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Phase I

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(Final report of the project KFRI 289/98 – Phase I. Jan. 98 to Dec. 2000)

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PROJECT PROPOSAL

Project No.	**KFRI 289/98**
Title	**Maintenance of seed stands and species trial plots of rattans. Phase I**
Investigator	**Dr. C. Renuka**
Objectives	**1. To monitor the growth of different species of rattans in the experimental plots** **2. To maintain and manage the seed stands and germplasm plot**
Project period	**Jan. 1998 – Dec. 2001**
Duration	**3 years**
Funding agency	**Kerala Forest Department Development Fund**

CONTENTS

ABSTRACT

Rattan populations in Kerala are getting reduced drastically and hence there is an urgent need for evolving a strategy for scientific management and conservation of this valuable resource. Along with the preservation of existing natural resources, germplasm preservation and cultivation of commercially important species also have to be done. Before starting cultivation in large scale, suitable species for a particular locality should be selected and the species performance assessed. In this context, Kerala Forest Research Institute initiated germplasm conservation, species trials to evaluate the performance of various species at different altitudes and establishment of seed stands.

Eight rattan species, were evaluated for their performance at two altitudes 1000 m and 300 m at Vazhachal and Nelliampathy. Of these, *Calamus gamblei* is found to be the best suited species for higher elevation. At lower elevations, *Daemonorops kurzianus* and *C. rotang* are the suitable species. The Malaysian species, *C. caesius*, is not suitable for cultivation in Kerala.

Seed stands for nine commercially important rattan species were established - during of which four species - have started flowering and fruiting. In the germplasm collection, 28 species of rattans have been established, some of which also have started flowering and fruiting. *C. perigrinus*, a species introduced from Thailand, has also started to produce fruits regularly.

ACKNOWLEDGEMENTS

The author is grateful to Dr. J. K. Sharma, Director, KFRI for providing all the facilities for the successful completion of this study. The statistical advice was given by Dr. K. Jayaraman, Scientist-in-Charge, Statistics Division, KFRI, whose involvement during the formulation of the experiment and data analysis is much appreciated. Mrs. P. Rugmini, Statistics Division, KFRI did major part of the data analysis. Thanks are also due to Mr. A. G. Varghese for his assistance in data processing, to Mr. V. B. Sreekumar, V. V. Rangan and James P. Thomas for helping in the field work, to Dr. E. P. Indira, Dr. M. S. Muktesh Kumar and Dr. Maria Florence for editorial scrutiny.

INTRODUCTION

Rattans, the spiny climbing palms with about 600 species in 13 genera, are distributed in tropical and subtropical Asia and equatorial Africa. In India, there are about 61 species of rattans under 4 genera, *Calamus, Daemonorops, Korthalsia* and *Plectocomia* distributed in the Western Ghats of Peninsular India, sub Himalayan hills and valleys of eastern and northeastern India and the Andaman and Nicobar Islands. One genus and 21 species have so far been reported from the Western Ghats; 3 genera and 18 species from the Andaman and Nicobar islands and 3 genera and 17species and two varieties from North Eastern States (Basu, 1992; Renuka, 1992, 1995, 1999; Renuka *et al.*, 1997; Sunny Thomas *et al*.,1998).

Being an important forest produce next to timber, rattan forms an integral part of rural and tribal populace in many of the tropical countries. It is not only the chief raw material for industries in various parts of the world, but also holds great social significance as a source of livelihood for the people residing near the forest areas. Although economically important, rattan remained as a neglected natural resource till recent times. With the rampant destruction of forests and habitats, its stock at present, is highly depleted. The exploitation of wild rattans is increasing with global increase in demand for rattan (cane) furniture. Consequently this resource is over exploited and has become short in supply. Many of the species reported earlier from certain localities are not present there now. Within the last 20 years the range of distribution of rattans and the population size have diminished drastically.

Presently, there is no insufficient quantity of rattans from natural habitats to meet the demands of the cane industry. Many of the cane industrial units in southern India are known to get their supplies from N.E. India. But the status of forests in N.E. India itself is a matter of concern due to shifting cultivation and heavy logging (Renuka, 1996). In the Andaman and Nicobar islands also the natural resource is getting depleted at a faster

rate due to over-exploitation (Renuka, 1995). If the depletion continues in the present rate, the natural rattan resources will almost be totally decimated in a few years.

Most of the rattans that occur in the Western Ghats of Kerala region are in the juvenile stage, due to unscientific exploitation. Mature rattans are restricted mostly to remote areas. Therefore there is an urgent need to develop a strategy for scientific management to conserve this valuable forest resources.

The main steps to be taken to tackle the problem of rattan conservation are

i. preservation of natural resources,

ii. cultivation of commercially important species to relieve the pressure on the wild stock and to enhance production, and

iii. germplasm preservation

Preservation of natural resources

Even though strict control of the exploitation of wild stock is prevalent, many times this cannot be effectively implemented. It is practically impossible to control the illicit extraction from the forest areas. Extraction can be controlled in protected areas like Biological parks and Wildlife Sanctuaries and this will help to conserve rattan to a certain extent.

Cultivation

Cultivation of commercially important species for the industrial sector can relieve the pressure on the wild stock. Before adapting the species for large scale plantations outside its natural home, species trials should be conducted to assess the suitability of the species for a particular geo-climatic region. Though rattans occur from almost sea level to 2000 m, most of them show altitudinal preferences. Many of the species are distributed below

1000 m, while some are found only at higher altitudes. Some species are restricted to certain localities.

Rattans are gaining importance as a plantation crop. State forest departments and private agencies have started large scale cultivation of different species of rattans. When plantations are established for raw material production, the use of genetically improved seeds appears a necessity for higher productivity.

Rattan is not domesticated and so it is not subjected to any selection. The method followed in selecting the superior plants in other crops cannot be applied to rattans since the age of the clump cannot be determined in the natural forests. Hence it is very difficult to compare and assess the superiority. Some of the clumps might have been partially harvested earlier, making it impossible to assess the original growth. The only possible way of selection at present is to select the mother plants on the basis of phenotypic superiority.

To start cultivation in the plantation level, a regular seed supply should be obtained for which it will be necessary to set aside some accessible stands of good rattans as seed stands. It has however proved difficult to maintain seed stands in the wild since no rattan seems to be safe from rattan collectors. Extraction of rattan before flowering and the destruction of natural habitat of rattan drastically affect the seed source. Hence there is a need to raise seed stands in protected areas.

Germplasm

The alarming rate at which the tropical forests are being destroyed is leading to the depletion of genetic resources as well. Considering the rate at which tropical forests, the habitats of rattans, are being destroyed, we are likely to lose the rattan gene pool necessary for the selection of species for various purposes. Hence effective measures are to be taken to conserve and propagate the endangered as well as other species.

In very general terms, gene conservation aims at maintaining the entire gene pool of species and populations for many generations. The objectives of conserving forest genetic resources are to secure the ability of forest plant species to adapt to environmental changes and to maintain the basis for improving production and other benefits through future selection and breeding activities. When a species has been identified as a target for gene resource conservation, the objective will be to conserve as much of the genetic variation as practically possible. Genetic variability also constitutes the raw material for further breeding programmes. The higher the variability within a population, the better the chances are to select individuals with desirable characteristics. The two basic methods of conserving genetic resources are evolutionary conservation (dynamic conservation) and static conservation (Guldager, 1975; Frankel and Soule, 1981). Evolutionary conservation is done in living populations, *in situ* or *ex situ*. In such populations, the genetic composition of target species is allowed to adapt to the prevailing environmental conditions. Static conservation maintains specific genetic compositions, eg., in the form of seeds or gametes in long term storage or vegetatively propagated clones in clone collections and will usually be *ex situ.* Well-defined genetic material can thus be conserved with present genetic composition, as no changes, in principle, should take place in static conservation.

The *ex situ* (outside the natural range) method, is implemented in the form of artificially regenerated blocks of plants established in managed sites. This avoids direct dependence on the original populations. In a number of cases, *ex situ* conservation of plants has allowed saving populations threatened with physical destruction or genetic deterioration due to hybridization with exotic populations. The main limitation of *ex situ* conservation of plant collections is its cost.

In this context, the Kerala Forest Research Institute started germplasm conservation, studies on the *ex-situ* performance of different species of rattans and establishment of seed stands of commercially important rattans under a project funded by IDRC, Canada. The present project was taken up to continue the earlier studies and to maintain these

study plots and conservation plots. Species trial is conducted at two localities, Vazhachal and Nelliampathy. Seed stands are located at Pattikad of Thrissur forest Division and at Nelliampathy of Nemmara forest Division. The germplasm conservation plot is situated at the Institute campus at Peechi.

MATERIALS AND METHODS

SPECIES TRIAL

Before adapting the species for large scale plantations outside its natural home, species trials should be conducted in each country to know which species is suitable for a particular climatic region. Hence in 1993 a species trial was conducted with eight commercially important species. The species selected are given in Table 1.

Table 1. Species selected

Species	Place of collection
Calamus andamanicus (SP5)	Andamans
C. caesius (SP3)	Malaysia
C. gamblei (SP4)	Kerala (Moozhiar)
C. karnatakensis (SP6)	Karnataka
C. pseudorivalis (SP1)	Andamans
C. pseudotenuis (SP2)	Kerala (Peermedu)
C. rotang (SP8)	Kerala (Quilon)
Daemonorops kurzianus (SP7)	Andamans

The experiment was conducted at two different altitudes in natural evergreen forests. The first site was selected at Vazhachal at an elevation of 300 m and second site was selected at Nelliampathy at an elevation of 1000 m. In each site, randomised complete block design was used with the eight species replicated in two blocks. A line of 10 plants constituted a plot. Within a block, the number of such plots for a species was allowed to vary with the availability of seeds. However the number of plots taken for a species remained the same over the two blocks.

One year old seedlings were outplanted at the onset of monsoon. The seedlings were planted with 2 m spacing.

Yearly observations were taken on the survival and height of the stem for eight years. Some of the seedlings had perished in the rosette stage (The seedlings will remain without stem formation at least for four years) itself. The data obtained from each location pertaining to height and survival percentage over different periods were subjected to analysis of variance separately. Comparison of means was carried out using least significant difference test. The analysis of variance conformed to that of a univariate mixed model analysis.

The height values were subjected to logarithmic transformation and the survival percentage was transformed to angular scale before the analysis.

SEED STANDS

Two areas were selected for raising seed stands, one at Kachithodu of Pattikkad Range in Thrissur Forest Division at an elevation of 300 m and another at Nelliampathy of Nemmara Forest Division at an elevation of 1000 m. Seed stands were raised for eleven species, but two species from the Andamans did not perform well. At present, seed stands of nine species exist (Table 2). Depending on the availability of seedlings the plot size differed between species. Two species were planted at Nelliampathy viz., *Calamus pseudotenuis* and *C. vattayila*. The plot size of *C. pseudotenuis* was 3.6 ha. The seedlings were line planted at a distance of 2 m. The distance between two lines was 10 m. Since a portion of the plot was rocky, only 1210 seedlings could be accommodated. A one hectare plot was selected for *C. vattayila*. The seedlings were line planted with a spacing of 2 m and the distance between lines was 10 m. A total of 500 plants were established. Later on, this plot was encroached by private estate owners and most of the plants were destroyed. Only 50 plants are remaining now. Seven species were planted at Pattikkad. The number of plants under each species differed based on the availability of seeds. The seedlings were line-planted. A spacing of 4 m was provided between plants in case of clump forming species.

These seed stands were used to study the growth performance of the species. From each plot 15- 20 plants were selected randomly so as to represent the whole area of the plot, the plants were tagged and growth measurements like height of the stem, number of new shoots produced, number of different stems in a clump, height of different stems in a clump, etc. were taken once a year. The same plants were measured in the second year also. Every year another set of 15 to 20 plants was selected at random from each plot, so as to represent the whole area of the plot, and growth measurements were taken. The plants selected for the second set would differ from year to year.

Table 2. Species planted in seed stands

No.	Name of the species	Place where planted	Year of planting
1.	*C. hookerianus*	Kachithodu	1992
2.	*C. metzianus*	Kachithodu	1996
3.	*C. pseudorivalis*	Kachithodu	1994
4.	*C. rotang*	Kachithodu	1994
5.	*C. thwaitesii*	Kachithodu	1992
6.	*C. travancoricus*	Kachithodu	1996
7.	*C. viminalis*	Kachithodu	1993
8.	*C. vattayila*	Nelliampathy	1993
9.	*C. pseudotenuis*	Nelliampathy	1992

GERMPLASM CONSERVATION

Germplasm of rattans is preserved in the Institute campus. An area of 0.5 ha was selected inside the campus where a moist deciduous vegetation exists. Planting material of different species of rattans was procured from India as well as abroad and assembled in the selected area. Ten plants of each species were planted in a line at a distance of 2 m. The distance between two lines was 6 m.

RESULTS AND DISCUSSION

SPECIES TRIAL

The data collected for 8 years have been analysed for survival percentage and growth in height.

Survival

The analyses of variance on survival percentage for both the locations are presented in Table 3. At Nelliampathy the effects due to species, and period x species interaction did not turn out to be significant. But variation due to period was significant. The non-significant interaction between species and period indicates that the species do not differ in their survival pattern across time (Fig. 1). Mean values of survival percentage of eight species corresponding to different periods are reported in Table 4. At Nelliampathy, *C. gamblei* and *C. karnatakensis* recorded higher survival percentage (Table 4). At Vazhachal, there was no significant effects due to species (Table 5), but the effects due to period and period x species interaction turned out to be significant. The significant interaction between period and species indicates that the survival pattern of different species differ across time (Fig. 2). At the end of the reporting period, at Vazhachal, *D. kurzianus* (SP7) showed higher survival percentage compared to other species (Table 5).

Table 3. Analysis of variance of data on survival percentage of plants at Nelliampathy and Vazhachal in angular scale

Source		Nelliampathy		Vazhachal	
	df	MSS	F value	MSS	F value
Species	7	3692.13	1.82(ns)	1231.22	1.99(ns)
Block	1	8576.24	4.23(ns)	5755.79	9.32*
Species x Block	7	2028.65	1.65(ns)	617.65	2.02(ns)
Replication within block x species	24	1227.01	-	305.45	-
Period	6	2107.77	8.52**	10842.09	62.16**
Species x period	42	102.98	0.42(ns)	305.45	1.75*
Block x period within species	48	247.49	0.90(ns)	174.42	1.54*
Residual	144	275.71		113.39	

Df - Degrees of freedom * - Significant at P=0.05 (ns) - Nonsignificant
MSS - Mean sum of square ** - Significant at P=0.01

Table 4. Mean survival percentage of different species at Nelliampathy at various periods (year)

Period (years after planting)	Survival Percentage							
	SP1#	SP2	SP3	SP4	SP5	SP6	SP7	SP8
2	90.00	70.00	40.00	80.00	75.00	100.00	90.00	100.00
3	90.00	66.25	25.00	80.00	70.00	100.00	80.00	90.00
4	83.00	50.00	15.00	65.00	62.50	100.00	80.00	80.00
5	81.00	42.50	15.00	60.00	55.00	100.00	80.00	80.00
6	71.00	52.50	15.00	60.00	52.00	80.00	40.00	50.00
7	70.00	52.50	15.00	60.00	45.00	80.00	40.00	50.00
8	54.00	52.50	15.00	60.00	40.00	60.00	10.00	50.00

SP1 -- *C. pseudorivalis* SP2 -- *C. pseudotenuis* SP3 -- *C. caesius*
SP4 -- *C. gamblei* SP5 – *C. andamanicus* SP6 -- *C. karnatakensis*
SP7 -- *Daemonorops kurzianus* SP8 -- *C. rotang*

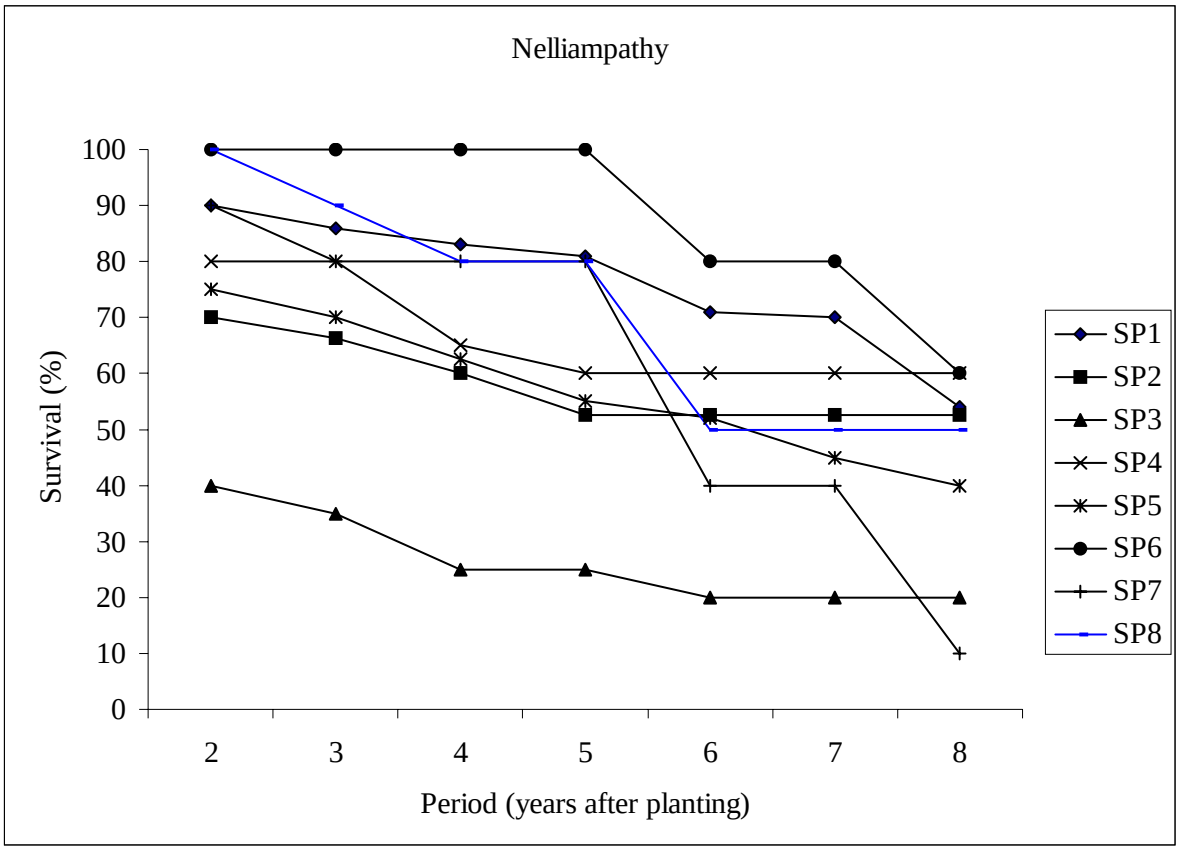

Fig. 1

Even though there was a gradual reduction in the survival rate at both places, in Vazhachal it was very prominent. This can be attributed to the heavy reed growth and disturbance from the elephants.

Table 5. Mean survival percentage of different species at Vazhachal at various periods (year)

Period (years after planting)	Survival Percentage							
	SP1#	SP2	SP3	SP4	SP5	SP6	SP7	SP8
2	95.00	96.25	72.50	97.50	72.50	85.00	80.00	95.00
3	95.00	87.50	70.00	97.50	70.00	85.00	75.00	95.00
4	92.00	78.75	37.50	95.00	60.00	85.00	70.00	85.00
5	86.00	72.50	37.50	95.00	50.00	85.00	70.00	85.00
6	39.00	48.75	27.50	25.00	48.75	25.00	40.00	55.00
7	34.00	28.75	20.00	5.00	26.25	25.00	35.00	25.00
8	10.00	13.75	10.00	0.00	18.75	20.00	35.00	25.00

SP1 -- *C. pseudorivalis* SP2 -- *C. pseudotenuis* SP3 -- *C. caesius*
SP4 -- *C. gamblei* SP5 – *C. andamanicus* SP6 -- *C. karnatakensis*
SP7 -- *Daemonorops kurzianus* SP8 -- *C. rotang*

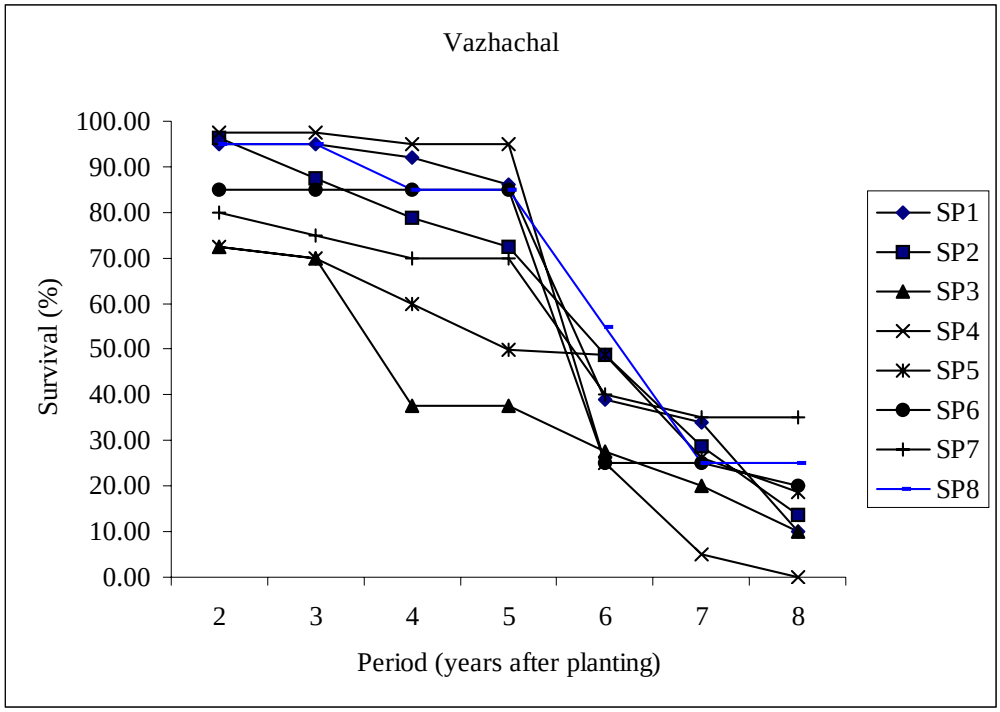

Fig. 2

Height

The analyses of variance (ANOVA) on height, for both the locations, are presented in Table 6. At Nelliampathy, the effects due to period and, period x species interaction did not turn out to be significant. The differences between species were significant Table 6. Figure 3 shows the height growth recorded by different species. The mean height values of different species are reported in Table 7. The reduction of height in some years is due to the damage caused by the wild animals. Pair-wise comparison between species showed that *C. gamblei* (SP4) differed significantly from all the other species.

At Vazhachal, ANOVA (Table 6) showed that there was no significant difference between species with respect to height, but there was significant difference between periods. Interaction between period and species was highly significant, indicating that the species differed in their height growth pattern across time (Fig. 4). Mean values of height of the eight species corresponding to the different periods are reported in Table 8. Since the interaction between period and species was found to be significant, pair-wise comparison between the species means under each period can be carried out. Hence, in order to evaluate the performance of difference species at the end of the trial, pair wise comparison between the species means at the 8^{th} period was carried out using least significant difference test. Pair wise comparison between species showed that *C. rotang* (SP8) and *D. kurzianus* (SP7) differed significantly from all the other species but not between themselves. At 8^{th} year after planting *C. rotang* (SP8) was found to have higher height value when compared with that of other species.

In Vazhachal the height of most of the species decreased drastically at the 7^{th} year (Fig. 4). This is due to the cutting of the extractable length of rattan by the local people as well as the damage caused by the elephants.

Table 6. Analysis of variance of data on height (cm) of different species at Nelliampathy and Vazhachal

Source		Nelliampathy		Vazhachal	
	df	MSS	F value	MSS	F value
Species	7	20.84	5.38*	8.88	2.65(ns)
Block	1	25.71	6.64*	25.97	7.76*
Species x block	7	3.87	0.34(ns)	3.34	1.06(ns)
Replication within block x species	24	3.24	-	3.15	-
Period	6	1.79	0.83(ns)	21.96	13.11**
Species x period	42	1.71	0.78(ns)	3.54	2.12*
Block x period within species	48	2.15	1.17(ns)	1.67	0.82(ns)
Residual	144	1.84		2.04	

df - Degrees of freedom * - Significant at P=0.05 (ns) - Non significant
MSS - Mean sum of square ** - Significant at P=0.01

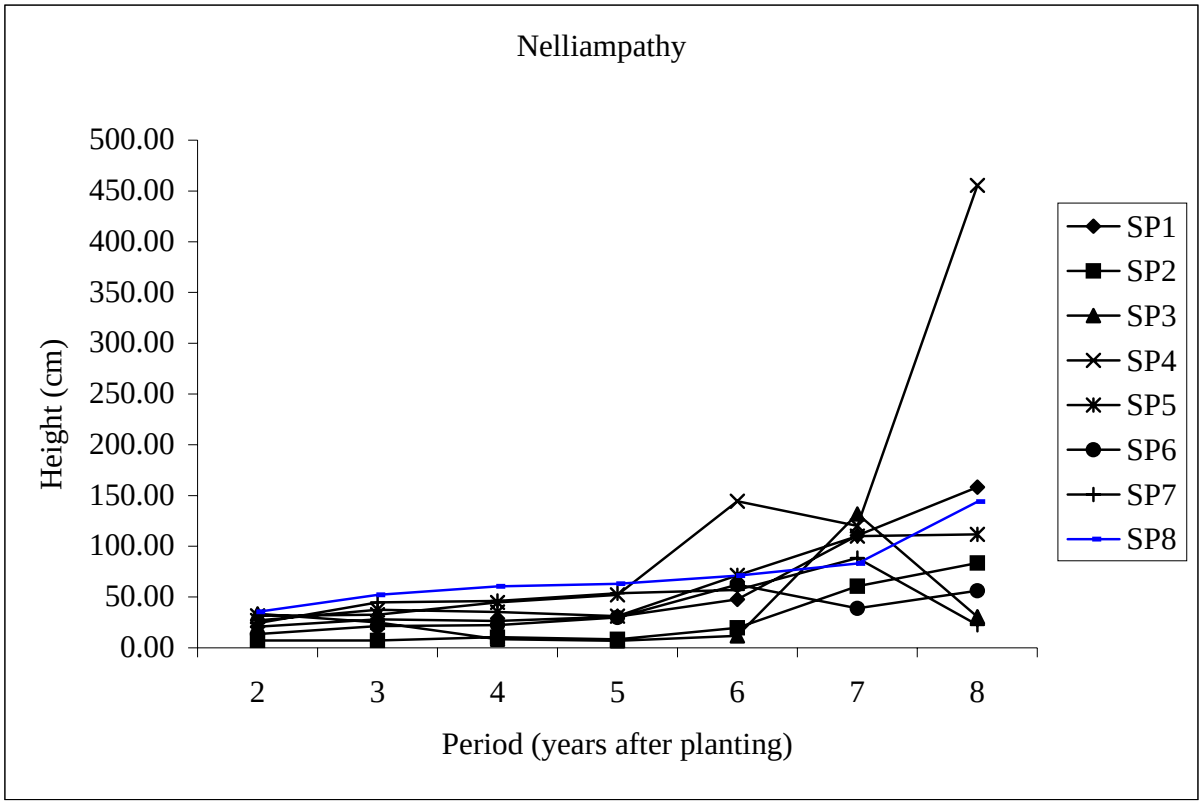

Fig. 3

Table 7. Mean height (cm) of different species at Nelliampathy at various periods (year)

Period (years after planting)	Height (cm)							
	SP1#	SP2	SP3	SP4	SP5	SP6	SP7	SP8
2	20.1	7.0	33.5	31.5	26.8	13.5	24.3	35.4
3	25.3	7.1	25.0	32.5	37.4	21.3	44.6	52.1
4	26.4	10.4	8.4	44.7	35.2	22.3	46.2	60.4
5	30.6	8.2	6.8	52.2	31.0	29.9	53.7	63.1
6	47.6	19.5	11.7	144.3	71.3	62.1	57.1	71.1
7	110.7	60.6	131.8	120.0	110.0	38.8	88.3	83.0
8	158.2	83.4	30.5	455.4	111.8	56.1	22.5	144.0

SP1 -- *C. pseudorivalis* SP2 -- *C. pseudotenuis* SP3 -- *C. caesius*
SP4 -- *C. gamblei* SP5 – *C. andamanicus* SP6 -- *C. karnatakensis*
SP7 -- *Daemonorops kurzianus* SP8 -- *C. rotang*

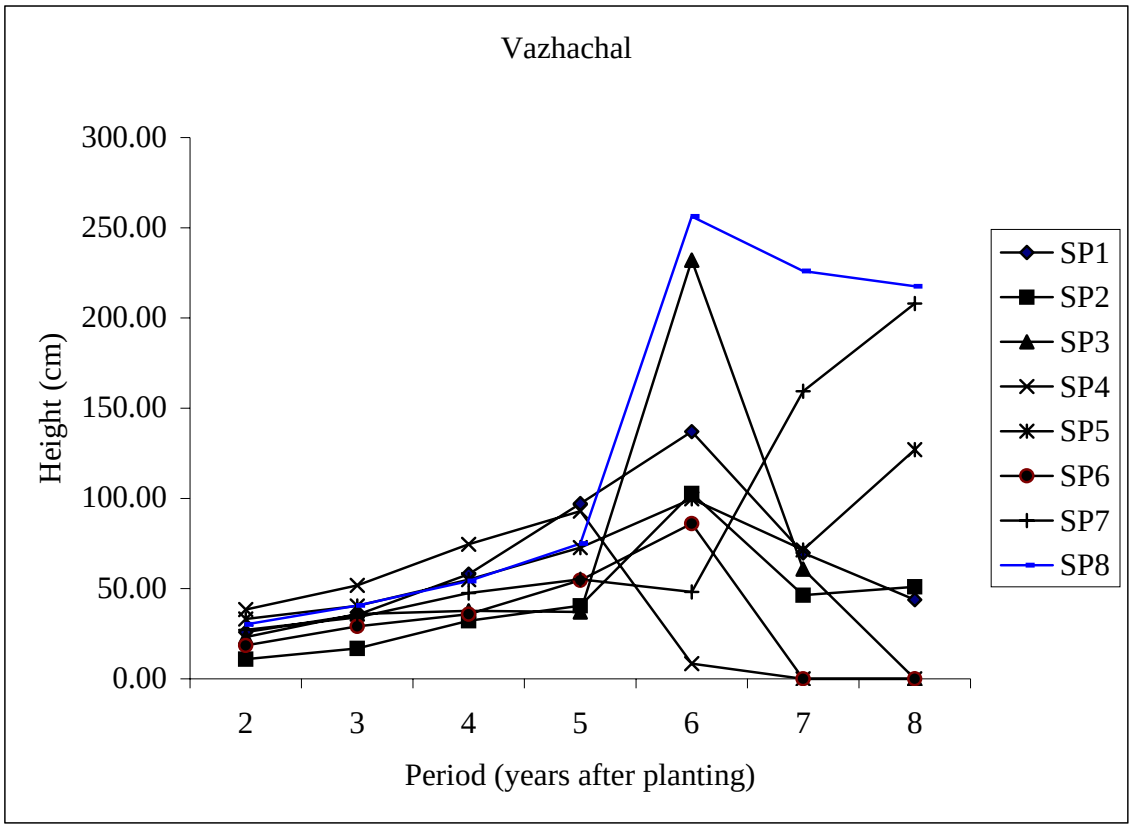

Fig. 4

Table 8. Mean height (cm) of different species at Vazhachal at various periods (year)

Period (years after planting)	Height (cm)							
	SP1[#]	SP2	SP3	SP4	SP5	SP6	SP7	SP8
2	25.8	10.9	23.1	38.3	33.1	18.4	27.0	30.1
3	35.4	16.8	35.8	51.7	40.3	29.0	33.9	40.6
4	57.9	32.1	37.6	74.5	54.9	35.8	47.5	54.1
5	97.0	40.4	37.0	92.8	72.7	54.6	55.1	74.9
6	136.9	102.7	232.0	8.4	99.7	86.0	48.1	256.2
7	69.7	46.2	60.8	0.0 [$]	71.4	0.0 [$]	159.3	226.0
[*]8	43.8[bc]	50.9[b]	0.0[c] [$]	0.0[c] [$]	127.0[b]	0.0[c] [$]	208.0[a]	217.5[a]

[*] Values superscribed by the same letter in the row, do not differ significantly

SP1 -- *C. pseudorivalis* SP2 -- *C. pseudotenuis* SP3 -- *C. caesius*
SP4 -- *C. gamblei* SP5 – *C. andamanicus* SP6 -- *C. karnatakensis*
SP7 -- *Daemonorops kurzianus* SP8 -- *C. rotang*

[$] Damage caused by elephants

Performance of species with regard to height indicated that, *C. gamblei* (SP4) had higher value in height at Nelliampathy but had a poor growth at Vazhachal. In the case of *D. kurzianus* (SP7), it performed well at Vazhachal and not at Nelliampathy. This can be attributed to the altitudinal differences in the localities. *C. gamblei* occurs naturally above 700 m. and hence the better growth in Nelliampathy which is of 1000 m elevation. *D. kurzianus* grows below an altitudinal level of 300 m in the natural forests. ANOVA on height and survival of Vazhachal (Table 3 & 6) showed similar results, ie., significant difference between periods, significant interaction between periods and species and no significant difference between species. No such trend was seen at Nelliampathy.

When both survival and height growth are considered *C. gamblei* is the best species suited for places of about 1000 m elevation. In the seedling stages, *D. kurzianus* was showing better growth performance at higher elevations (Renuka and Rugmini, 1996). It

showed 80 percent survival till the 5th year, and then suddenly decreased to 40 percent in the next year and to 10 percent in the 8th year. At about 300 m elevation *D. kurzianus* and *C. rotang* are the preferred species. In both the locations, *C. caesius* (SP3) was not performing well. It is a Malaysian species and the species trial showed that it is not suited for cultivation in Kerala

SEED STANDS

Seed stands of nine species exist, two species at Nelliampathy and six at Kacchithodu. Out of the nine species, four started flowering and fruiting.

In *C. rotang*, *C. pseudorivalis* and *C. hookerianus* measurements were taken from year 1999 onwards and in other species from year 2000. *C. viminalis* is still in the rosette stage. The heights of the main stem and suckers were taken separately. The mean height of the main stem and mean of total height for the different species are tabulated in Table 9. The height of the main stem and that of all the suckers were added together to get the total height. Small diameter rattans are growing faster as shown by *C.rotang, C. metzianus* and *C. travancoricus. C. thwaitesii* is a large diameter rattan and its growth in height is slow in the early years.

Measurements will be continued in the next phase of the project.

Table 9. Growth characters of different species

Year of planting	Species	Height of main stem (cm)				Total Height (cm)				Total no. of suckers per plant			
		1999		2000		1999		2000		1999		2000	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Kachithode													
1994	*C. rotang*	301.67	99.96	307.69	104.24	956.33	534.09	960.10	491.95	3.21	1.42	3.00	1.44
1992	*C.hookerianus*	171.33	112.73	194.38	59.97	255.40	148.15	287.67	325.50	8.20	3.93	3.42	1.64
1996	*C.metzianus*			209.72	63.00			388.94	120.09			2.18	0.40
1996	*C. travancoricus*			77.12	57.33			77.12	57.33			1.61	0.70
1992	*C.thwaitesii*			44.04	12.12			44.04	12.12			Nil	Nil
1994	*C.pseudorivalis*	106.90	71.96	109.67	88.04	117.24	92.42	109.67	88.04			Nil	Nil
Nelliampathy													
1992	*C. pseudotenuis*			44.97	10.12			44.97	10.12			Nil	Nil
1993	*C. vattayila*			133.42	94.19			133.42	94.19			Nil	Nil

SE - Standard error

GERMPLASM CONSERVATION

At present, there are 28 species of rattans in the germplasm plot at KFRI at Peechi. Four species were introduced from China, two from Malaysia, one from Thailand and one from Laos. Out of these the Malaysian species, *C. caesius* and *C. manan*, perished after an initial growth for two years. Two species collected from the Andamans were destroyed by rodents. The roots of these species were much relished by rodents. *Calamus perigrinus*, introduced from Thailand, started flowering and fruiting. Some of the Indian species also have started flowering.

Table 10. Species planted in the germplasm plot at KFRI

Name	Country of origin	Name	Country of origin
1. Daemonorops margaritae	China	***15. Calamus kingianus***	India
2. Calamus simplicifolius	”	***16. C. andamanicus***	”
3. C.tetradactylus	”	***17. C. gamblei***	”
4. C .thysanolepis	”	***18. C. brandisii***	”
***5. Calamus* sp.**	Laos	***19. C. nagbettai***	”
6. C. perigrinus	Malayasia	***20. C. pseudorivalis***	”
7. C. dransfieldii	India	***21. C. prasinus***	”
8. C. delessertianus	”	***22. C. viminalis***	”
9. C.vattayila	”	***23. C. karnatakensis***	”
10. C. tenuis	”	***24. C. baratangensis***	”
11. C. pseudotenuis	”	***25. C. travancoricus***	”
12. C. thwaitesii	”	***26. C. metzianus***	”
13. C. rotang	”	***27. Daemonorops kurzianus***	”
14. C. hookerianus	”	***28. D. rarispinosus***	”

CONCLUSION

Among the species evaluated in the species trial *Calamus gamblei* was found to be the best for altitudes of about 1000 m. At about 300 m elevation *Daemonorops kurzianus* and *C. rotang* are the preferred species. *Calamus caesius*, a Malayasian species, is not suitable for cultivation in Kerala.

Seed stands of nine commercially important species have been established, of which four started flowering and fruiting. In the germplasm collection, 28 species of rattans are present, some of which started flowering and fruiting. *Calamus perigrinus*, a species introduced from Thailand, also is flowering and fruiting regularly.

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