Genetic Resources and Use, R.Rao and Rao, A.N. (Eds.) Proc. of Second INBAR-IPGRI Biodiversity Genetic Resources and Conservation Working Group Meeting, 28-29, November, JogJakarta, Indonesia. p. 48-50.

4. Suma, T.B., Sunil Thomas and E.M. Muralidharan (1999) High frequency organogenesis in *Clausena indica* - a tree host of sandal. In : Plant Tissue Culture and Biotechnology- Emerging Trends. Kavi Kishor, P.B. (Ed.) , Universities Press. p. 96-99.

5. Valsala, K. and E.M. Muralidharan (1999) In vitro regeneration in three species of Rattan (Calamus spp.), In : Plant Tissue Culture and Biotechnology- Emerging Trends. Kavi Kishor P.B. (Ed.) , Universities Press. p. 118-122.

Publications in Proceedings of Symposia, Conferences etc.

1. Muralidharan, E.M. (1995) An evaluation of cost reduction measures in micropropagation. Proc. of Seventh Kerala Science Congress, Palakkad, January 27-29, pp 17-19.

2. Muralidharan, E.M. (1995) Low-input micropropagation of some species of Zingeberaceae. Paper presented at The All India Symp. on Recent Advances in the Biotechnological Applications of Plant Tissue and Cell Culture, June 23-25, CFTRI, Mysore .

3. Valsala, K. and E.M. Muralidharan (1998) Plant regeneration from in vitro cultures of rattan (*Calamus*). In: Damodharan, A.D. (Ed.), Proceedings of 10th Kerala Science Congress, Kozhikode , January, 1998. pp. 161-163
4. Muralidharan, E.M. (1999) , Energy Conservation measures in a Tissue culture facility. In: Renewable energy 1999, Proc. of ANERT National Conference, February 1999, p. 135-138.

R&D PROJECTS BEING PURSUED/CARRIED OUT BY INVESTIGATOR

No.	Project title	Funding Agency	Duration		No. of Scientist on the Project	Total Approved Cost (Rs)
			From	To		
1	Micropropagation of three species of bamboos	KFRI Plan funds	April, 2003	March 2006	1	8,37,000
2.	Micropropagation of selected clones of teak for improvement of planting stock	KFRI plan funds	April, 2003	March 2006	1	6,36,000

Highlights of progress of the project to date (in 200 words) for ongoing projects

1. Cultures have been established from nodal explants collected from mature plants of three species of bamboo. Shoot multiplication is in progress and different parameters are being tested to improve the multiplication rates and obtain rooting.
2. Cultures are being initiated from selected outstanding clones of teak of Kerala. Shoot initials have been obtained from nodes and shoot tips explants and multiplication is being attempted.

4 . Investigator

Name	:	Dr. KK. Seethalakshmi
Sex	:	Female
Designation	:	Scientist E1
Address	:	Division of Plant Physiology Kerala Forest Research Institute, Peechi 680 653
Date of birth	:	14th May 1953
Telephone	:	0487-2699037
Fax	:	0487 260249
E mail	:	seetha@kfri.org
Education Qualifications	:	Ph. D. Botany – 1983, University of Madras M. Sc. Botany – 1975, University of Calicut B. Sc. Botany - 1973, University of Calicut (First class in both graduation and post- graduation and first rank for post graduation)

List of publications (relevant to bamboo from 1998 -2002)

Books

Seethalakshmi, K.K; Kumar, M. 1998. **Bamboos of India: A Compendium**. Kerala Forest Research Institute, Peechi and International Network for Bamboo and Rattan, Beijing: 342p.

Pandalai R. C., Seethalakshmi, K.K. and Mohanan C. 2002. Nursery and Silviculture techniques for Bamboos. KFRI Handbook No. 18. Kerala Forest Research Institute, Peechi; Development Commissioner (Handicrafts) Ministry of Textiles, Government of India and United Nations Development Programme. 40p.

Edited Books

Mohanan C, Chacko K. C, Seethalakshmi, K. K, Sankar, S. Renuka, C, Muralidharan, E. M and Sharma, J. K (Eds) 2002. Proceedings of the National Workshop on Policy and Legal Issues in Cultivation & Utilization of Bamboo, Rattan and Forest Trees in Private & Community Lands. Development Commissioner (Handicrafts), Ministry of Textiles, Government of India and United Nations Development Programme, New Delhi and Kerala Forest Research Institute, Peechi 7-9 August 2001. 221p

Seethalakshmi, K.K. Sankar, S and Sharma J. K. (Eds) 2002. Bamboo Resource Development and Utilization in Kerala. Kerala Forest Research Institute, Peechi, Development Commissioner (Handicrafts), Ministry of Textiles, Government of India and United Nations Development Programme, New Delhi. 22 July 2002. 29p.

Scientific papers and chapter in book

Abdul Kader, S; Preethi Madhavan; Ravendran, V.P; Seethalakshmi, K.K. 2001. Albino seedlings in bamboo (***Ochlandra travancorica*** (Bedd.) Benth. ex Gamble). Indian Journal of Genetics 61(2): 194-195.

Kumar, M; Seethalakshmi, K.K; Stephen Sequiera. 1999. Two new species of *Ochlandra* Thw. (Poaceae - Bambusoideae) from Southern India. Rheedea 9(1): 31-35.

Mathew, G; Seethalakshmi, K.K. 1998. A new report of *Achroia grisella* Fb. (Lepidoptera: Galleriidae) as a seed pest of bamboo reed (*Ochlandra ebracteata* Raizada & Chatterjee). Entomon 23(3): 239-240.

Seethalakshmi, K.K; Preethi Madhavan. 1999. Molecular techniques for bamboo systematics. In: Joseph P. Varghese (Ed). Molecular Approaches to Crop Improvement. C.M.S.College, Kottayam: 130-136.

Seethalakshmi, K.K. 2001. Biodiversity, conservation and genetic improvement of bamboo. In: Uma shanker, R; Ganeshaiah, K.N; Bawa, K.S. et al, Eds. Forest Genetic Resources: Status, Threats and Conservation Strategies. Oxford and IBH Publishing Co, New Delhi: 225-235.

Seethalakshmi, K.K. 2002. Cultivation and utilization of bamboos - support and services. In: Seethalakshmi, K.K, Sankar, S, Sharma, J.K., Eds. Bamboo Resource Development and Utilisation in Kerala: Proceedings of the Interaction Workshop, Thiruvananthapuram, 22 July 2002. Kerala Forest Research Institute, Peechi; Development Commissioner (Handicrafts), Ministry of Textiles, Government of India and United Nations Development Programme, New Delhi: 21-23.

R&D PROJECTS BEING PURSUED/CARRIED OUT BY INVESTIGATOR

No.	Project title	Funding Agency	Duration		No. of Scientists on the Project	Total Approved Cost (Rs in lakhs)
			From	To		
1.	Development of Bamboo sector in Kerala – Resource Development	Director, Industries, Govt of Kerala	2003	2004	5	20
2	Macro-propagation of two commercially important bamboo species	Kerala State Council for Science and Technology	2003	2004	2	4.61
3	Resource Development and utilization of cane and bamboo species suitable for handicrafts	Development Commissioner (Handicrafts), Ministry of Textiles	2000	2003	18	79

Highlights of progress of the project to date for ongoing projects

1. Development of bamboo sector in Kerala: Resource enhancement: The project envisages raising bamboo plantation in ten selected Panchayats of Kerala. Planting of selected species is being done in the Panchayats with people's participation. The target is to make the Panchayats self reliant with regard to bamboo raw-material

2. Macropropagation of two commercially important bamboo species: Improvement of the technology for production of planting stock in bulk for two bamboo species *Bambusa bambos* and *Dendrocalamus brandisii* is envisaged in this project. Experiments are being done to enhance the number of sprouts, roots and induction of rhizome and thus increase the number of plants per bamboo through macro propagation. Experiments in progress using various permutations and combinations of growth regulating substances, rooting media, fertilizers and misting.

5. Investigator

Name	Dr. Pradeep Raj Karat, IFS
Sex	Male
Designation	Joint Project Director, AHADS
Address	Joint Project Director, Attappady Hills Area Development Society, Agali (PO), Palakkad District, Kerala State, 678 581.
Date of Birth	July,27,1963
Phone Number	0492-454517, 454489. (Off) 0492-424885 (Mannarkkad) (Res.) 0493-742809 (Kottakkal)
E-Mail	prkarat @ rediffmail.com.

Educational Qualifications

Degree	Subject	Year	Place
B.Sc. (Ag.)	Agriculture	1984	Thrissur, Kerala
M.Sc. (Ag.)	Genetics	1987	Dharwad, Karnataka
Ph.D.	Genetics	1993	IARI, New Delhi
P.G. Diploma	Forestry	1995	IGNFA, Dehradun

Professional Experience

1. Forest officer of Indian Forest Service, Orissa Cadre since 1992
2. Countries visited and international training received

Institute Name	Name of Training	Duration (in number of days)	Year
Asian Institute of Training, Bankok, Thailand	Exposure training in Mangroves Management	6	1998
Asian Institute of Training, Manila, Philippines	Exposure training in Mangroves Management	8	1998
Forest Department, Malaysia	Exposure training in Mangroves Management	3	1998

3. Field Experience

Designation	Department	Place of Posting	Duration	
			From	To
D.F.O. (Territorial)	Forest	Boudh, Orissa	Oct,17,1997	Aug,18,1998
D.F.O.(Wild Life)	Forest	Rajnagar, Orissa	Sept,8,1998	Feb,2,2001
D.F.O. (Territorial)	Forest	Balangir, Orissa.	Feb,26,2001	April,24,2001
Joint Project Director	Rural Development	AHADS, Attappady, Kerala	May,7,2001	Till Date

B. Institute of Forest Genetics and Tree Breeding, Coimbatore

1. Project Coordinator

Name	:	Dr. K.Gurumurthi
Sex	:	Male
Date of Birth	:	August 12, 1944
SC/ST	:	No

Educational ***(Post-Graduation onwards & Professional Career)***

S.No	Institution and Place	Degree Awarded	Year	Award/Prize/ Certificate*
1	BITS, Pilani	M.Sc	1966	
2	Gujarat university	Ph.D	1971	

* Obtained distinction (75%) in plant physiology

Awarded "Seth Memorial Prize" for best paper published in Indian Forester 1984

Certificate of appreciation and cash award for excellence in clonal forestry

Research experience in various institutions ***(if necessary, attach separate sheets)***

Before Joining ICFRE

Name of the organization	Designation	Brief experience
Gujarat University, Ahmedabad	Research Scholar	Physiology of seed germination and biochemical studies during germination
Punjab University, Chandigarh	Research Associate cum Lecturer	Physiological and biochemical studies associated with rooting in forest plants

Research Experience in ICFRE

- Established model propagation facilities at the Institute of Forest Genetics and Tree Breeding
- Established a model clone bank at IFGTB
- Assisted the Indian Council of Forestry Research and in formulation of projects for international funding

- ❖ Obtained FORTIP network project for operation in our country with ten other countries participating
- ❖ Functioned as Assistant Regional Advisor FAO/UNDP/FORTIP project
- ❖ Functioned as FAO consultant for the Government of Bhutan to establish propagation facility in 1993.
- ❖ As FAO Consultant established a complete propagation facility at Bhutan and provided propagation training to the foresters of Department of Forestry, Bhutan in 1994
- ❖ Conducted International Propagation programme for the FORTIP, which was subsequently published as FAO publication
- ❖ Functioning as Chief Technical Advisor for Tree Improvement of Casuarina.
- ❖ Worked as National Consultant of FAO to bring out document on Baseline Studies on Tree Improvement in India.
- ❖ Formulated the contract consultancy with Andhra Pradesh Forest Development Corporation.
- ❖ Functioned as Team leader of Technical Consultancy on Clonal technology for paper pulp plantations for Andhra Pradesh Forest Development Corporation.
- ❖ Functioning as Team Leader for a World Bank Consultancy work for Kerala Forest Development Corporation Project on Clonal Technology
- ❖ During 1977-1988 carried out extensive studies of various aspects of plantation forestry with emphasis on energy plantations, rural fuel wood systems, short spacing short rotation forestry, community fuel wood systems in close collaboration with state forest departments of Gujarat, Tamil Nadu. Also functioned as Member of the scientific advisory committee of Ministry Non Conventional Energy Sources.

Publication ***(Number only)***

Books: 3 **Research Papers, Reports:** 110 **General articles:** 15

Patents: Nil **Others** ***(Please specify)*** Technical bulletins: 3

List of important publications relevant to the proposed area of work.

S.No	Title of Paper	Authors	Reference of Journal	Year of Public - ation
1	Continuous shoot proliferation of *Dendrocalamus strictus* in stationary liquid cultures	Preetha, N., Yasodha, R., Sumathi, R. Gurumurthi, K.	Journal of Tropical Forest	1992
2	Continuous mass propagation of Bamboo	Preetha, N., Yasodha, R., Sumathi R. Gurumurthi, K	International Bamboo Newsletter (Canada).	1992
3	Mass propagation protocol for bamboos	Preetha,.N., Madhavi Rani, A., Yasodha, R., Stanely Jagadees, S. Gurumurthi, K	ICFRE Technical bulletin	1993
4	*In vitro* flowering in *Dendrocalamus strictus*	Preetha,N., Yasodha,R., Sumathi,R. Gurumurthi,K	Sylva Plus	1994
5	Genetic enhancement and mass production of quality propagules of *Bambusa nutans* and *Dendrocalamus membranaceous*	Yasodha, R., Sumathi, R. Malliga, P Gurumurthi, K	Indian Forester	1997
6	Micropropagation of difficult to propagate clones of eucalypts.	Yasodha, R Sumathi,R. Gurumurthi,K.	IUFRO conference on Silviculture and improvement of eucalypts, Brazil	1997
7	Micropropagation of Bamboos- Commercialisation of the Technique	Yasodha,R., Sumathi,R., Malliga,P., Gurumurthi,K	XI World Forestry Congress, Turkey	1997
8	*In vitro* regeneration of plants from mature *Eucalyptus tereticornis*	Sumathi, R. Malliga, P., Venkataramanan, K.S. Stanley, J. Yasodha, R	Sylva Plus	2000

9	Branch segments of mature Eucalypts-As a source of explant for microprogation	Yasodha.R ,Sumathi R, Gurumurthi K	IUFRO International Symposium on "Developing the Eucalypt of the future" Valdivia-Chile	2001
10	Rescuing of a mature candidate plus tree of *Eucalyptus tereticornis*	Sumathi R, Yasodha R., Gurumurthi, K	IUFRO International Symposium on "Developing the Eucalypt of the future" Valdivia-Chile	2001

Projects carried out by Investigator

S.No	Title of Project	Funding Agency	Duration From	Duration To	No.of Scientist/Associates working under the project	Total approved Cost of the Project (Rs in lakhs)
1.	Tree Improvement and propagation (as Assistant Regional Advisor)	FAO	1990	1995	Scientist-1	Rs. 35.00
2.	Production of high yielding varieties of Eucalyptus and Casuarina	ICFRE	1992	2002	Scientist- 2 Research Asst- 3	Rs . 35.0*
3.	Assessing growth and physiological variations like photosynthesis in fast growing tree species for improving yield.	ICFRE	1994	2002	Scientist- 1 Research Asst- 2	Rs . 25.0*
4.	Fingerprinting of economically important clones of Casuarina and eucalypts	DBT	1999	2003	Scientist - 3 SRF - 1	Rs. 27.00

* including infrastructure and equipments

Highlights of progress of the project(s) to date (in 200 words) for ongoing projects only*(if necessary attach separate sheets)*

Project 1: Production of High Yielding Propagules of Casuarina and Eucalypts

A model vegetative propagation complex consisting of a large model shade house system with double roof structures and mist chambers have been developed keeping in view the need for the vegetative propagules to root optimally. The structures have been designed to reduce gradient in vapour pressure deficit between the plant and the semi micro environment and semi micro environment and the atmosphere. The shade house system is also provided with optimum misting structures for rooting of cuttings. A polytunnel with humidifier controlled fogger has also been established for direct rooting of tissue culture plants. The entire complex is designed and developed specifically to multiply superior propagules using combination of micro and macro propagation protocols. A mist chamber has been designed and developed with specific purpose of maintaining high humidity, reduced ambient temperature, adequate air circulation yet with relatively reduced gradient in vapour pressure.

Clones of *Eucalyptus tereticornis* and 19 clones of *Eucalyptus camaldulensis* were culled from a stressed area of 106 ha. by a selection process which helped in selection of 2 to 3 percentage of the population. Specific criteria have been developed for selection process and the clones rooted and assembled in the clone bank.

Surveying the coastal plantations of *Casuarina* and applying a high intensity selection procedure, superior performers of *Casuarina equisetifolia* have been selected, clones rooted and assembled in the vegetative propagation complex. The total of 106 very high yielding trees were identified and the vegetative material as cladodes was brought in large number and from these clones which were then rooted in institute campus and the clone banks established. During the experimentation, techniques were also developed to collect vegetative materials and transport them for long distances. This technique is widely publicised and practised. Similarly protocol for successful rooting to the extent of 85 per cent was also developed. The clones thus rooted have been established as clone banks. The inter clonal assessment of 106 established clones were completed.

Project 2. Assessing growth and physiological variations like photosynthesis in fast growing tree species for improving yield.

To identify the salinity resistant clones of *Casuarina equisetifolia* 99 clones of *Casuarina equisetifolia* have been subjected to salinity. The salinity resistance of the each clone was assessed by measuring growth characters like height, CDM, biochemical characters like Chlorophyll, proline, carbohydrates and physiological characters like photosynthesis, Chlorophyll florescence. The result of the various assays showed significant variation among the clones, which helps to identify clones from highly susceptible to highly resistant clones under saline condition

Biochemical analysis has been taken up to characterise all the clones of Eucalyptus and Bamboo. Leaf proteins were extracted, isolated and fractionated through Fast Protein Liquid Chromatography using size exclusion column. In case of Bamboo it was observed that the molecular weight of different fractions ranged from < 3,000 to > 70,000 KDa. Essentially it consisted of four different fractions, of which more than 50 per cent consisted of protein fraction with molecular weight less than 3000 KDa. In flowered cultures the percentage of protein fraction with molecular weight less than 3000 KDa was found to be less, whereas, in cultures with multiple shoots it was more. Among the genotypes also, the percentage of this protein fraction was varied.

Application of Mahalanobis D^2 statistics for the analysis of the 19 clones of *Eucalyptus camaldulensis* resulted in identifying four clusters. The objective of estimating the D^2 values and determining the clustering of the clones is to determine the extent of closeness or distance of the selected clones for the desired characters, it also estimates the genetic distance between the clones and clusters. The number of clones in the cluster varied from one to nine. To estimate the genetic divergences *of Casuarina equisetifolia* clones the Ward's dendrogram method was used. The clones selected from Chidambaram, Chengalpet and Tiruchendur (Tamil Nadu) were used for the divergence studies. 37 clones collected from Tiruchendur area falls in six clusters with 2-8 clones per cluster. 28 clones of Chidambaram, Chengalept areas were formed four clusters with 2-12 clones per cluster. The characters considered for analysis are height, dbh, cdm, frustum volume, total volume and needle length.

Project 3: Fingerprinting of economically important clones of Casuarina and Eucalyptus

Methods were standardized for fingerprinting of Casuarina clones using Inter Simple Sequence Repeat – PCR (ISSR-PCR) and FISSR-PCR with the assistance of Centre for DNA Fingerprinting and Diagnostics, Hyderabad. Thirty oligonucleotide primers were screened for polymorphism with two clones of *Casuarina*. Six primers, which showed more then five informative amplified products, were selected to analyse the extent and nature of polymorphism in all the 12 clones of *Casuarina equisetifolia*. Methods were optimized for fingerprinting of the clones of Eucalyptus and Casuarina using RAPD technique. 40 oligonucleotide random primers (OPB-1 to 20, OPE-1 to 20) were screened with 4 female and 8 male clones of Casuarina and 30 primers showed polymorphism at least between two clones. Among the 30 polymorphic primers, 3 primers were selected for fingerprinting studies. In Eucalyptus, 20 oligonucleotide random primers (OPC-1 to 20) were screened and 11 primers were identified for fingerprinting

Project 4: Genome evaluation and characterization in casuarinas and eucalypts for improving productivity and conservation

This project aims to develop methods for DNA markers, which will enable to document and measure variation within and between species, provenances and populations of *Casuarina* and *Eucalyptus*. Variation found in these species, provenances and clones would improve the method of selection of superior genotypes and identify genetically divergent clones. Knowledge on the distribution of genetic variability within and among the provenances/ genotypes can be used in utilization of genetic resources for maximum gain.

2. Principal Investigator

Name : **Ms.R.Yasodha**

Sex : Female

Date of Birth: 24.05.1967

SC/ST : No

Educational *(Post-Graduation onwards & Professional Career)*

S.No	Institution and Place	Degree Awarded	Year	Award/Prize/Certificate
1	Bharathiar University, Coimbatore	M.Sc.	1989	University First Rank
2.	Bharathidhasan University, Trichy	M.Phil.	1990	Distinction

Research experience in various institutions ***(if necessary, attach separate sheets)***
Undergone training in 'Forest genetics' at University of Melbourne, Australia for a period three months in 1995.

Publication ***(Number only)***

Books: Research Papers, Reports: 20 **General** articles:
Patents: 1 Others *(Please specify)*

List of important publications relevant to the proposed area of work:

S. No	Title of Paper	Authors	Reference of Journal	Year of Publication
1	Continuous shoot proliferation of *Dendrocalamus strictus* in stationary liquid cultures	Preetha, N., Yasodha, R., Sumathi, R. Gurumurthi, K.	Journal of Tropical Forest	1992
2	Continuous mass propagation of Bamboo	Preetha, N., Yasodha, R., Sumathi R. Gurumurthi, K	International Bamboo Newsletter (Canada).	1992
3	Mass propagation protocol for bamboos	Preetha, N., Madhavi Rani, A., Yasodha, R., Stanely Jagadees, S. Gurumurthi, K	ICFRE Technical bulletin	1993

4	*In vitro* flowering in *Dendrocalamus strictus*	Preetha,N., Yasodha,R., Sumathi,R. Gurumurthi,K	Sylva Plus	1994
5	Genetic enhancement and mass production of quality propagules of *Bambusa nutans* and *Dendrocalamus membranaceous*	Yasodha, R., Sumathi, R. Malliga, P Gurumurthi, K	Indian Forester	1997
6	Micropropagation of difficult to propagate clones of eucalypts.	Yasodha, R Sumathi,R. Gurumurthi,K.	IUFRO conference on Silviculture and improvement of eucalypts, Brazil	1997
7	Micropropagation of Bamboos- Commercialisation of the Technique	Yasodha,R., Sumathi,R., Malliga,P., Gurumurthi,K	XI World Forestry Congress, Turkey	1997
8	*In vitro* regeneration of plants from mature *Eucalyptus tereticornis*	Sumathi, R. Malliga, P., Venkataramanan , K.S. Stanley, J. Yasodha, R	Sylva Plus	2000
9	Branch segments of mature Eucalypts-As a source of explant for microprogation	Yasodha.R ,Sumathi R Gurumurthi K	IUFRO International Symposium on "Developing the Eucalypt of the future" Valdivia-Chile	2001
10	Rescuing of a mature candidate plus tree of *Eucalyptus tereticornis*	Sumathi R, Yasodha R, Gurumurthi K	IUFRO International Symposium on "Developing the Eucalypt of the future" Valdivia-Chile	2001

Projects carried out by Investigator

S. No	Title of Project	Funding Agency	Duration		No.of Scientist/Associates working under the project	Total approved Cost of the Project (Rs . Lakhs)
			From	**To**		
1	Development of micropropagation technique for selected tree species including procedure for hardening, weaning and out planting	ICFRE	1992	2002	Scientist- 1 Research Asst- 2	Rs . 35.0
2	Biotechnology of trees	World Bank	1995	2001	Scientist- 2 Research Asst- 2	Rs. 33.0
3	Fingerprinting of economically important clones of Casuarina and eucalypts	DBT	1999	2003		Rs. 27.00

Highlights of progress of the project(s) to date (in 200 words) for ongoing projects only ***(if necessary attach separate sheets)***

Project 1. Development Of Tissue Culture Micropropagation Technique For Selected Tree Species Including Procedure For Hardening Weaning And outplanting

Bench scale method for commercial propagation of *Bambusa arundinacea, Dendrocalamus strictus, Bambusa nutans* and *Dendrocalamus membranaceous* was developed using seed quality and seedling vigour to mass produce quality propagules. Mass propagation of Bamboos has been carried for *Bambusa arundinacea, Bambusa nutans, Dendrocalamus strictus and Dendrocalamus membranaceous*. The multiplication is being carried out in a commercial tissue culture laboratory (SPIC Agro Biotech Ltd., Coimbatore) at the rate of Rs.5/- per plant. By transferring the multiple shoot cultures and the standardising protocol to SPIC ABC Ltd., we are able to produce maximum number of quality planting material of bamboo.

The recalcitrant clones of *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* were multiplied using micropropagation techniques. Ten clones of *Eucalyptus camaldulensis* and 5 clones of *Eucalyptus tereticornis* were established under *in vitro* conditions. Among different root induction media composition tested, Knop's medium was found to be the most suitable one. After 15-20 days of rooting medium, the plants were directly transferred to the

shade house for acclimatisation and the survival rate of plants after three months was 80%. Tissue culture work on Teak was initiated using the seeds from Clonal Seed Orchard of Maharashtra. The available protocols for micropropagation of teak were compared and a refined protocol for bench scale multiplication was established. The *in vitro* produced shoots were rooted under *in vivo* conditions with 80% rooting.

Using combination of micro and macro propagation protocols a provenly superior tree of *Eucalyptus tereticornis* was cloned by rejuvenating and subsequent multiplication in the mist chamber complex. Tissues were obtained from 15 year old adult trees. A basic clone bank, which has been established, can provide clones for distribution.

Micropropagation methods were developed to multiply *Oxytenanthera stocksii,* one of the economically important, solid bamboo in India, where the flowering was not reported so far.

Project 2: Fingerprinting of economically important clones of Casuarina and Eucalyptus

Methods were standardized for fingerprinting of Casuarina clones using Inter Simple Sequence Repeat – PCR (ISSR-PCR) and FISSR-PCR with the assistance of Centre for DNA Fingerprinting and Diagnostics, Hyderabad. Thirty oligonucleotide primers were screened for polymorphism with two clones of *Casuarina.* Six primers, which showed more then five informative amplified products, were selected to analyse the extent and nature of polymorphism in all the 12 clones of *Casuarina equisetifolia.* Methods were optimized for fingerprinting of the clones of Eucalyptus and Casuarina using RAPD technique. 40 oligonucleotide random primers (OPB-1 to 20, OPE-1 to 20) were screened with 4 female and 8 male clones of Casuarina and 30 primers showed polymorphism at least between two clones. Among the 30 polymorphic primers, 3 primers were selected for fingerprinting studies. In Eucalyptus, 20 oligonucleotide random primers (OPC-1 to 20) were screened and 11 primers were identified for fingerprinting

Project 3: Genome evaluation and characterization in casuarinas and eucalypts for improving productivity and conservation

This project aims to develop methods for DNA markers, which will enable to document and measure variation within and between species, provenances and populations of *Casuarina* and *Eucalyptus*. Variation found in these species, provenances and clones would improve the method of selection of superior genotypes and identify genetically divergent clones. Knowledge on the distribution of genetic variability within and among the provenances/ genotypes can be used in utilization of genetic resources for maximum gain.

Investigator

Name : Dr. Santan Barthwal

Sex : Male

Date of Birth: 12.11.1971

SC/ST : No

Educational ***(Post-Graduation onwards & Professional Career)***

S. No	Institution and Place	Degree Awarded	Year	Award/Prize/ Certificate
1	G.B.Pant University of Agriculture and Technology, Pantnagar, Udham Sing Nagar, Uttaranchal	M.Sc. (Plant Physiology)	1995	82.9 %
2.	G.B.Pant University of Agriculture and Technology, Pantnagar, Udham Sing Nagar, Uttaranchal	Ph.D. (Plant Physiology)	2003	73%

Research experience in various institutions ***(if necessary, attach separate sheets)***

- Presently working on *in vitro* selection technique for salt tolerant *Casuarina equisetifolia*. The work involves standardization of regeneration protocol under stressed condition.
- Worked on morphological descriptors in Casuarinas. The morphological traits identified for clonal identity include length of deciduous branchlet, internode length, number of nodes and leaflets, length of leaflet and their ratios.
- Involved in clonal propagation and germplasm maintenance of Eucalypts, Casuarina, Acacia, Teak and Bamboos.

Publication ***(Number only)***

Books: 3 chapters **Research Papers, Reports:** 3 **General articles:** nil

Patents: nil **Others** ***(Please specify)***

List of important publications relevant to the proposed area of work:

In Journals:

S.No	Title of Paper	Authors	Reference of Journal	Year
1	Effect of Salt Stress on Rooting of *Casuarina equisetifolia* Cuttings.	**Santan Barthwal,** Raman Nautiyal, M. Ganesan, K.S. Venkataramanan and K. Gurumurthi	Journal of Tropical Forest Science, Malaysia.	Accepted for publication
2	Importance of biotechnological Research in Tree Species of Dashamula.	Yasodha R., Modhumita Ghosh, **Santan Barthwal** and Gurumurthi, K	Indian Forester	Aaccepted for publication
3	Salt Stress: Responses and mechanism of tolerance in plants	**Santan Barthwal,** K. Gurumurthi and R.C. Pant	Journal of Plant Biology	Under revision

In Conferences / symposium / proceedings

1. Barthwal S., Mathur, D., Pant, R.C. and Garg,G.K..1996.Physio-morphological and anatomical adaptations of sugarcane (*Saccharum officinarum* L.) to periodical waterlogging. Paper presented at National Symposium on Modern Trends in Plant Physiology. G. B. Pant University of Agriculture and Technology, Pantnagar. March 18-20, 1996.
2. Santan Barthwal, Shashi Bhushan Tripathi, R.Yasodha and K. Gurumurthi. Inflorescence reversion in casuarina equisetifolia. Paper presented at International Symposium on Recent Advances in Biological Sciences, KSR College of Arts and Science Tiruchengode Tamil Nadu 11th and 12th Oct. 2001.
3. Santan Barthwal, R. Yasodha, Raman Nautiyal and K. Gurumurthi. 2001. Studies on Morphological Features of Casuarina equisetifolia branchlets for developing suitable descriptors for clonal characterization. 5th Casuarina workshop at RFRC Rajahmundry Andhra Pradesh 8th and 9th October 2001.
4. Barthwal, S., Tripathi, S.B, Nautiyal, R, Gurumurthi,K and Pant R.C. 2003. Photosynthesis as Selection Criteria for Rapid Screening of Eucalyptus Clones for Salt Tolerance. 2nd International Congress of Plant Physiology on Sustainable Plant Productivity Under Changing Environment. 8-12 Jan 2003. New Delhi.

In Books:

1. K. Gurumurthi Santan Barthwal and C. Surendran . Vegetative Propagation. In: Forest Tree Breeding, ICAR Text Book. (in press)
2. Santan Barthwal, Kannan Chandrashekhar Warrier, Ashok Kumar and Kailash Paliwal(2001). Photosynthesis and Water Relations in Casuarina equisetifolia. In, Casuarina: Improvement and Utilization. Eds Gurumurthi, K., Nicodemus, A. and Siddapa. IFGTB, ICFRE, India.

3. Santan Barthwal, Raman Nautiyal, M. Ganeshan, R.Yasodha and K.Gurumurthi (2001). Clonal Descriptors for Casuarina equisetifolia. In, Casuarina: Improvement and Utilization. Eds Gurumurthi, K., Nicodemus, A. and Siddapa. IFGTB, ICFRE, India

Projects carried out by Investigator

S. No	Title of Project	Funding Agency	Duration		No.of Scientist/Associates working under the project	Total approved Cost of the Project (Rs . Lakhs)
			From	**To**		
1	Assessing growth and physiological variations like photosynthesis in fast growing tree species for improving yield **(as Co-investigator from 1998-2001)**	ICFRE	1992	2001	8	
2	Isolation of somaclonal variants of *Casuarina equisetifolia* for salinity tolerance **(as PI**	ICFRE	2002	2007	4	9.4 Lakh

Highlights of progress of the project(s) to date (in 200 words) for ongoing projects only *(if necessary attach separate sheets)*

Project : Isolation of somaclonal variants of *Casuarina equisetifolia* for salinity tolerance

Standardization of protocol for callus culture is under progress. Various basal media were tested for optimizing the callus growth in *Casuarina equisetifolia* cotyledons. Growth hormones and their concentrations were tested to induce morphogenetic callus from seedling explants. More than 100 media combination of BAP, Kinetin, 2,4-D and NAA were tested for callus initiation and callus growth. Initiation of the callus was achieved with over 90 percent success from the cotyledonary as well as needle explants. Multiplication of callus is undergoing for testing of regeneration / initiation of suspension cultures purpose.

C. Institute of Wood Science and Technology, Bangalore

1.Project Coordinator (IWST)

Name : Dr. K. Satyanarayana Rao

Sex : Male

Designation : Director

Institute : Institute of Wood Science and Technology, Bangalore

Date of Birth : 04.09.1944

Education (Post-Graduation onwards and Professional Career)

Sl. No.	Institution-Place	Degree Awarded	Year
1	Andhra University	M.Sc	1964
2	Andhra University	Ph.D	1976

Research Experience in various institutions.

1 Has 37 years of experience as a scientist of the Forest Research Institute (F.R.I.) / Indian Council of Forestry Research and Education Institute of Wood Science and Technology (IWST))

2 .Has experience as a Research Manager and Director of IWST (one of the Institutes under I.C.F.R.E.) since 1997. As the Director,he holds first line research and administrative responsibilities for broad based research programmes of the Institute encompassing the fields of forest products (Wood Science and Technology), forestry, non-wood forest products, forestry extension, joint forest management and coastal forestry research. Implemented a just concluded (December 2001) World Bank sponsored Forestry Research Education and Extension Project (F.R.E.E.P.) component of the Institute that included among other things; Projects on Sandal, Tree Improvement as well as a Programme of Planting Stock Improvement.

Sandal, teak, eucalyptus, casuarinas, bamboo etc., are species involved in the above projects/programme. This programme (1994 - 2001) has resulted in establishment of 120 ha. of seed production areas of teak, eucalypts and casuarina species; 34 ha of seedling seed orchards of teak, sandal and casuarinas and 12 ha of clonal seed orchard of sandal, teak, casuarinas and eucalypts; 6.0 ha of Vegetative Multiplication Gardens of teak, eucalypts and bamboo species (rhizome bank); a modern nursery and tissue culture laboratory aimed at improvement in supply of quality planting stock / tree improvement.

3. His contribution in sandal include maintaining and managing three sandal field stations namely: a well grown clonal germplasm bank and host trial of sandal at Gottipura, a clonal seed orchard at Nallal near Bangalore and a field station for screening and control of spike disease experiments at Yelawala near Mysore and establishment of a new clonal seed orchard at Tirupati and seedling seed orchard at Kuchuvarpalli and Talkona (AP). He also conducted an International Seminar on "Sandal Wood and its Products" (18th - 19th December 1997) and published its proceedings jointly with Australia Centre for International Agricultural Research (A.C.I.A.R.), Canberra titled "Sandal and its Products" (Editors: A. M. Radomiljac, H. S. Ananthapadmanabha, R. M. Welbourn and K. Satyanarayana Rao)

4. He has organized seminars / workshops in forestry such as

- National Demonstration Workshop on "Uses of Advanced Clonal Technologies in Forestry" 17-18th April 1998 at Hyderabad.
- Workshop on "Coastal Forestry, Forest Product and Population " February 10 – 11th, 1999 at Chennai

- Second Regional Level Workshop on "Greening India through Agroforestry and JFM" 12th September 2000, at Bangalore.
- Training workshop on "Intellectual Property Rights in Forestry Issues" 19-21st December 2001 at Bangalore.

And a number of other Workshops / Seminars / Interactive meetings / Demonstrations.

5. Dr. Rao also implemented an UNDP Project for 3 years titled "Strengthening and developing the ICFRE".

6. Dr. Rao is the President of the Indian Academy of Wood Scinece and conducted several investigations directed towards widening the choice of tree species for different users especially in the fabrication of marine structures and crafts; providing better utilization and new markets for lesser-known tropical timbers.

7 Dr.Rao is a member of the working group of the Planning Commission on:

- "Industry participation and strengthening of interface between industry, R&D institution and academia for S&T"
- "Research and Education for the Environment and Forest sector for the tenth Five Year Plan of the Planning Commission".

8 He has more than eighty publications including research reports, books and papers in National and International journals.

2 Principal Investigator

Name	:	Dr. T.S. Rathore
Sex (M/F)	:	Male
Designation	:	Scientist E and Head of the Division
Address	:	Tree Improvement & Propagation Division, Institute of Wood Science and Technology, Bangalore – 560 003
Date of Birth	:	01.04.1957
Telephone	:	+91-(080)-3346811 +91-(080)-3465516 (Res)
Fax	:	+91-(080)-3340529

Education(*Post-Graduation onwards & Professional Career*):

Sl. No	Institution Place	Degree Awarded	Year
1.	Jodhpur University, Jodhpur	M.Sc. (Botany)	1979
2.	Jodhpur University, Jodhpur Title of Ph.D. Thesis: "Clonal multiplication of some tree species through culture, differentiation and establishment (*Eucalyptus viridis* R.T. Bak and *Eucalyptus sideroxylon* A. cunn Ex wolls".	Ph.D. (Botany)	1984

Research experience in various institutions

Name of the Institution	Post held	Period From	Period To	Subject and area of research in which he is engaged actively
Jodhpur University, Jodhpur	Research Fellow (JRF, SRF and PDF)	Aug. 1979	July 1985	Plant Tissue Culture (Tree Improvement)
North Eastern Hill University, Shillong	Senior Scientific Officer	Aug. 1985	July 1989	Plant Tissue Culture (Propagation and Conservation)
Jodhpur University, Jodhpur	Research Associate	Aug. 1989	Aug.1991	Plant Tissue Culture) (Tree Improvement)

Tata Energy Research Institute, Delhi	Scientist	Septemb er 1991	October 1991	Plant Tissue Culture) (Tree Improvement)
Jodhpur University, Jodhpur	Assistant Professor	Nov. 1991	Oct. 1992	Biotechnology (Plant Tissue Culture
Arid Forest Research Institute, Jodhpur	Scientist - SD	Nov. 1992	Oct. 1993	Plant Tissue Culture) (Tree Improvement)
J.N.V. University, Jodhpur	Assistant Professor	Nov. 1993	June 1997	Biotechnology (Plant Tissue Culture
Institute of Wood Science and Technology, Bangalore	Scientist - SE	July 1997	Continue d	Planting Stock Improvement and Tree Improvement (Plant Tissue Culture)

- Research experience of 21 years in Plant Biotechnology particularly of forest tree species.
- Teaching experience in plant biotechnology for 5 years at Post Graduate level and 7 years at under graduate level.
- Advanced training in forest biotechnology with special reference to molecular biology and genetic engineering at Forest Science Department, Oregon State University, Corvallis, USA (from April 2nd to June 22nd, 2001).

Publications (*Numbers only*) : 30

Books: NIL, Research Papers: 30, Reports: 7, General articles: NIL
Patents: NIL
Others (*Please specify*): M.Sc. dissertation in Biotechnology – 10
Ph.D. registered students - 5

List of important publications relevant to the proposed area of work:

Sl. No.	Title of Paper	Authors	Reference of Journal	Year
1.	Cytological investigations in someimportant tree species of Rajasthan IV. Male meiosis studies in the genus *Salvadora* L.	Kumar, A., Rao, S.R. and **Rathore, T.S.**	Cytologia **60** (in press)	2002.
2.	In vitro propagation of Neem from seedling and mature tree.	Arya, S., **Rathore,T.S.** and Arya, I.D.	I.J. Pl. Genetic Resources **8**: 247-252	1995.
3.	Cloning of *Anogeissus acuminata* through tissue culture.	**Rathore,T.S.,** Deora,N.S., Shekhawat,N.S. and Singh,R.P.	Biologia Plantrum **35**:381-386	1993.
4.	Factors affecting *in vitro* clonal propagation of *Prosopis cineraria*	Shekhawat, N.S., **Rathore, T.S.,** Singh, R.P., Deora, N.S. and Rao, S.R.	Plant Growth Regulation **12**: 273-280	1993
5.	Clonal propagation of *Zyzyphus* species through culture.	**Rathore, T.S.,** Singh, R.P., Deora, N.S. and Shekhawat, N.S	Scientia Horticulture **51**: 165-168	1992.
6.	Cloning of Maytenus emarginata (Wild) Ding-Oh- A tree of Indian Desert, through tissue culture.	**Rathore,T.S.,** Singh,R.P., Deora,N.S. and Shekhawat,N.S.	Plant Cell Report **11**: 449-451	1992.
7.	Clonal propagation of desert teak (*Tecomella undulata*) through tissue culture.	**Rathore,T.S.,** Singh,R.P. and Shekhawat,N.S.	Plant Science **79**: 217-222	1991
8.	In vitro regeneration of pitcher plant (Nepenthes khasiana Hook F.) A rare insectivorous plant of India. J.	**Rathore,T.S.,** Tandon,P. and Shekhawat,N.S.	Plant Physiology **139**: 246-298	1991
9.	Micropropagation of *Anogeissus pendula* Edgew. An arid forest tree	Joshi, R., Shekhawat, N.S. **and Rathore, T.S.**	Ind. J. Exp. Biol. **29**: 615-618	1991

Project(s) carried out by Investigator

Sl. No	Title of project	Funding agency	Duration From - to
1.	Setting up of a unit for Micropropagation, Acclimatization, Establishment and Improvement of trees of Arid Zones	DBT (Govt. of India)	1994-1998
2.	Cytogenetical Investigation and conservation of Novel genotypes of some important trees of Rajasthan	DST (Govt. of India)	1996-1999
3.	Research on Sandal: Develop nursery practices including *in vivo* and *in vitro* propagation techniques for mass production of high quality planting stock of sandal	World Bank	Aug. 1998-Dec.2000
4.	Tree Improvement: i) Studies on vegetative propagation of *Tectona grandis* and *Eucalyptus tereticornis*	World Bank	Aug. 1998-Dec.2001
	ii) Develop tissue culture protocols or selected genotypes of *Tectona grandis* and *Eucalyptus tereticornis*	World Bank	Aug. 1998-Dec.2001
5.	Planting Stock Improvement Programme of important species of Andhra Pradesh, Karnataka and Goa viz; Casuarina, Eucalyptus, Teak and Bamboo.	World Bank	Sept. 1997-Dec.2001
6.	Refinement of protocols for rapid clonal propagation of Sandal and Red sanders : Demonstration of field performance and evaluation of genetic fidelity" **(on going project)**	DBT	Jan 2003 – Dec. 2005

Highlights of progress of the project(s) to date (in 200 words) for ongoing projects only

Developed modern root trainer based nursery technique for production of quality seedlings of sandal in 270 cc block type root trainer in six months period and used for field trials and plantations. Initial survival rate was above 90%. Developed basic protocol for *in vitro* cloning of sandal from mature trees through axillary shoot proliferation, which need improvement for high rate of *in vitro/ex vitro* root induction.

Refined vegetative propagation method of *Eucalyptus tereticornis* for high rate of rooting from leafy stem cuttings. Conducted studies on critical factors influencing rooting from stem cutting of teak and achieved regeneration 60-70 per cent rooting from leafy stem cutting. Observed variation in rooting from different type of cuttings, period of collection and between clones in *E. tereticornis* and *Tectona grandis*. Refined protocol of micropropagation of *E. tereticornis* and *Tectona grandis* by rapid shoot multiplication and *ex vitro* rooting and hardening.

Studies were conducted on *Pseudooxytenanthera stocksii* micropropagation through axillary shoot proliferation from mature and selected plants and optimized conditions on shoot induction and multiplication. Studies are being conducted on somatic embryogenesis and *in vitro/ex vitro* root induction from *in vitro* shoots of *P. stocksii.*

2. Co-Investigator-1

Name	:	Dr. S.Viswanath
Sex	:	Male
Designation	:	Scientist –D
Address	:	Tree Improvement & Propagation Division Institute of Wood Science & Technology 18th Cross, Malleswaram, Bangalore 560003
Date of Birth	:	27th December, 1963
Telephone	:	+91-(080)-3346811 +91-(080)-3342672 (Res)
Fax	:	+91-(080)-3340529
E-mail	:	sviswanath@iwst.res.in

Educational Qualification:

Sl.No	Degree	Year	Name of Board/University
1	B.Sc. Agriculture	1986	Kerala Agricultural University
2	M.Sc Forestry	1989	Kerala Agricultural University
3	Ph.D in Forestry	1999	Kumaon University, Nainital

Specialization : Agroforestry

Areas of interest : Silviculture, Agroforestry, Seed ecology, Biodiversity

No of Publications : 34

Honors/Awards/Fellowships/Recognition

ICFRE Research fellowship in 1990

ICAR - Agricultural Research Service in Forestry discipline-1992

FAO fellowship for advanced training in Agroforestry at School of Forest Resources and Conservation, University of Florida, USA in 1996

Award for presenting Best Paper in the Oral Session of the **National Workshop** on **Homestead Farming** at Kerala Agricultural University, Vellainikkara, Thrissur, 6-7th March 2003.

Presently guiding 5 research scholars for Ph.D in FRI Deemed university in the capacity of main supervisor on various forestry/agroforestry related topics.

Professional Experience

- June 2003 to till date continuing as Scientist D in Tree Improvement and Propagation Division of Institute of Wood Science and Technology, Bangalore.
- July 1999 to May 2003 as Scientist C (as Scientist D from January 2002 onwards) in Forest productivity and Agroforestry Division, Institute of Forest Genetics and Tree Breeding (IFGTB) under the Indian Council for Forest Research & Education at Coimbatore, TamilNadu state. Currently working on aspects related to Forest productivity and Agroforestry.
- Aug 1992 to July 1999 as Scientist B in Tropical Forest Research Institute (TFRI) under the Indian Council for Forest Research & Education (ICFRE) at Jabalpur. More than five years of active involvement in Agroforestry research, management and involvement in externally funded research programmes.
- Jan 1990 to May 1992 as Research Fellow in Silviculture division, Forest Research Institute, (ICFRE) Dehra Dun, U.P.state, India on a project looking into the Soil seed bank Dynamics and Germination Eco-Physiology of selected species in a Himalayan Moist Temperate Forest in Kedarnath Forest Division in the Western Himalayas.
- Jan 1989 to Jan 1990 as Agricultural Officer, Dept of Agriculture. Govt of Kerala, India. Being in-charge of the agricultural development and planning activities at the grass root level, gained experience in office and staff administration in addition to agricultural training, extension and planning.

Publications

Viswanath, S. 2003. Growing 'casuarinas' in Southern India. ***APANews*** 21: 12-14

Sathyakumar, S and **S.Viswanath 2003**. Observations on food habits of Asiatic black bear in Kedarnath Wild life Sanctuary, India: Preliminary evidence on their role in seed germination and dispersal ***URSUS*** 14 (1) : 103-108

Viswanath,S; Maria Dominic Savio and B. Gurudev Singh. 2002. Neem in Farm Forestry Practices in Tamilnadu: Prospects And Opportunities. **ENVIS** Forestry Bulletin 2 (1): 23-27

Viswanath,S ; R.P. Singh and R.C. Thapliyal. 2002. Seed germination patterns in a Himalayan moist temperate forest. ***Tropical Ecology*** 43 (2): 265-273

Viswanath,S; P. Manivachakam and M.George 2001. Casuarina in Agroforestry Practices. *In* **Casuarina: Improvement and Utilization.** (eds) Gurumurthi K., A. Nicodemus and Siddappa . IFGTB Publication, Coimbatore, pp 187-192

Sidadappa & **S. Viswanath** 2002. Strengthening efforts of NGO's in participatory Natural resource management through Agroforestry-an operational experience from Coimbatore. In *Proceedings of the Workshop on Joint Forest Management and Watershed Development. Vol-II.*. Tamil Nadu Forest Department. pp 29-38.

Viswanath,S ; M.George and P. Manivachakam. 2001. *Casuarina equisetifolia* in agroforestry practices in Tamil Nadu: Opportunities and Limitations. In *Proceedings of the Fifth Annual Workshop of Casuarina Network.* IFGTB, pp 202-206.

Siddappa, **S. Viswanath,** C. Muralidhara Rao and S. Saravanan 2001. Problems in cultivation and utilization of forest trees and medicinal plants in Tamil Nadu. In *Proceedings of the National Workshop on Policy and Legal issues in cultivation and utilization of Bamboos, Rattans and Forest trees in Private and Community lands.* KFRI, pp.109-111.

Viswanath, S; P.K.R. Nair; P.K. Kaushik & U. Prakasam 2000. *Acacia nilotica* trees in rice fields: A traditional agroforestry system in Central India. ***Agroforestry Systems*** 50 (2): 157-177

Purushothaman, S; **S.Viswanath** & C. Kunhikannan 2000. Economic valuation of extractive conservation in a tropical deciduous forest in Madhya Pradesh, India. ***Tropical Ecology*** 41 (1): 61-73.

Viswanath, S; G.R.S. Reddy; P.K. Kaushik, U. Prakasam; P. Srivastava & A.K. Sah. 2000. Babul (*Acacia nilotica*) + Rice system of Chattisgarh, TFRI Research Bulletin, Agroforestry series-2.

Viswanath, S; G.R.S. Reddy & N.C. Pant 1999. Prospects of alley cropping in Central India. In ***Forestry Research in Conservation of Natural Forests.*** (Eds) R.S. Negi *et al*, ICFRE, DehraDun. pp,190-197.

Viswanath, S; P.K. Kaushik; D.K. Pandey & Amit Sahai 1998. Effect of *Acacia nilotica* (L.) Willd ex. Del. on rainfed paddy crop in Chattisgarh,.MadhyaPradesh. ***Annals of Forestry.*** 6(1): 103-109.

Viswanath, S; P.K. Kaushik & U. Prakasam 1998. Biomass production and survival of *Sesbania sesban* in alley cropping. ***Forest, Farm and Community Tree Research Reports*** 3: 59-61

Viswanath, S; P.K. Kaushik; D.K. Pandey; K.S. Negi & N.C. Pant 1997. Effect of pruning treatments on Sesbania sesban (L.) Pers. alley cropped with maize and cowpea. ***Range Management and Agroforestry*** 18 (1): 71-78.

Purushottaman, S; Mukundan, K & **S.Viswanath.** 1996. The impact of cement klin dust on rural economy-A case study. ***Indian Journal of Agricultural Economics*** 51 (3): 407 – 411