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Maintenance of provenance trial plots of eucalypts and acacia and development of new clones for establishment of Clonal Multiplication Area (CMA)

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(Final Report of the Project KFRI 415/2003)

E. J. Maria Florence
M. Balasundaran (up to March 2010)

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ABSTRACT OF PROJECT PROPOSAL

	Project No.:	KFRI 415/2003
	Title of the project:	Identification of promising provenances of new fast growing species and development of new eucalypt and acacia clones for establishment of Clonal Multiplication Area (CMA)
	Objectives:	**1.** Identification of new candidate plus trees (CPTs) of *E. tereticornis, E. camaldulensis, E. globulus, E. grandis, Acacia auriculiformis* and *A. mangium* **2.** Vegetative multiplication of the candidate plus trees of eucalypts and acacia spp. and their evaluation for growth and disease resistance for selection of new clones **3.** Planting and maintenance of new clones produced in the year 2003 **4.** Supply of new clones of *Eucalyptus* spp. and *Acacia* spp. to the Kerala Forest Department for establishing clonal multiplication area and clonal plantation
	Date of commencement:	April 2003
	Date of completion:	March 2012
	Funding agency:	KFRI Plan grant
	Principal Investigator:	Dr. E. J. Maria Florence
	Associate:	Dr. M. Balasundaran (Up to March 2010)
	Nursery men:	K.A Thankachan (Kottappara) K.K Muraly (Devikulam)

CONTENTS

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ABSTRACT

KFRI had established two Clonal Multiplication Units, one at Kottappara, in Kodanad Range for low altitude species of eucalypts and acacias and another one at Devikulam in Munnar Division for high altitude species. More than one lakh fifty thousand ramets of eucalypts and acacia clones were developed from Kottappara and 64061 ramets were supplied to KFD, JK Paper Mills and HNL during the reporting period and the rest of ramets were planted in CMA at Kottappara. Around 20000 ramets of different clones were developed from Devikulam during the previous years and a total of 14235 ramets were supplied to KFD, HNL and other private agencies. Clonal plantations for eucalypts and acacia were developed at Chinganchira and Thirumany and clonal seed orchard for eucalypts at Mallankuzhy. Clonal seed orchards of *E. grandis* were developed at Sevenmala and Pettimudy in Munnar range. Clonal Multiplication Area (CMA) of different clones of *E. grandis* was developed at Central Nursery, Devikulam. A total of 39 clones (natural hybrids) were developed at Kottappara and 99 clones at Devikulam showing good growth and vigour planted in the clonal testing area (CTA) for testing the growth and disease susceptibility. Among the different clones of *E. grandis*, a hybrid clone urograndis had shown promising growth. There was no incidence of pink disease in any of the clones supplied from Kottappara and Devikulam. 50 kg seeds of *A. mangium* were collected from the elite trees at Kottappara and supplied to KFDC, KFD, HNL and Star Paper Mills, Saharanpur for producing the seedlings for their plantations. Two kg seeds of *E. pellita* were supplied also to Parry Agro Industries, Nilgiris. The provenance plots of eucalypts and acacias at Kottappara have to be continuously maintained as they are precious stock of original introduction of the popular exotics.

Maintenance of provenance trial plots of eucalypts and acacia and development of new clones for establishment of Clonal Multiplication Area (CMA)

1. Introduction

Eucalyptus, a native of Australia was introduced in India as early as 1790 in South India. During 1990s, eucalypts plantations covered about 40000 ha in Kerala. However, except in a few localities, the performance of the species was far from satisfactory (Nair *et al.*, 1986). The average productivity of eucalypt plantations in Kerala was recorded to be considerably low as indicated by a study conducted by KFRI (Nair *et al.*, 1997). According to the report the Mean Annual Increment (MAI) of seedling crop of *Eucalyptus* 'hybrid' was 7.65 m^3 ha^{-1} at 8 year rotation and for the first coppice crop 2.54 m^3 ha^{-1}. The MAI for seedling crop of *E. grandis* at 10 year rotation was 10 m^3 ha^{-1}. The low productivity of the plantations was mainly due to their susceptibility to diseases besides the genetically poor seeds used for raising plantations. Two severe diseases of eucalypts were pink disease caused by *Corticium salmonicolor* infecting 3-year old seedlings causing die-back and leaf infection (leaf blight) caused by several species of *Cylindrocladium* affecting both seedlings in nursery and plantations during rainy season. The loss due to pink disease has been estimated at 55-95% in *E. tereticornis* plantations while *Cylindrocladium* infection can result 100% mortality in nurseries.

1.1. Productivity improvement of Eucalypts

As the first step towards improving the productivity of eucalypts, KFRI had initiated testing the adaptability of several new Australian provenances by establishing four multi-location provenance trial plots comprising 83 provenances of *E. tereticornis, E. camaldulensis, E. urophylla, E. pellita and E. grandis* during 1990, 1992 and 1993 at Kottppara (Malayattoor Division),. Muthanga (Wayanad Division,

Wayanad Wild Life sanctuary), Vallakkadavu (Peermedu Division) and Punalur (Punalur Division). Approximately 28 ha plantation was established using provenance seeds obtained from the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia.

1.2. Productivity improvement of Acacias

Acacias were introduced in Kerala on a large scale during 1980s as part of the social forestry project funded by World Bank. The information on adaptability and growth performance of various provenances was unavailable before the introduction of the species in various locations. Considering the increasing importance of *Acacia* spp. as raw material for pulpwood industries, multi-location trials were established in 1997 at Kodnad and Kulathupuzha for 38 provenances of *A. mangium*, *A. auriculiformis*, *A. crassicarpa* and *A. aulacocarpa* (*A. peregrina*) with the seeds obtained from CSIRO, Australia.

1.3. Work done at Kottappara

As part of the research work carried out during 1990-2003, KFRI had established Eucalypt provenance trial plots (12 ha) during 1990, 1992 and 1993 for species such as *E. tereticornis*, *E. camaldulensis*, *E. urophylla* and *E. pellita*. Plots of 1 ha each for Clonal multiplication area (CMA), Clonal gene bank (CGB) and Clonal testing area (CTA) were also maintained. Other facilities established at Kottappara included field donal multiplication units (mist chamber), hardening units and semi-permanent sheds for storing root trainers and nursery implements (Sharma *et.al.*, 2000).

1.4. Work done at Devikulam

Clonal nursery was also established at Devikulam in Idukki District for carrying forward the clonal forestry programme for high altitude pulpwood species such as *E. grandis*, *E. urophylla* and *E. globulus*. This facility comprised of a semi-permanent building, progeny trial of *E. grandis* and *E. urophylla* provenances, Clonal Multiplication Area (CMA) for *E. grandis*, *E. urophylla*, *Urograndis* (hybrid of *E. urophylla x E. grandis*) and *E. globulus* (1 ha), clonal propagation and hardening units (Balasundaran and Florence, 2002).

1.5. Objectives

The objectives of the present project were:

(1) To identify new candidate plus trees (CPTs) of *E. tereticornis*, *E. camaldulensis*, *E. globulus*, *E. grandis*, *Acacia auriculiformis* and *A. mangium*

(2) Vegetative multiplication of the candidate plus trees of eucalypts and acacia spp. and their evaluation for growth and disease resistance for selection of new clones

(3) Planting and maintenance of new clones produced in the year 2003

(4) Supply of new clones of *Eucalyptus* spp. and *Acacia* spp. to the Kerala Forest Department for establishing clonal multiplication area and clonal plantation

2. Materials and Methods

2.1. Multiplication of clones at Kottappara

As per the requirement, every year selected clones of eucalypts and acacias were multiplied by rooting 2-noded cuttings prepared from 45-day-old coppice shoots at Kottappara and supplied to the Forest Department and other agencies. The details of the clones multiplied

including the name of the provenance to which it belonged are provided below (Table 1; 2).

Table 1. Eucalypt clones developed by KFRI

Sl. No.	Clone No.	Provenance Name	Seed lot No.
Eucalyptus tereticornis			
1.	KFRI 14	Kennedy River, Qld1	14802
2.	KFRI 16	Morehead River, Qld	13444
3.	KFRI 28	80 Km NNW Cook town	15198
4.	KFRI 38	East of Kupiano, PNG2	13398
5.	KFRI 43	Ravenshoe, Qld	14424
6.	KFRI 47	Kennedy Creek Pen Dev Road, Qld	15827
7.	KFRI 49	Morehead River, Qld	13444
8.	KFRI 56	Ravenshoe, Qld	14424
9.	KFRI 58	Kennedy River, Qld	14802
10.	KFRI 62	Palmer River, Qld	13847
11.	KFRI 65	Kennedy Creek Pen Dev Road, Qld	15827
Eucalyptus camaldulensis			
1.	KFRI 7	Katherine Nt 3	13801
2.	KFRI 10	Cape River, Qld	13815
3.	KFRI 22	West of Irvine Bank	15234
4.	KFRI 23	West of Normanton,Qld	13695
5.	KFRI 24	Daly Waters, Nt	13943
6.	KFRI 25	Katherine, Nt	13801
7.	KFRI 41	Victoria River, Nt	13928
8.	KFRI 54	Cape River, Qld	13815
9.	KFRI 55	Victoria River, Nt	13928
10.	KFRI 59	Region East of Petford, Qld	14338
11.	KFRI 68	11Cape River, Qld	13815

Qld1 - Queensland; PNG2 - Papua New Guinea; Nt3 - Northern Territory

Table. 2. Acacia clones developed by KFRI

Sl. No	Clone No.	Provenance name/Source	Seed lot No.
1.	*Acacia mangium* KFRI M 1	Wipm Oriomo, PNG	17872
2.	*Acacia auriculiformis* KFRI AA 1	Springvale (Half sib progenies	MPM
3.	*Mangium* hybrid FC 6 and HT 10	West Coast Paper Mills, Dandeli, Karnataka	---

2.2. Supply of clones to Kerala Forest Department

2.2.1. Kottappara

As eucalypts and acacia clones were requested by the Forest Department for raising clonal plantations, 10 clones of eucalypts and 3 clones of acacia spp. depending on disease resistance and higher growth rate were selected from the clones developed earlier and multiplied in the clonal facility at Kottappara adopting the method developed for vegetative multiplication (Balasundaran *et al.*, 2000).

In the year 2004, plots for planting the clones of eucalypts and acacias were selected at Chingamchira and Thirumany in Machad range of Thrissur Forest Division. The layouts for planting the clones were prepared and planting operations supervised. The plants were evaluated for growth and resistance/tolerance against incidence of pink disease. Growth measurements (GBH) were taken at the 6th year. For developing clonal seed orchard of *Eucalyptus tereticornis,* plots were selected at Mallankuzhy in Vazhany forest range in the year 2006. The layout for planting the clones was prepared and the planting operations supervised. Regular weeding and maintenance were carried out by the Forest Department for the initial three years. Observation on the growth as well as pink disease incidence was recorded at the 6th year.

2.2.2 Devikulam

For selecting candidate plus trees (CPT) of *E. grandis,* 45 trees with good growth and vigour were selected from a 7-year-old plantation (32 ha) at Kacheriland near Devikulam. All trees were felled during March and the coppices were multiplied vegetatively. Twenty three of them were maintained in the clonal multiplication area at Devikulam. A

hybrid of *E. grandis* x E. *urophylla* (urograndis) (Fig. 1) which had shown good performance in growth was also selected for multiplication.

Figure 1. Ramets of Urograndis in root trainer

For developing clonal plantation in the year 2003, clones of *E. grandis* were planted at Sevenmala in Munnar range. In the year 2004, different clones of *E. grandis* were produced and planted in the Central nursery campus at Devikulam. For developing a clonal seed orchard, 23 clones of *E. grandis* and urograndis were multiplied and planted in Sevenmala plantation at Devikulam in the year 2005. Seed orchard of various clones was also developed in the year 2006 and 2007 respectively at Pettimudy in Munnar range. In all the places (Sevenmala, Central nursery, Devikulam and Pettimudy) the layout of the plot as well as the planting operations of the clones were carried out by the Forest Department. Regular maintenance of all the plots for the initial three years was also carried out by the Forest Department. The girth at breast height (GBH) was measured and incidence of pink disease assessed from Sevenmala, Pettimudy and Central nursery plantations at the 6th year.

2.3. New clones developed

Seedlings were raised using seeds of *E. tereticornis* and *E. pellita,* collected from the superior trees of the existing provenance trial plots of

Kottappara for selecting interspecific hybrids. The seeds were sown in nursery beds and the hybrids were selected based on their phenotype and growth performance. Each year about 1000 seedlings showing phenotypic difference and vigour in growth were out planted to test disease tolerance and growth in the CMA at Kottappara. Similarly, seeds of *E. urophylla* and *E. grandis* collected from the provenance trial plots at Vallakadavu and Muthanga were also raised in seed beds at Devikulam for selecting interspecific hybrid seedlings. Clones were also developed from promising trees of clonal testing area (CTA). Whenever new clones are developed, they were supplied to Central Nursery at Chettikulam, Kerala for further multiplication and testing by the Forest Department.

2.4. Vegetative multiplication of *Eucalyptus globulus*

Eucalyptus globulus were introduced in Kerala through social forestry programmes (Stephanson, 2007) and are mainly planted in high altitude areas. Since it is introduced as a plantation species, the vegetative multiplication was attempted. Three year old *E. globulus* plants in the clonal multiplication area of Devikulam were felled for producing coppice shoots. Forty-five-days-old coppices were selected for rooting and the procedure for vegetative propagation followed as per Sharma *et al.*, (2000). Three different concentrations of IBA viz. 4000, 5000 and 6000 ppm were tested for rooting and sprouting.

2.5. Maintenance work

The major maintenance work carried out were weeding, labelling the plots and fixing boards for larger plots. Maintenance of clonal nurseries, propagation units and hardening sheds at Kottappara and Devikulam were also done during the project period. Every year for protecting the plots from fire, fire lines were taken around the plots at Kottappara and Devikulam before summer season. In 2007 the shed for keeping the implements at

Kottappara was damaged by wind fallen acacia trees and was reconstructed. The mist propagation trenches at Kottappara and Devikulam and the pump house at Devikulm which were damaged by wild elephants in 2008 were also repaired during the reporting period.

2.6 Supply of seeds

Seeds of *E. tereticornis*, *E. pellita* and *E. urophylla* were collected from the superior provenance trees growing at Kottappara and *E. grandis* from Muthanga. They were used for raising hybrids and also for distribution to various agencies. *A. auriculiformis* and *A. mangium* seeds were collected from provenance trees raised at Kottappara for supplying to Kerala Forest Department, Kerala Forest Development Corporation, Hindustan Newsprint Ltd., Velloor and other private agencies.

3. Results

3.1. Multiplication and supply of clones at Kottappara and Devikulam

More than one lakh fifty thousand ramets of eucalypts and acacia clones were developed from Kottappara and 64061 ramets were supplied to Kerala Forest Department, JK Paper Mills and Hindustan Newsprint Ltd. (HNL) (Table 3) during the years and the rest of the ramets were planted in CMA for replacement of old clones.

Table 3. Clones supplied from Kottappara

Year	Department/agency	Area of planting	Species	Ramets
2004	KFD	Chingamchira and Thirumany (Machad range)	Eucalypts and *acacia* spp.	11000
	JK Paper Mills		Eucalypts spp.	500
2005	KFD	Chingamchira and Thirumany (Machad range) casualty replacement	Eucalypts and *acacia* spp.	3567
	HNL	Kottappara	Eucalypts and *acacia* spp.	19840
	Central Nursery	Chettikulam	*Eucalyptus pellita* and *E. urophylla*	120
2006	KFD	Mallankuzhy	Eucalypts and *acacia* spp.	4950
2007	HNL	Kottappara	*Acacia* spp.	9234
2008	HNL	Kottappara	*Acacia* spp.	7550
2011	HNL	Kottappara	*Acacia* spp.	7300
			Total ramets	64061

Around 20000 ramets of different clones were developed from Devikulam (Table 4) and a total of 14235 ramets were supplied to KFD, HNL and other private agencies.

Table 4. Clones supplied from Devikulam

Year	Department/ agency	Area of planting	Species	No. of ramets
2003	KFD	Sevenmala (Munnar range)	*E. grandis*	3200
2004	KFD	Devikulam Central nursery	*E. grandis*	2000
2005	KFD	Sevenmala (Munnar range)	*E. grandis*	5025
2005	HNL	--	*Urograndis*	100
2006	KFD	Pettimudy (Munnar range)	*E. grandis*	1460
2007	KFD	Pettimudy (Munnar range)	*E. grandis*	2350
2010	The Bombay Burmah Trading Corporation Ltd. Coimbatore	---	Urograndis	100
Total ramets				14235

3.2 Clones planted at Chinganchira and Thirumany

In the year 2004, plots for planting clones of eucalypts and acacia were selected at Chinganchira and Thirumany, both in Machad range, in Thrissur Forest Division. 11000 ramets of selected clones of eucalypts and acacia were supplied for planting in the above plots. The details of the clones supplied are listed in table 5.

Table. 5. Clones planted at Chingamchira and Thirumany in 2004

Species	Clone No.	Ramets supplied
E. tereticornis	KFRI 14	750
	KFRI 16	500
	KFRI 43	500
	KFRI 49	1000
	KFRI 56	500
	KFRI 65	250
E. camaldulensis	KFRI 25	1500
	KFRI 23	1500
E.urophylla	KFRI 100	500
	KFRI 101	500
Acacia species	*Mangium* hybrid	1000
	Acacia mangium	1500
	A. auriculiformis	1000
	Grand Total	11000

The layout (Figs. 2 & 3) for planting the clones was prepared and planting operations supervised. The ramets were planted in 2m x 2m spacing. Since large number of causalities was there, in the year 2005, 3567 ramets of 10 clones of eucalypts and 3 clones of acacia spp. were planted at Thriumany and Chinganchira.

The measurements of girth at breast height (GBH) were taken after 6 years of planting. From each clone of eucalypts and acacia, the GBH of 25 trees selected at random was taken and the mean calculated (Tables 6 & 7). No incidence of pink disease was recorded on any of the clones. Since there was no maintenance in the plot after the initial three years of planting, heavy growth of weeds was noticed.

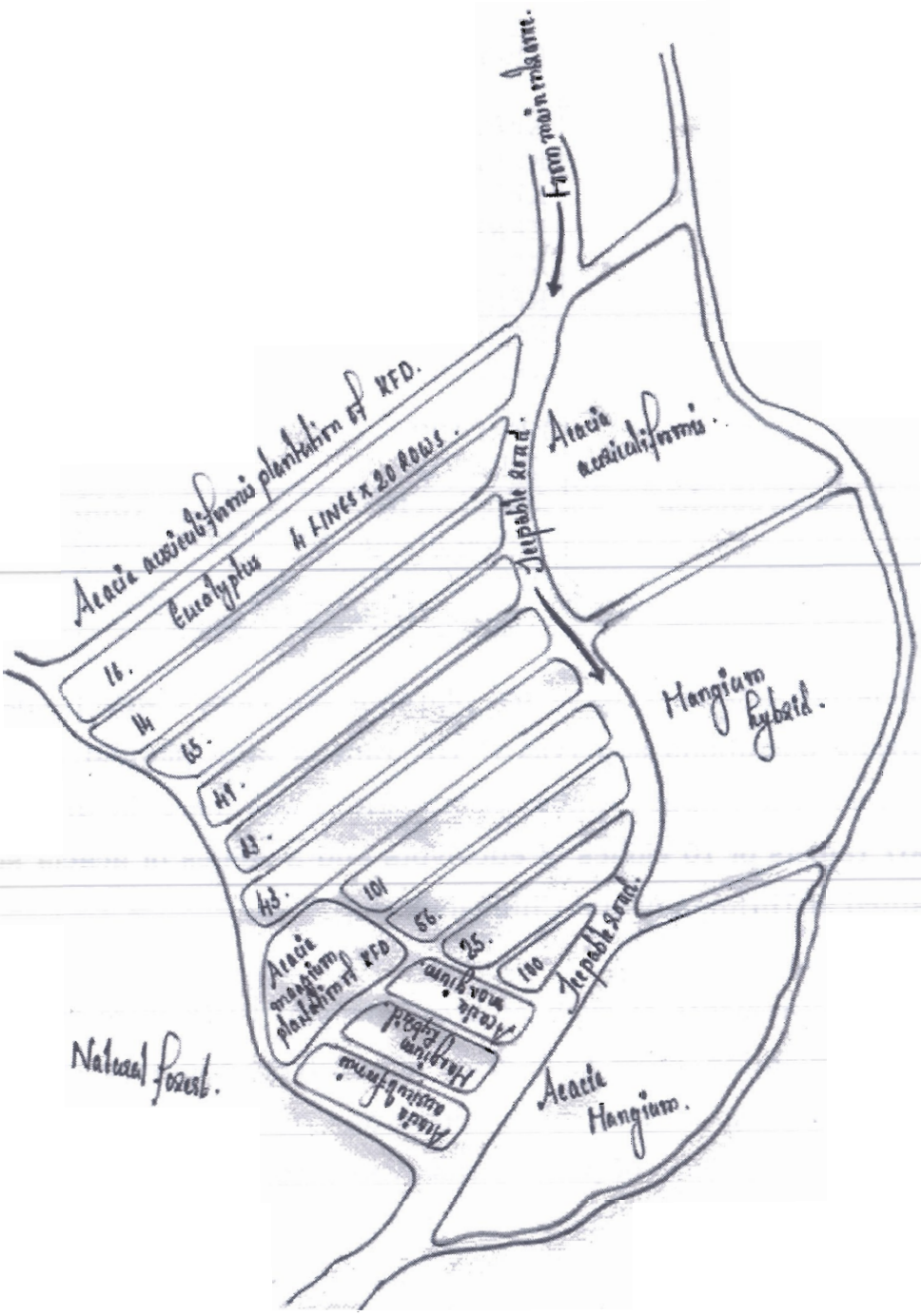

Figure 2. Layout of Thirumany plantation

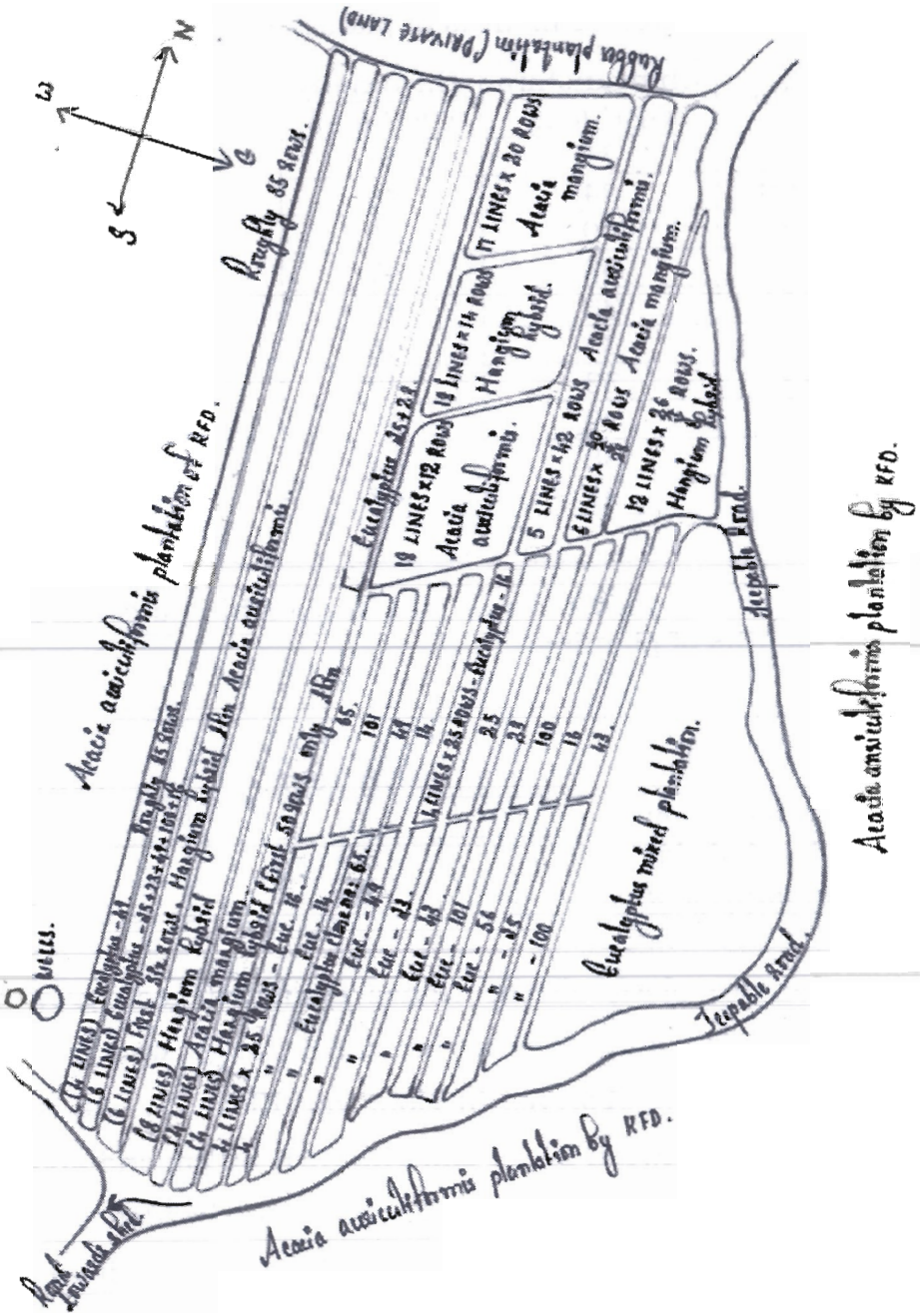

Figure 3. Layout of Chinganchira plantation

Table 6. Growth of eucalypts clones at Chinganchira and Thirumany after 72 months of planting

Clone No.	Chinganchira	Thirumany
	GBH (cm)	GBH (cm)
KFRI16	31	51
KFRI 100	34	49
KFRI 25	40	50
KFRI 56	33	47
KFRI 101	33	37
KFRI 43	34	46
KFRi 23	33	47
KFRI 49	39	49
KFRI 65	38	50
KFRI 14	37	47

Table 7. Growth of acacia clones at Chinganchira and Thirumany after 72 months of planting

Clones	Chingchira	Thriumany
	GBH (cm)	GBH (cm)
Acacia mangium	73	78
Mangium hybrid	59	56
Acacia auriculiformis	56	52

Among the two plots, all the clones exhibited good growth (GBH) at Thirumany. At Chinganchira, the GBH range was from 31-40 cm. Highest growth was observed in clone no. KFRI 25. At Thirumany the GBH range was between 37-51 cm. The GBH 50 cm and above was noted in KFRI clone nos. 25, 16 and 65. There was no incidence of pink disease in any of the clones in both the plots. When the maintenance work of both the plots was compared, weed growth was found comparatively less in Thirumany. This may be the reason for better growth at Thriumany. Among the three species of acacia clones, better growth was noted in *A. mangium* clones in both the plots (Table 7).

3.3 Clones planted at Mallankuzhy

For developing clonal seed orchard of *Eucalyptus tereticornis,* plots were selected at Mallankuzhy in Vazhany forest range in the year 2006. 4350 ramets of 13 clones of *E. tereticornis* and 2 clones of ITC Bhadrachalam (BCM) were planted at a spacing of 2m x 2m in a randomized complete block design (RCBD). The layout for planting the clones was made as mentioned earlier and planting operations supervised. In the layout, the number allotted to KFRI clones has been replaced by serial numbers (Table 8). The provenance name of each clone is also given in table 8. Totally there were 15 plots. In 11 plots, 360 ramets (20 rows of 18 ramets) of different clones were planted. In plot number 9 and 13 there were only 120 (12 rows of 10 ramets) plants. Two additional plots of 75 ramets (15 x 5 rows) each were also maintained for testing the performance of the clones. (Table 9a-m).

Table 8. Serial number allotted for KFRI clones

Sl. No.	Clone No.	Provenance No.
1	KFRI 14	KENNEDY RIVER, QLD
2	KFRI 16	MOREHEAD RIVER, QLD
3	KFRI 20	KENNEDY CREEK PENDEV ROAD, QLD
4	KFRI 28	80 Km NNW COOK TOWN
5	KFRI 43	RAVENSHOE, QLD
6	KFRI 47	KENNEDY CREEK PENDEV ROAD, QLD
7	KFRI 49	MOREHEAD RIVER, QLD
8	KFRI 56	RAVENSHOE, QLD
9	KFRI 59	RERGION OF PETFORD
10	KFRI 58	KENNEDY RIVER, QLD
11	KFRI 65	KENNEDY CREEK PENDEV ROAD, QLD
12	KFRI 67	ORO BAY TO EMO, PNG
13	KFRI 35	KENNEDY CREEK PENDEV ROAD, QLD
14	BCM 3	ITC, BHADRACHALAM
15	BCM 6	ITC, BHADRACHALAM

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(a). Plot 1

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m^2)

8	5	14	1	13	14	6	12	13	6	1	11	12	11	12	5	4	9	8	11
1	13	12	2	9	10	15	2	8	4	15	10	3	14	15	9	10	7	1	12
9	14	6	4	14	7	1	9	3	9	5	11	6	2	4	6	14	5	15	4
2	8	13	7	2	5	13	15	4	6	7	8	10	14	8	13	10	8	1	9
3	1	12	8	10	8	2	5	2	1	3	12	9	11	7	12	15	6	10	14
7	4	5	1	4	11	13	4	7	14	9	5	7	6	1	8	14	11	5	7
15	3	7	2	9	14	2	14	6	10	1	15	14	11	9	13	3	7	1	4
8	12	8	6	3	10	15	7	5	15	11	10	12	13	6	8	14	8	5	2
1	14	3	2	12	9	11	3	13	9	3	8	2	4	5	10	7	9	3	6
6	10	12	15	4	6	10	1	14	6	11	7	3	11	1	3	2	6	12	1
8	14	8	2	8	3	15	7	8	1	3	2	5	10	2	14	7	5	4	11
6	10	15	6	13	14	10	12	5	12	11	8	1	12	5	3	11	1	10	14
13	5	8	14	9	4	7	3	6	13	3	7	13	10	4	2	6	8	2	3
9	14	9	15	2	14	2	12	5	11	5	1	11	12	6	11	13	11	5	4
2	5	3	13	12	7	13	3	14	10	2	13	3	9	4	8	4	7	1	13
15	1	9	5	9	5	12	4	2	11	9	15	12	11	7	15	3	10	3	9
9	7	13	12	4	11	15	13	10	7	10	13	4	10	5	10	4	15	12	13
15	4	15	9	15	13	6	12	6	15	8	15	2	11	6	7	11	1	4	1

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(b). Plot 2

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m^2)

5	14	10	3	13	10	4	15	13	4	3	2	15	2	15	14	6	7	5	2
3	13	15	8	7	12	9	8	5	6	9	12	11	10	9	7	12	1	3	15
7	10	4	6	10	1	3	7	11	7	14	2	4	8	6	4	10	14	9	6
8	5	7	13	8	14	4	9	6	4	1	5	12	10	9	13	12	5	3	7
11	3	15	5	12	5	8	14	8	3	9	15	7	2	1	15	8	4	12	10
1	6	14	3	6	2	13	9	1	10	7	14	1	4	3	5	10	2	14	1
9	11	1	8	7	10	8	10	4	12	3	5	10	2	7	13	11	1	3	6
5	15	5	4	11	12	4	1	14	9	2	12	15	13	4	5	10	5	14	8
3	10	11	8	15	7	2	11	13	7	11	5	8	6	14	12	1	7	11	4
4	12	15	9	6	4	12	3	10	4	2	1	11	2	3	11	8	4	15	3
5	10	5	8	5	11	9	1	9	3	11	8	14	12	8	10	1	14	6	2
4	12	15	4	13	10	13	15	14	15	2	5	3	15	14	11	2	3	12	10
13	14	5	10	7	6	1	11	4	13	11	1	13	12	6	8	4	5	8	11
7	10	7	9	8	10	8	15	14	2	14	3	2	15	4	2	13	2	14	6
8	14	11	13	15	1	13	11	10	12	8	13	11	7	6	5	6	1	3	13

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(c). Plot 3

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area=360 x 4 = 1440m^2)

6	12	14	13	8	14	2	15	8	2	13	4	15	4	15	12	11	10	6	4
13	8	15	9	10	7	5	9	6	11	5	7	1	14	5	10	7	3	13	15
10	14	2	11	14	3	13	10	1	10	12	4	2	9	11	2	14	12	2	11
9	6	10	8	9	12	2	5	11	2	5	6	7	14	5	8	7	6	13	10
1	13	15	6	7	6	9	12	9	13	1	15	10	4	3	15	9	2	7	14
3	11	12	13	11	4	8	5	3	14	10	12	3	2	13	6	14	4	12	3
5	1	3	9	10	14	9	14	2	7	13	6	14	4	10	8	1	3	13	11
6	15	6	2	1	7	2	3	12	5	4	7	15	8	2	6	14	6	12	9
13	14	1	9	15	10	4	1	8	10	1	6	9	11	12	7	3	10	1	2
2	7	15	5	11	2	7	13	14	2	4	3	1	4	13	1	9	2	15	13
6	14	6	9	6	1	5	3	5	13	1	9	12	7	9	14	3	12	11	4
2	7	15	2	8	14	8	15	12	15	4	6	13	15	12	1	4	13	7	14
8	12	6	14	10	11	3	1	2	8	1	3	8	7	11	9	2	6	9	1
10	14	10	5	9	14	9	15	12	4	12	13	4	15	2	4	8	4	12	11
9	12	1	8	15	3	8	1	14	7	9	8	1	10	11	6	11	3	13	8
5	13	10	12	10	12	15	11	9	4	10	5	15	4	3	5	1	7	1	10
10	3	8	15	11	4	5	8	7	3	7	8	11	7	12	7	11	5	15	8
5	11	5	3	5	8	7	11	6	5	3	5	6	4	5	3	4	13	11	13

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(d). Plot 4

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m^2)

6	13	11	1	12	11	14	9	12	14	1	10	9	10	9	13	8	15	6	10
1	12	9	3	15	4	5	3	6	8	5	4	7	11	5	15	4	2	1	9
15	11	14	8	11	2	1	15	7	15	13	10	14	3	8	14	11	13	14	8
3	6	15	12	3	13	14	5	8	14	2	6	4	11	6	12	4	6	1	15
7	1	9	6	4	6	3	13	3	1	5	9	15	10	5	9	3	14	4	11
2	8	13	1	8	10	12	5	2	11	15	13	2	14	1	6	11	10	13	2
5	7	2	3	15	11	3	11	14	4	1	6	11	10	15	12	7	2	1	8
6	9	6	14	7	4	14	2	13	5	10	4	9	12	14	6	11	6	13	3
1	11	7	3	9	15	10	7	12	15	7	6	3	8	13	4	2	15	7	14
14	4	9	5	8	14	4	1	11	14	10	2	7	10	1	7	3	14	9	1
6	11	6	3	6	7	5	2	6	1	7	3	13	4	3	11	2	13	8	10
14	4	9	14	12	11	12	9	5	9	10	6	1	9	13	7	10	1	4	11
12	13	6	11	15	8	2	7	14	12	7	2	12	4	8	3	14	6	3	7
15	11	15	5	3	11	3	9	13	10	13	1	10	9	14	10	12	10	13	8
3	13	7	12	9	2	12	7	11	4	3	12	7	15	8	6	8	2	1	12
5	1	15	13	15	13	9	8	3	10	15	5	9	10	2	5	7	4	7	15
15	2	12	3	8	10	5	12	4	2	4	12	8	4	13	4	8	5	9	12
5	8	5	2	5	12	4	8	13	5	7	5	2	10	5	2	10	1	8	1

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(e). Plot 5

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m^2)

1	6	12	5	2	12	11	7	2	11	5	10	7	10	7	6	15	9	1	10
2	15	7	13	9	8	14	13	1	15	14	8	3	12	14	9	8	4	5	7
9	12	11	15	12	4	5	9	3	9	6	10	11	13	15	11	12	6	11	15
13	1	9	2	13	6	11	14	15	11	4	1	8	12	14	2	8	1	5	9
3	5	7	1	8	1	13	6	13	5	14	7	9	10	4	7	13	11	8	12
4	15	6	5	15	10	2	14	4	12	9	6	4	11	5	1	12	10	6	4
14	3	4	13	9	12	13	12	11	8	5	1	12	10	9	2	3	4	5	15
1	7	1	11	3	8	11	4	6	14	10	8	7	2	11	1	12	1	6	13
5	12	3	13	7	9	10	3	2	9	3	1	13	15	6	8	4	9	3	11
11	18	7	14	5	11	8	5	12	11	10	4	3	10	5	3	13	11	7	5
1	12	1	13	1	3	14	4	14	5	3	13	6	8	13	12	4	6	15	10
11	8	7	11	2	12	2	7	6	7	10	1	5	7	6	3	10	5	8	12
2	6	1	12	9	15	4	3	11	2	3	4	2	8	15	13	11	1	13	3
9	12	9	14	13	12	13	7	6	10	6	5	10	7	11	10	2	10	6	15
13	6	3	2	7	4	2	3	12	8	13	2	3	9	15	1	15	4	5	2
14	5	9	6	9	6	7	15	13	10	9	14	7	10	4	14	3	8	3	9
9	4	2	7	15	10	14	2	8	4	8	2	15	8	6	8	15	14	7	2
14	15	14	4	14	2	8	15	1	14	3	14	1	10	14	4	10	5	15	5

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(f). Plot 6

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m$^{2)}$

14	2	1	15	11	1	6	9	11	6	15	5	9	5	9	2	10	7	14	5
15	11	9	3	7	8	12	3	14	10	12	8	13	1	12	7	8	4	15	9
7	1	6	10	1	4	15	7	13	7	2	5	6	3	10	6	1	2	6	10
3	14	7	11	3	2	6	12	10	6	4	14	8	1	12	11	8	14	15	7
13	15	9	14	8	14	3	2	3	15	12	9	7	5	4	9	3	6	8	1
4	10	2	15	10	5	11	12	4	1	7	2	4	6	15	14	1	5	2	4
12	13	4	3	7	1	3	1	6	8	15	14	1	5	7	11	13	4	15	10
14	9	14	6	13	8	6	4	2	12	5	8	9	11	6	14	1	14	2	3
15	1	13	3	9	7	5	13	11	7	13	14	3	10	2	8	4	7	13	6
6	8	9	12	10	6	8	15	1	6	5	4	13	5	15	13	3	6	9	15
14	1	14	3	14	13	12	4	12	15	13	3	2	8	3	1	4	2	10	5
6	8	9	6	11	1	11	9	2	9	5	14	15	9	2	13	5	15	8	1
11	2	14	1	7	10	4	13	6	11	13	4	11	8	10	3	6	14	3	13
7	1	7	12	3	1	3	9	2	5	2	15	5	9	6	5	11	5	2	10
3	2	13	11	9	4	11	13	1	8	3	11	13	7	10	14	10	4	15	11
14	15	7	2	7	2	9	10	3	5	7	12	9	5	4	12	13	8	13	7
7	4	11	9	10	5	12	11	8	4	8	11	10	8	2	8	10	12	9	11
12	10	12	4	12	11	8	10	14	12	13	12	12	5	12	4	5	15	10	15

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(g). Plot 7

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m$^{2)}$

3	10	7	4	6	7	9	13	6	9	4	5	13	5	13	10	15	8	3	5
4	6	13	14	8	12	2	14	3	15	2	12	11	7	2	8	12	1	4	13
8	7	9	15	7	1	4	8	11	8	10	5	9	14	15	9	7	10	9	15
14	3	8	6	14	10	9	2	15	9	1	3	12	7	2	6	12	3	4	8
11	4	13	3	12	3	14	2	14	4	2	13	8	5	1	13	14	9	12	7
1	15	10	4	15	5	6	15	1	7	8	10	1	9	4	3	7	5	10	1
2	11	1	14	8	7	14	7	9	12	4	3	7	5	8	6	11	1	4	15
3	13	3	9	11	12	9	1	10	2	5	12	13	6	9	3	7	3	10	14
4	7	11	14	13	8	5	11	6	8	11	3	14	15	10	12	1	8	11	9
9	12	13	2	15	9	12	4	7	9	5	1	11	5	4	11	14	9	13	4
3	7	3	14	3	11	2	1	2	4	11	14	10	12	14	7	1	10	15	5
9	12	13	9	6	7	6	13	10	13	5	3	4	13	10	11	5	4	12	7
6	10	3	7	8	15	1	11	9	6	11	1	6	12	15	14	9	3	14	11
8	7	8	2	14	7	14	13	10	5	10	4	5	13	9	5	6	5	10	15
14	10	11	6	13	1	6	11	7	12	14	6	11	8	15	3	15	1	4	6
2	4	8	10	8	10	13	15	14	5	8	2	13	5	1	2	11	12	11	8
8	1	6	13	15	5	2	6	12	1	12	6	15	12	10	12	15	2	13	6
2	15	2	1	2	6	12	10	3	2	11	2	3	5	2	1	5	4	15	4

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(h). Plot 8

Clones 15 24 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m$^{2)}$

14	10	3	7	11	3	5	6	11	5	7	13	6	13	6	10	15	8	14	13
7	11	6	4	8	1	9	4	14	15	9	1	12	3	9	8	1	2	7	6
8	3	5	15	3	2	7	8	12	8	10	13	5	4	15	5	3	10	5	15
4	14	8	11	4	10	5	9	15	5	2	14	1	3	9	11	1	14	7	8
12	7	6	14	1	14	4	10	4	7	9	6	8	13	2	6	4	5	1	3
2	15	10	7	15	13	11	9	2	3	8	10	2	5	7	14	3	13	10	2
9	12	2	4	8	3	4	3	5	1	7	14	3	13	8	11	12	2	7	15
14	6	14	5	12	1	5	2	10	9	13	1	6	11	5	14	3	14	10	4
7	3	12	4	6	8	13	12	11	8	12	14	4	15	10	1	2	8	12	5
5	1	6	9	15	5	1	7	3	5	13	2	12	13	7	12	4	5	6	7
14	3	14	4	14	12	9	2	9	7	12	4	10	1	4	3	2	10	15	13
5	1	6	5	11	3	11	6	10	6	13	14	7	6	10	12	13	7	1	3
11	10	14	3	8	15	2	12	5	11	12	2	11	1	15	4	5	14	4	12
8	3	8	9	4	3	4	6	10	13	10	7	13	6	5	13	11	13	10	15
4	10	12	11	6	2	11	12	3	1	4	11	12	8	15	14	15	2	7	11
9	7	8	10	8	10	6	15	4	13	8	9	6	13	2	9	12	1	12	8
8	2	11	6	15	13	9	11	1	2	1	11	15	1	10	1	15	9	6	11
9	15	9	2	9	11	1	15	14	9	12	9	14	13	9	2	13	7	15	7

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(i). Plot 9

Clones 15 8 Replications (10 x 12) = 120 Ramets (Area = 120 x 4 = 480m$^{2)}$

13	6	1	11	12	11	12	5	4	9	8	11
9	4	7	9	8	5	14	1	13	14	6	12
15	2	8	4	15	10	3	15	9	12	4	10
11	6	10	2	6	14	5	6	4	1	2	9
8	1	9	14	4	12	4	14	7	9	3	5
15	4	6	5	7	8	10	6	8	13	14	10
13	8	10	14	2	9	7	2	7	5	6	1
10	3	1	12	8	5	1	3	12	11	7	12
11	13	11	13	7	3	7	11	1	14	2	5
2	3	15	3	15	13	15	13	2	15	3	10

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(j). Plot 10 (with additional clones)

Clones 6 60 Replications (20 x 18) = 360 Ramets (Area = 360 x 4 = 1440m$^{2)}$

5	8	2	11	7	2	5	7	8	11	5	11	8	5	11	2	5	8	7	2
11	1	7	5	1	11	8	2	1	2	1	7	2	1	7	1	11	1	11	5
5	8	2	8	7	2	1	7	5	7	11	8	5	8	5	8	2	8	7	8
2	1	7	5	1	8	11	8	11	2	5	1	2	11	1	11	7	11	5	1
7	5	11	8	11	7	1	2	1	7	11	8	7	5	8	5	2	1	8	2
2	1	7	1	5	8	5	7	5	8	2	5	11	1	2	11	7	5	7	5
5	11	5	8	2	11	1	11	1	11	1	7	8	5	8	5	8	11	2	8
7	8	1	7	5	8	7	5	8	5	8	11	1	7	2	1	2	1	5	7
11	2	5	8	2	11	2	1	2	11	2	5	8	5	8	11	5	8	11	8
7	8	7	11	5	1	7	5	8	5	1	7	11	7	2	7	1	2	7	2
5	1	5	2	7	8	11	2	1	7	2	5	8	5	8	11	5	11	1	8
11	8	7	8	1	2	7	5	11	5	8	1	7	1	2	1	7	2	7	2
5	1	11	2	7	5	8	1	8	2	11	2	5	8	7	8	5	8	1	8
11	7	8	1	8	11	2	11	7	5	1	7	11	1	5	2	1	7	2	7
2	1	5	2	7	5	7	1	8	2	11	8	5	2	11	7	8	5	1	11
8	11	7	1	8	2	11	2	11	5	1	2	7	1	5	1	2	11	7	5
7	1	8	2	11	7	1	5	1	2	11	5	11	8	11	7	8	1	2	1
11	2	11	7	1	8	11	2	11	7	1	2	1	7	2	1	2	11	7	11

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(k). Plot 11 (with additional clones)

Clones 6 60 Replications (20 x 18) = 360 RAMETS (Area = 360 x 4 = 1440m$^{2)}$

2	8	5	11	1	5	2	1	8	11	2	11	8	2	11	5	2	8	1	5
11	7	1	2	7	11	8	5	7	5	7	1	5	7	1	7	11	7	11	2
2	8	5	8	1	5	7	1	2	1	11	8	2	8	2	8	5	8	1	8
5	7	1	2	7	8	11	8	11	5	2	7	5	11	7	11	1	11	2	7
1	2	11	8	11	1	7	5	7	1	11	8	1	2	8	2	5	7	8	5
5	7	1	7	2	8	2	1	2	8	5	2	11	7	5	11	1	2	1	2
2	11	2	8	5	11	7	11	7	11	7	1	8	2	8	2	8	11	5	8
1	8	7	1	2	8	1	2	8	2	8	11	7	1	5	7	5	7	2	1
11	5	2	8	5	11	5	7	5	11	5	2	8	2	8	11	2	8	11	8
1	8	1	11	2	7	1	2	8	2	7	1	11	1	5	1	7	5	1	5
2	7	2	5	1	8	11	5	7	1	5	2	8	2	8	11	2	11	7	8
11	8	1	8	7	5	1	2	11	2	8	7	1	7	5	7	1	5	1	5
2	7	11	5	1	2	8	7	8	5	11	5	2	8	1	8	2	8	7	8
11	1	8	7	8	11	5	11	1	2	7	1	11	7	2	5	7	1	5	1
5	7	2	5	1	2	1	7	8	5	11	8	2	5	11	1	8	2	7	11
8	11	1	7	8	5	11	5	11	2	7	5	1	7	2	7	5	11	1	2
1	7	8	5	11	1	7	2	7	5	11	2	11	8	11	1	8	7	5	7
11	5	11	1	7	8	11	5	11	1	7	5	7	1	5	7	5	11	1	11

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(l). Plot 12 (with additional clones)

Clones 6 60 Replications (20 x 18) = 360 RAMETS (Area = 360 x 4 = 1440m$^{2)}$

2	5	8	7	11	8	2	11	5	7	2	7	5	2	7	8	2	5	11	8
7	1	11	2	1	7	5	8	1	8	1	11	8	1	11	1	7	1	7	2
2	5	8	5	11	8	1	11	2	11	7	5	2	5	2	5	8	5	11	5
8	1	11	2	1	5	7	5	7	8	2	1	8	7	1	7	11	7	2	1
11	2	7	5	7	11	1	8	1	11	7	5	11	2	5	2	8	1	5	8
8	1	11	1	2	5	2	11	2	5	8	2	7	1	8	7	11	2	11	2
2	7	2	5	8	7	1	7	1	7	1	11	5	2	5	2	5	7	8	5
11	5	1	11	2	5	11	2	5	2	5	7	1	11	8	1	8	1	2	11
7	8	2	5	8	7	8	1	8	7	8	2	5	2	5	7	2	5	7	5
11	5	11	7	2	1	11	2	5	2	1	11	7	11	8	11	1	8	11	8
2	1	2	8	11	5	7	8	1	11	8	2	5	2	5	7	2	7	1	5
7	5	11	5	1	8	11	2	7	2	5	1	11	1	8	1	11	8	11	8
2	1	7	8	11	2	5	1	5	8	7	8	2	5	11	5	2	5	1	5
7	11	5	1	5	7	8	7	11	2	1	11	7	1	2	8	1	11	8	11
8	1	2	8	11	2	11	1	5	8	7	5	2	8	7	11	5	2	1	7
5	7	11	1	5	8	7	8	7	2	1	8	11	1	2	1	8	7	11	2
11	1	5	8	7	11	1	2	1	8	7	2	7	5	7	11	5	1	8	1
7	8	7	11	1	5	7	8	7	11	1	8	1	11	8	1	8	7	11	7

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(m). Plot 13 (with additional clones)

Clones 6 20 Replications (10 x 12) = 120 Ramets (Area = 120 x 4 = 480m$^{2)}$

8	11	5	11	8	5	8	2	5	2	7	2
1	2	1	7	2	1	7	1	11	1	11	5
8	11	8	5	11	8	5	8	5	7	2	1
1	5	7	2	7	1	2	7	1	8	11	8
8	2	8	5	8	11	8	5	11	2	7	2
1	11	7	11	2	1	7	1	8	5	8	1
8	2	5	8	7	11	8	11	7	1	2	11
1	7	11	1	5	2	1	5	2	5	8	7
5	2	5	2	11	7	11	7	1	7	2	1
11	7	11	7	8	1	5	2	5	11	5	7

Clone Performance Trial Plot (RCBD)

Number of clones : 15 x 5 rows
Number of Block : 2
Spacing : 10m x 10m

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(n). Plot 14

6	3	4	7	15	8	2	11	10	12	1	9	13	14	5

Plot chart of *Eucalyptus tereticornis* Clonal Seed Orchard

Table 9(o). Plot 15

13	11	7	2	14	5	8	9	10	12	4	15	3	6	1

The GBH measured at 6th year of planting is given in table 10. For each clone GBH measurement of 15 ramets were taken. The GBH ranged

between 21-33 cm. Among the clones, KFRI 58 showed the highest GBH of 33 cm whereas the lowest GBH of 21 cm was measured from the KFRI clone 67. The BCM clones were inferior to most of the KFRI clones but were better than KFRI 67 clone.

Table 10. GBH of eucalypts clones at Mallankuzhy

Sl. No.	Clone No.	GBH (cm)
1	KFRI 14	30
2	KFRI 16	28
3	KFRI 20	29
4	KFRI 28	24
5	KFRI 43	32
6	KFRI 47	27
7	KFRI 49	25
8	KFRI 56	32
9	KFRI 59	30
10	KFRI 58	33
11	KFRI 65	29
12	KFRI 67	21
13	KFRI 35	24
14	BCM 3	25
15	BCM 6	24

3.4 Clones supplied to Hindustan Newsprint Ltd.

In the year 2005, for raising pulp wood plantations at Kottappara, 19840 ramets of 8 eucalypt species and acacia hybrid were supplied to Hindustan Newsprint Ltd., Velloor. During the years 2007, 2008 and 2011, 9234 clones of *A. auriculiformis*, *A. mangium* and *Mangium* hybrid, 7550 and 7300 ramets of A. *auriculiformis* and *A. mangium* were supplied to HNL respectively. The growth observations of clones supplied to HNL were not recorded.

3.5 Growth measurements of clones supplied from Devikulam

3.5.1 Growth of clones at Sevenmala (2005) plantation

From the measurements it was observed that most of the clones were performing in a similar way with slight variation in GBH (Table 11). Among all the clones the hybrid clone urograndis had the highest GBH of 80cm.

Table 11. GBH of eucalypts clones at Sevenmala (2005)

Clone No.	GBH (cm)	Clone No.	GBH (cm)
1	66	25	67
7	68	26	65
8	74	30	67
10	70	31	70
12	76	32	65
13	72	34	64
16	68	36	67
19	69	39	69
20	70	41	62
21	65	43	67
22	70	45	71
23	73	Urograndis	80

3.5.2 Growth of clones in CMA at Central Nursery Devikulam

Almost similar growth was observed in the clones planted at central nursery, Devikulam. Among the 24 clones, highest GBH of 59 cm was recorded in clone of *E. urophylla.* Among *E. grandis* clones, clone number 24 had a GBH of 54 cm. The lowest GBH of 27 cm was noted in the clone numbers 1, 10, 12 and 20 (Table 12).

Table 12. GBH of eucalypts Clones at Central Nursery, Devikulam

Eucalyptus grandis Clone No.	GBH (cm)	*Eucalyptus grandis* clone No.	GBH (cm)
1	27	25	35
7	33	26	54
8	24	30	30
10	27	31	30
12	27	32	34
13	28	34	37
16	33	36	38
19	30	39	36
20	27	41	36
21	30	43	38
22	35	45	35
23	30	*E. urophylla*	59

3.5.3 Growth of clones at Pettimudy (2006 and 2007)

The growth (GBH) of the clones at Pettimudy planted during 2006 and 2007 is given in table 13.

Table 13. GBH of eucalypts clones at Pettimudy planted during 2006 and 2007

Clone No.	GBH (cm)	
	2006	2007
1	13	10
7	12	11
8	11	12
10	13	12
12	8	8
13	14	10
16	14	13
20	12	12
21	11	12
22	13	11
23	11	10
25	13	12
26	13	11
62	12	10

The highest GBH of 14 cm was recorded in clone numbers 13 and 16 during 2006. In 2007 plantation highest growth was recorded in clone number 16. In both the plantations the lowest growth of 8 cm was recorded in clone no. 12. The growth of the plants was very poor because the plots were prone to heavy winds.

3.6 New clones developed

The list of new clones developed from Kottappara and Devikulam are given in the Tables 13 and 14. In 2005-2007, a total of 39 clones including natural hybrids were developed at Kottappara and planted in the Clonal Testing Area (CTA) for testing the growth and disease susceptibility. From Devikulam 99 clones showing good growth and vigour were planted in the CMA. 120 ramets of 4 new clones (*E. pellita* and *E. urophylla*) developed from Kottappara (Figs. 4, 5, 6 and 7) were planted in the CMA of Central Nursery of Kerala Forest Department, Chettikulam for further multiplication.

Table 13. New clones developed from Kottappara

Year	Species	No. of clones
2005	*E. urophylla*	9
	A. mangium	6
	E. pellita	3
	E. urophylla (natural hybrid)	3
	E. pellita (natural hybrid)	2
2006	*E. urophylla (natural hybrid)*	5
	E. pellita (natural hybrid)	2
	A. mangium	2
	A. auriculiformis	2
2007	*E. urophylla (natural hybrid)*	3
	E. pellita (natural hybrid)	2

Table 14. New clones developed from Devikulam

Year	Species	Total No. of clones
2004	*E. grandis*	25
2005	*E. grandis* (seeds collected from plus trees)	15
2005	*E. grandis* (seeds collected from provenance trial plot at Wayanad	17
2006	*E. urophylla* (seeds collected from provenance trial plot at Wayanad)	42

Figure 4. Clones developed from hybrids of *E. urophylla*

Clones from hybrids of *E. urophylla* – 1

Clones from hybrids of *E. urophylla* - 2

Clones from hybrids of *E. urophylla* – 3

Clones from hybrids of *E. urophylla* - 4

Figure 5. Clones developed from hybrids of *E. pellita*

Clones of hybrids of *E. pellita* – 1

Clones of hybrids of *E. pellita*- 2

Clones of hybrids of *E. pellita* – 3

Clones of hybrids of *E. pellita* 4

Figure 6. Single clone of *E. urophylla* hybrid

Figure 7. Single clone of *E. pellita* hybrid

3.7. Vegetative multiplication of *Eucalyptus globulus*

The vegetative multiplication of *E. globulus* was not successful as the coppices did not root even after three months in the mist chamber. The coppices remained healthy during the first 30 days and afterwards started yellowing and finally all coppices wilted. There were no roots or sprouts in any one of the coppice cuttings in any of the rooting hormone concentration treatment. Further, vegetative propagation was not attempted as this species is not much preferred by the Kerala Forest Department for future planting.

3.8 Supply of seeds

The details of seeds of eucalypts and acacia supplied from Kottappara are given in table 15. The seeds of *A. mangium* were supplied to KFDC, KFD, HNL and Star Paper Mills, Saharanpur for producing the seedlings for their plantations. Also seeds of *E. pellita* were supplied to Parry Agro Industries, Nilgiris. All seeds were collected from the elite trees from the provenance trial plot at Kottappara.

Table 15. Seeds supplied from Kottappara

Year of supply	Species name	Supplied to	Quantity Kg.	Cost of seeds Rs.
2004	*A. mangium*	KFDC Thrissur	5	11500
"	"	Central Nursery, Kulathupuzha	4	
"	"	Central Nursery Chettikulam	5	
"	"	Star Paper Mills, Saharanpur	1	
2005	*A. mangium*	KFDC	5	10500
	"	Central Nursery, Kulathupuzha	4	
	"	Central Nursery, Chettikulam	5	
2007	*A. mangium*	HNL	20	30000
2010	*E. pellita*	Parry Agro Industries, Nilgiris	1.950	11700
		Total		63700

4. Conclusions

As an outcome of earlier studies conducted for improving the productivity of eucalypts and acacias, KFRI had established two Clonal Multiplication Units, one at Kottappara, in Kodanad range for low altitude species of eucalypts and acacias, and another at Devikulam in Munnar Division for high altitude species of eucalypts. More than 150000 ramets of eucalypts and acacia clones were developed at Kottappara and 64061 ramets supplied to KFD, JK paper Mills and HNL and the rest planted in CMA. Around 20000 ramets of different clones were developed from Devikulam during the reporting period and a total of 14235 ramets were supplied to KFD, HNL and other private agencies. Growth performance of clones planted in the plots at Chinganchira, Thirumany and Mallankuzhy were not much encouraging. This may not be due to the inferior quality of the clones but may be due to either poor site conditions or the lack of maintenance of the plots. Even though the growth was not encouraging, there was no incidence of pink disease in any of the clones in any of the plots. Among acacia clones better growth was observed in *A. mangium* both at Mallankuzhy and Thirumany. Good growth was observed in the Sevenmala plantation raised by KFD using the clones from Devikulam. In both the plantations raised during 2005 and 2006 at Pettimudy, the performance of the clones was not up to the mark. The reason may be the poor site condition and the windy weather. Among all the clones, the hybrid clone urograndis had promising growth. During 2005-2007, a total of 39 clones (natural hybrids) were developed at Kottappara and 99 clones from Devikulam. These clones showed good growth and vigour when planted in the clonal testing area (CTA) for testing the growth and disease susceptibility. The vegetative multiplication of *E. globulus* was not successful as the coppices did not root even after three months. Further, attempt to root the cuttings were not made as this species is not in much demand by the KFD. The seeds of *A. mangium* were collected from the superior trees at Kottappara and

supplied to KFDC, KFD, HNL and Star Paper Mills, Saharanpur for raising seedlings for their plantations. Seeds of *E. pellita* were also supplied to Parry Agro Industries, Nilgiris. Since KFD has almost stopped planting eucalypts and acacias, currently we have slowed down our work on the above two species. Nevertheless, the provenance plots of eucalypts and acacias at Kottappara have to be maintained as these plots have precious stock of original introduction of the popular exotics.

5. References

Balasundaran, M. and Maria Florence, E.J. 2002. Identification of promising provenances of new fast growing species and development of new eucalypt and acacia clones for establishment of Clonal Multiplication Area (CMA). KFRI Research Report No. 230, Kerala Forest Research Institute, Peechi, Trichur.

Nair, K.S.S., Jayaraman, K. and Chacko, K.C. 1997. Productivity of teak and eucalypts in Kerala. Final Report of the Project KFRI 250/96. Kerala Forest Research Institute, Peechi, Trichur.

Nair, K.S.S, Varma, R.V, Karunakaran, C.K, Muhammad, E, Chand Basha, S 1986 Field trials for controlling termites in eucalypt plantations. Sharma, J.K., *et al.* (Ed.) Eucalypts in India: Past, Present and Future. Proceedings of the National Seminar held at Kerala Forest Research Institute, Peechi, Kerala, India, 30-31 January 1984: p356-363.

Sharma, J. K., Balasundaran, M. and Maria Florence, E.J. 2000. Establishment of a semi- permanent field clonal propagation unit for *Eucalyptus*. KFRI Research Report No. 204, Kerala Forest Research Institute, Peechi, Trichur.

Stephanson K.A, 2007. Comparative viability of *Acacia auriculiformis, Eucalyptus globulus, Casuarina equisetifolia* and *Ailanthus malabarica* under Social Forestry Plantations in Kerala - an Analysis. Indian Forester, 133 (11), 1492-1503.