



ANNUAL REPORT ON
SILVICULTURAL RESEARCH
IN THE
MADRAS PRESIDENCY
FOR THE YEAR
1935-36

PART I
RESULTS—WORKING PLANS—STATISTICS—STAFF

PART II
EXPERIMENTAL DATA

MADRAS
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS

1937

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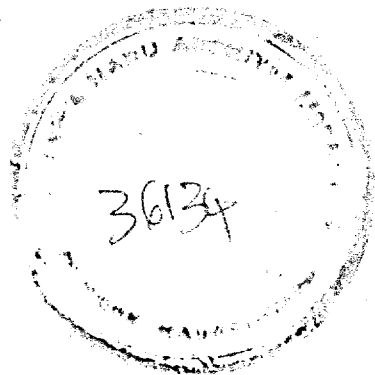


TABLE OF CONTENTS

PART I.

	PARAS.
Results and indications—	
(i) General—	
(a) General	1-3
(b) Climates	4-5
(c) Renumbering of experimental plots	6
(ii) Natural regeneration—	
By seed	7-15
By coppice	16-18
(iii) Seed—	
Pre-treatment	19-22
Seasonal collection	23
Method of sowing	24, 25
Locality tests	26
Storage	27
Weighment	28
Sorting by size	29, 30
Seed bearers, condition of	31-34
Origin	35, 36
(iv) Nursery work—	
Shading	37
Sheltering	38, 39
Repeatedly using the same nursery beds.. .. .	40
Methods of raising teak stumps	41, 43
Outturn of stumps — district work.. .. .	44, 45
(v) Artificial regeneration—	
(a) Mixed deciduous timber forests—	
Development of regenerated gaps	46
Sowing, transplanting, stumping — comparison —	
8 species	47-55
Pre-monsoon stump planting — 5 species	56-68
Stump planting—	
Age and diameter of stumps — 5 species	69-74
Length of root — teak	75
Cooly variation — teak	76, 77
Storage of stumps — teak	78
Transport of stumps — teak.. .. .	79, 80
Swampy areas	81
Transplanting — Chloroxylon swietenia	82
Teak plantations—	
Casualty replacement	83, 84
Effect of taungya crops	85, 86
Early and late planting with taungya	87
Planting distance	88
(b) Evergreen rain forests	89

TABLE OF CONTENTS

	PARAS.
(v) Artificial regeneration— <i>cont.</i>	
(c) Dry fuel forest—	
General	90-92
District work	93-108
Sowing—	
Best date—6 species	109-111
Comparison of dry and watered beds	112, 113
Effect of burning and soil working before sowing..	114-116
Germinating and untreated seed	117
Sowing, transplanting and stumping—	
Comparison — 20 species—	118, 119
in S.W. and N.E. monsoons—6 species	120
Stump planting — best date — 10 species	121
Sowing — <i>Santalum album</i>	122
Stump planting — <i>Santalum album</i>	123, 124
Soil working, 1st year	125, 126
(vi) Afforestation—	
Grassland catchment areas	127
Swamp edges and stream banks	131-134
(vii) Tending, thinning, cleaning etc.—	
Teak plantations—	
Weeding practice	135-140
Burning and cutting back	141
Cover crops	142
Thinning research	143-146
Effect of pruning young <i>Swietenia macrophylla</i>	147
Evergreen rain forests — soil working and trenching—	
<i>Hopea parviflora</i>	148
Fuel forests—	
Burning and cutting back — <i>Eucalyptus globulus</i> ..	149
Cutting of thorny bushes	150
(viii) Mixtures—	
(ix) Underplanting—	
(a) Teak plantations	151, 152
(b) Evergreen rain forests—	
Underplanting under shade	153
Fate of gap regeneration	154
Burning in gaps before regeneration.. .. .	155
Clear felling for regeneration	156
Regeneration—	
General	157
Best light conditions.. .. .	158
Burning before regeneration.. .. .	159
Direct sowing — best date — 3 species	160
Transplanting — best date — 4 species	161
Stump planting — best date — 2 species	162
Sowing, transplanting, stumping — comparison ..	163
Transplanting—	
Nursery and natural forest seedlings comparison ..	164
Naked root and basketed plants	165

TABLE OF CONTENTS

	PARAS.
(ix) Under planting— <i>cont.</i>	
(b) Evergreen rain forests— <i>cont.</i>	
Cuttings	166
Effect of weeding	167
Browsing and repulsive smears	168
(x) Silvicultural systems—	
(xi) Miscellaneous—	
(a) Spike Disease of Sandal—	
Introduction	169
New outbreaks	170
Transmission experiments with insect masses,—	
groups, or families	171, 179
Transmission experiments with individual species ..	180, 183
Specific vector experiments	184
Time of infection	185
Experiments aiming at prevention	186, 193
Experiments aiming at control or cure	194, 196
Susceptibility of areas and effect of environmental	
factors	197, 198
Summary	199
(b) Periodicity of height growth	200, 204
(c) Weeds—	
<i>Lantana</i> eradication	205, 212
Climber poisoning	213, 218
<i>Strobilanthes</i> eradication	219
<i>Eupatorium</i> eradication	220
Grass suppression in fuel coupes	221
II Working Plans and Statistics—	
(a) Working Plans	222
(b) Yield volume and form factor tables	223, 225
III Miscellaneous—	
Tours	226, 229
Records	230, 232
Staff	233
PART II.	
Experimental data—	
Climates	234
Renumbering of Experimental Plots	235
Seed—	
Storage	236
Weighment	237
Sorting according to size—Teak	238
Nursery—shading	239
Mixed deciduous timber forests—	
Sowing, transplanting, stumping—comparison— <i>Dalbergia latifolia</i>	240
<i>Pterocarpus marsupium</i>	241
<i>Pterocarpus dalbergoides</i>	242
<i>Terminalia crenulata</i>	243
<i>Xylia xylocarpa</i>	244
<i>Artocarpus hirsuta</i>	245

	PARAS.
Sowing and transplanting—	
Comparison— <i>Swietenia macrophylla</i> —Size of transplants ..	246
Pre-monsoon stump planting—	
Teak	247
<i>Dalbergia latifolia</i>	248
<i>Pterocarpus marsupium</i>	249
<i>Terminalia crenulata</i>	250
<i>Artocarpus hirsuta</i>	251
Stump planting—	
Effect of age and diameter of stumps—Teak	252
<i>Dalbergia latifolia</i>	253
<i>Pterocarpus Marsupium</i>	254
<i>Terminalia crenulata</i>	255
<i>Artocarpus hirsuta</i>	256
Effect of length of root—Teak	257
Effect of cooly variation—Teak	258
Effect of storage of stumps—Teak	259
Teak plantations—	
Effect of taungya crops on	260
Early and late planting with taungya	261
Dry Fuel Forests—	
Direct sowing—	
Best date.	262, 263
Dry and watered beds—comparison	264, 265
Burning and soil working before sowing	266, 267
Germinating and untreated seed	268
Sowing, transplanting and stumping—Comparison	269, 270
South-west and north-east monsoons	271
Stump planting—Best date	272
Tending, Thinning, cleaning, etc.—	
Teak plantations—	
Effect of burning and cutting back	273
Cover crops— <i>Leucaena glauca</i>	274
Soil working and trenching—	
<i>Hopea parviflora</i>	275
Evergreen rain forest—	
Burning before gap regeneration	276
Best light conditions for regeneration	277
Burning before regeneration	278
Sowing—best date	279
Transplanting—best date	280
Stump planting—best date	281
Sowing, transplanting, stumping—comparison	282
Transplanting—	
Nursery and natural forest seedlings—comparison	283
Naked root and basketed seedlings—comparison	284

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PART I.

I. RESULTS AND INDICATIONS.

(i) GENERAL.

1. As in previous years, a large amount of the work done this year has been small scale [Stage I (a)] investigations in experimental gardens. Inevitably, a large proportion of the work consisted of repetitions of previous experiments in order to confirm the results and indications obtained from them, and also of routine seed germination and weighment tests.

2. The most important results obtained during the year are probably the following:—

The successful control of the spike disease of sandal over large areas in the case of new outbreaks provided that they are reported and anti-spike measures adopted without delay.

Confirmation of transmission by insects of the spike disease of sandal and demonstration of the fact that the disease thus induced under controlled conditions can be further transmitted by grafting (as is the case with natural spike). The successful control of lantana at a reasonable cost by chemical spraying. A spray has been evolved which while killing out the lantana does not usually affect other species growing in the pest.

The successful underplanting of dense lantana with *Bambusa*. The bamboo has grown right up through the lantana without any attention and is killing out the pest.

The successful transport of teak stumps to distant places. Stumps have been sent journeys of 1,000 miles taking up to 14 days and in the majority of cases after two years the plants resulting from these stumps have been as good as and better than those from local stumps in spite of the fact that they were growing in localities climatically very different from that in which they were raised in the nursery.

A demonstration of the necessity for 'rab' regeneration in our dry fuel forests,—apart from the mortality caused by man, grazing, fire, etc., the ordinary coppice felling causes about 5 per cent of the stools to die each time the operation is done.

Demonstration of the benefits of soil working in the regeneration of dry fuel forests. Soil working resulted in three times as many seedlings surviving the hot weather.

Confirmation by large scale experiments that in mixed deciduous forest of good quality the beneficial effects (if any) of forking as a weeding method in teak plantations compared with mamooty scraping were in no way commensurate with the extra cost of forking.

Further confirmation of the smallness of the risks run in pre-monsoon stump planting of teak in our better teak districts even in a year abnormally lacking in early rains. This has also been confirmed by large scale district work, the averaged results of which were within 2 per cent of those obtained in small scale experiments. Even in a bad year, pre-monsoon stump planting gives considerably better results than normal monsoon planting.

3. During the year an increase in office staff was sanctioned and the period under report has been spent not in initiating new work (as should be the case) but in continuing existing lines of research and in attempting to bring the field work and its records and office work up to date. The arrears which unfortunately accumulated in the past few years owing to lack of staff are slowly being worked off and all old experiments have now been summarized and closed.

CLIMATES.

4. In an endeavour to give an idea of the climates in which the experiments have been done a rainfall statement for all research centres is given in paragraph 234. In this statement the rainfall figures are given in inches monthwar and underneath this is given the number of rainy days in that month, e.g.,

10.71	(inches of rain in the month)
15	(rainy days in the month).

In addition to this, the last column of the table gives the average annual rainfall of the place over as long a period of years as is possible together with the average number of rainy days per year where it is known. The period of rainfall given (1st April 1935 to 1st June 1936) covers all the 1935 experiments. The rainfall is totalled for the year 1st April 1935 to 1st April 1936 as this period covers most measurements and is to be compared with the average annual rainfall given in the last column.

5. 1935 was the second abnormally poor year for rains in the districts containing our better type of forests. In consequence it was a very poor seed year, particularly for teak, mahogany and most evergreen species and our most important teak districts were unable to supply even their own seed requirements. This was not the case however in the dry fuel forests. The south-west monsoon although light, was very late in arriving, but its showers continued almost up to the north-east

monsoon. Consequently it was a very fair seed year in the dry districts. Practically no break occurred between the monsoons and the result has been a good year for "rab" regeneration.

6. *Renumbering of experimental plots of South Coimbatore and Palghat divisions.*—During the year it was noticed that the experimental plot numbers of South Coimbatore and Palghat divisions which had started as separate series, in the course of time had become amalgamated and this led to confusion. In consequence the experimental plots of these two divisions were re-numbered.

In this report the experimental plots are referred to by their new numbers. For the benefit of those following the reports of particular experiments through several years, a statement correlating old and new numbers is given in paragraph 235.

(ii) NATURAL REGENERATION.

By seed.

7. *Attempt to induce natural regeneration by clearing undergrowth—Swietenia macrophylla.*—Experimental plot No. 125. Nilambur division is an experiment started in 1933 to ascertain whether clearing dense undergrowth under mahogany trees where natural regeneration is scanty will induce abundant regeneration. When the plot was opened all natural regeneration existing was pulled out and counted. 1933 was a very poor seed year and very little regeneration resulted. 1934 was a fairly good seed year and resulted in almost exactly the same number of new seedlings as were originally pulled out. 1935 was a poor seed year. Regeneration existing on the ground in December 1935 was 886 plants in the treated areas and 1,301 in the control areas. Regeneration in the treated strips has been badly browsed and looks unhealthy while that in the control strips is healthy and has not been browsed. It appears therefore that the clearing of undergrowth is definitely harmful.

8. *Mesua ferrea.*—Similar experiments (Experimental plot 23 Wynaad and 55 Coimbatore South divisions) with *Mesua Ferrea* show that although there have only been very slight seed falls in the last three years the treatment has had no beneficial effect.

9. *Calophyllum elatum.*—Experimental plot No. 56 South Coimbatore division has given inconclusive results as there has been practically no seed fall since the experiment was started three years ago.

10. *Hopea parviflora.*—In Experimental plot 54 South Coimbatore division although there has been very little seed fall in the last three years enumerations show that the treatment has had no beneficial effects in inducing natural regeneration as the numbers of seedlings resulting in the treated and untreated plots are almost exactly the same.

Canopy manipulation over natural regeneration.

11. *Hopea parviflora*.—Experimental plots 37, 38 and 39 South Coimbatore division were opened in 1931 in Karian Shola to study the effect of canopy manipulation on natural regeneration of *Hopea parviflora* 5'—10' high. Three treatments were applied in which (A) all but the top canopy was cut (B) the undergrowth was cut and (C) control in which nothing was done.

Casualties have been negligible and during the five years the plots have been open the treatments have shown the following average annual height increment (A) 13.7" (B) 6.0" (C) 7.2". This well demonstrates the benefit obtained by the canopy opening. The plants in the area where the undergrowth was cut (B) have put on a fair girth increment but have suffered from bark stripping by deer.

12. Experimental plots 42 and 43 South Coimbatore division were opened in 1932 in Karian shola to study the effect of canopy manipulation on unestablished natural regeneration of *Hopea parviflora*. Two treatments were applied in which (A) all but the top canopy was removed and (B) control in which nothing was done. In addition in the (A) treatment, part was fenced and the remainder left unfenced.

During the four years the plot has been open the unestablished regeneration has increased under the various treatments in the following percentages:—

A-1 Top canopy only—fenced—50 per cent.

A-2 Top canopy only—unfenced—43 per cent.

B Control—7 per cent.

These figures well illustrate that to establish young natural regeneration of *Hopea* it is very beneficial to open the canopy.

13. *Mesua ferrea*.—Experimental plots 44 and 45 South Coimbatore division were opened in 1932 to test the effect of canopy opening on natural regeneration of *Mesua ferrea* 5'—10' high. Two treatments were applied (A) in which only the top canopy was left and (B) the control in which nothing was done. The two treatments show an average annual height increment of (A) 6.3" and (B) 4.5", but the small regeneration on the ground is not quite as good as it was.

Experimental plots 3 and 4, Wynaad division were opened in 1932 and two treatments applied (A) cutting undergrowth, (B) control. They show an average annual height increment of (A) 0.7" and (B) 3.2". The state of small regeneration on the ground has not moved.

Experimental plots 5 and 6 Wynaad division were similarly opened in 1932. In these two experiments neither the large nor the small regeneration on the ground has moved at all.

The above experiments show that for *Mesua ferrea* it is not advantageous to open the canopy or remove undergrowth at least before the natural regeneration is 5'—10' high.

14. *Complete opening of the canopy over natural regeneration—Swietenia macrophylla*.—An experiment on the growth and survivals of young natural regeneration of mahogany under mother trees (Experimental plot 127 Nilambur) in which seedlings were selected in two groups under shade and in the open in a randomised way showed that although the two sets of seedlings were initially comparable in mean height, the opening of the canopy caused a significant increase in the height growth of 10 per cent at the end of the first year and 25 per cent at the end of the second year. The mean height of the seedlings was approximately 6' at the time of opening. During the two years of the experiment casualties have been negligible (due to browsing and bark stripping by deer) and there has been no difference in incidence of insect attack between the two treatments.

It appears therefore that it is both beneficial and safe to remove the canopy over natural mahogany seedlings 5'—6' in height.

15. *Canopy manipulation over regeneration of Pterocarpus santalinus*.—*Pterocarpus santalinus* (Red Sanders) a valuable species in some of the dry districts, often regenerates itself by seed profusely but the regeneration dies back each year although it increases in density year by year. The District Forest Officer, Chittoor, has been very successful in bringing on this regeneration into a sapling and pole stage by opening the canopy over a "mat" of seedlings which was considered dense enough to open over.

This procedure has also been recognized in other districts but no records have been kept of work done and no counts made to give an idea of when regeneration is sufficient to start operations. Controlled experiments with this object have now been started and preliminary counts show that this "mat" of regeneration contains approximately 550 seedlings per 100 square feet.

16. *Natural regeneration by coppice*.—In Experimental plot No. 11 Chittoor division, three species (*Acacia sundra*, *Albizzia amara*, and *Azadirachta indica*) were dealt with and three treatments applied (1) high cutting, with trimming, (2) low cutting with trimming, (3) low cutting without trimming. The fourth treatment of high cutting without trimming was omitted as a sufficient number of stools was not available and it was considered best to get more reliable results with fewer treatments.

Measurements one year after applying treatments show the following mortalities of stools:—

Species.	Percentage of stools dead.			
	High cutting with trimming. PER CENT.	Low cutting with trimming. PER CENT.	Low cutting without trimming. PER CENT.	
<i>Acacia sundra</i>	4.2	0.5	0.0	Treatment omitted owing to insufficient number of stools.
<i>Albizzia amara</i>	2.4	4.8	1.2	
<i>Azadirachta indica</i>	2.3	3.7	..	
Average for all 3 species ..	3.2	6.4	3.8	

The three treatments in ordinary district work correspond to good, poor, and very poor work, and it is seen that for all three treatments and all three species (1,224 stools) the ordinary operation of coppicing has caused 4.3 per cent of the stools to die and in addition to this 0.65 per cent of the stools were still green but had produced no shoots at all. Thus the mortality may be put at 5 per cent.

This result has been obtained in one of the dry fuel forests of Chittoor district and it is interesting to compare it with the similar result obtained in a *Eucalyptus globulus* high elevation fuel forest of the Nilgiris (vide paragraph 149).

17. This comparatively high mortality once again brings into prominence the necessity for "rab" regeneration in fuel forests to make up the loss of stock caused by coppice felling.

It is to be noted that the highest mortality in all species has been caused by the treatment of low cutting with trimming and this in practice has been considered to be the best type of work. It is possibly due to the shaking of the roots in a dry soil by the trimming after the initial felling has been done.

It will of course be many years before we can determine the effect of the treatments on the volume of fuel produced.

18. In Experimental plot No. 142 Palghat division an experiment has been started to determine whether it is advisable to thin out teak coppice when grown for the purpose of producing poles. The thinning out was done when the coppice was 18 months old and of course produced secondary shoots but one year later these secondary shoots although vigorous were in no way interfering with the original coppice shoots.

Measurements one year after treatment (or three years after the coppice felling) show that all treatments in which the number of coppice shoots per stool were reduced, have produced coppice shoots significantly bigger in height and diameter than the untreated control. It however remains to be seen which treatment gives the greatest money yield at the end of the rotation.

Abbreviated results are:—

Treatment.				Mean height in feet.	Difference of means.	Signifi- cance.
A.	Reduction to 1 shoot per stool	..	..	14.51±0.53	+4.27±0.60	S.
B.	Do. 2	..	..	12.69±0.49	+2.45±0.52	S.
C.	Do. 4	..	..	11.93±0.43	+1.69±0.46	S.
D.	Untreated control	..	..	10.24±0.28	Control.	

Treatment.				Mean dia- meter in inches.	Difference of means.	Signifi- cance.
A.	Reduction to 1 shoot per stool	..	..	1.46±0.13	+0.64±0.14	S.
B.	Do. 2	..	..	1.19±0.09	+0.37±0.10	S.
C.	Do. 4	..	..	1.02±0.05	+0.20±0.07	S.
D.	Untreated control	..	..	0.82±0.43	Control.	

(iii) SEED.

19. *Seed pre-treatment.*—Routine seed pre-treatment tests were made with 13 species, the treatments used being cold, hot, and boiling water, with an untreated control in each case. Seed purity percentage and seed weights were also recorded.

The germinative capacity of seed of the following species was not apparently improved by any of the treatments used:—

Acacia ferruginea.
 „ *leucophloea.*
 „ *sundra.*
Acrocarpus fraxinifolius.
Albizia amara.
Anacardium occidentale.
Azadirachta indica.
Cassia fistula.
Cassia marginata.
Cassia siamea.
Chloroxylon swietenia.
Dalbergia latifolia.
Dalbergia sissooides.
Dendrocalamus strictus.
Gmelina arborea.
Lagerstroemia lanceolata.
Pithecolobium dulce.
Prosopis juliflora.
Pterocarpus dalbergioides.
Pterocarpus marsupium.
Tectona grandis.
Terminalia chebula.
Terminalia crenulata.
Terminalia paniculata.

Treatment with boiling water (water 20 times the volume of the seed used is brought to the boil, taken off the fire, the seed immediately put in and left till cold) appears to increase the germination of *Acacia auriculiformis* and *Acacia cyanophylla*, the latter being very marked.

Soaking in cold water for 24 hours was beneficial in the cases of *Calophyllum elatum*, *Gluta tranvancorica*, *Pterocarpus santalinus* and *Xylia xylocarpa*, being very marked in the case of the *Pterocarpus* (Red Sanders). It is again brought to notice that the pre-treatment of teak seed by soaking it in cold water neither increases nor accelerates its germination.

20. The results of pre-treatment tests are summarized in the table below. Generally 100 seeds for each treatment were used in

each test though in a few cases 200 or 50 seeds were used. The results of previous years' tests are included.

Species.	Num- ber of tests made.	Average germinative capacity with				Remarks.
		Untreated.	Cold water.	Hot water.	Boiling water.	
<i>Acacia auriculiformis</i> ..	5	15	16	22	26	Boiling water best in 4 out of 5 tests. Boiling water best in 8 out of 9 tests.
Do. <i>cyanocephala</i> ..	9	11	14	17	35	
Do. <i>ferruginea</i> ..	5	64	57	62	60	
Do. <i>leucophloea</i> ..	10	19	9	14	24	
Do. <i>sundra</i> ..	10	34	23	30	25	
<i>Acrocarpus fraxinifolius</i> ..	25	8	8	9	6	Untreated consis- tently best.
<i>Albizia amara</i> ..	18	42	37	31	38	
<i>Anacardium occidentale</i> ..	6	70	53	54	24	
<i>Azadirachta indica</i> ..	6	44	40	30	9	
<i>Calophyllum elatum</i> ..	1	3	8	6	0	
<i>Cassia fistula</i> ..	13	11	11	8	7	
<i>Cassia marginata</i> ..	12	17	22	13	5	
<i>Cassia siamea</i> ..	13	52	36	46	3	
<i>Chloroxylon swietenia</i> ..	11	14	12	11	1	
<i>Dalbergia latifolia</i> ..	22	31	26	29	5	
Do. <i>sissoides</i> ..	30	26	26	32	5	Seed coat removed.
<i>Dendrocalamus strictus</i> ..	5	33	22	22	0	
<i>Gluta travancorica</i> ..	5	11	15	10	6	
<i>Gmelina arborea</i> ..	25	20	19	18	6	
<i>Lagerstroemia lanceolata</i> ..	30	5	4	4	0	
<i>Pithecolobium dulce</i> ..	8	43	13	38	5	
<i>Prosopis juliflora</i> ..	5	71	72	61	54	
<i>Pterocarpus dalbergioides</i> ..	2	20	20	23	14	
Do. <i>santalinus</i> ..	12	25	71	33	19	
Do. <i>do.</i> ..	1	24	40	33	10	
Do. <i>maritimum</i> ..	52	38	31	33	14	* Damaged by white ants.
<i>Tectona grandis</i> ..	40	28	27	24	8	
<i>Terminalia chebula</i> —						
(1) (whole fruit) ..	10	18	12	21	3	
(2) (fleshy covering removed)	3	4	6	5	7	
(3) (kernel) ..	4	6	1	2	0*	
<i>Terminalia crenulata</i> —						
(1) fresh seed ..	47	32	36	32	6	
(2) stored 14 months ..	10	9	8	7	8	
<i>Terminalia paniculata</i> ..	10	13	8	10	0	
<i>Xylocarpus</i> ..	42	20	26	25	13	

21. *Seed pre-treatment—Obdurate species.*—Seven species which usually give a very low germination per cent were experimented on with special tests to try and increase their germination.

The treatments used were (A) control, (B) soaking in lime water for 24 hours, (C) soaking in cold water for 48 hours and then keeping moist in straw out of free air circulation (fermenting), (D) scorching over a fire, (E) soaking in concentrated sulphuric acid and (F) exposing to the sun and watering on alternate days.

Results are seen in the table below :—

Species.	Number of tests						
		Control.	Lime water.	Fermenting.	Scorching.	Sulphuric acid.	Weathering.
<i>Acacia auriculiformis</i> ..	10	0	0	10	0	10	10
<i>Acacia leucophloea</i> ..	20	0	0	17	0	13	10
<i>Acrocarpus fraxinifolius</i> ..	3	0	0	0	0	0	0
<i>Cassia fistula</i> ..	21	0	0	0	0	0	0
<i>Cassia marginata</i> ..	11	0	13	10	0	0	0
<i>Pterocarpus santalinus</i> ..	20	0	0	10	0	0	0
<i>Terminalia chebula</i> ..	21	16	0	40	16	0	11

* Test not done.

22. Concentrated sulphuric acid hastened and greatly improved the germination of *Cassia fistula* and *Cassia marginata* while fermenting improved that of *Acacia auriculiformis*, *Acacia leucophloea* and greatly improved that of *Terminalia chebula*.

23. *Seed—seasonal collection within the fruiting season.*—Tests were made of seed collected at fortnightly intervals throughout the fruiting seasons of seven species, *Acacia leucophloea*, *Artocarpus hirsuta*, *Cassia fistula*, *Cassia marginata*, *Mesua ferrea*, *Pterocarpus santalinus* and *Terminalia chebula*. In each case these seed collections covered a period of six weeks to two months but in no case were there any definite variations in germinative capacity throughout the fruiting season.

With each species and each date of collection four separate tests of 100 seeds each were done.

24. *Method of sowing—Hopea parviflora.*—*Hopea* seed was sown (i) with the wings vertical (in the position it falls through the air) (ii) on its side (in the position it normally lies on the ground) and covered with earth to a depth of $\frac{1}{8}$ " and (iii) on its side but well covered with $\frac{1}{2}$ " of soil. Germination was (i) eleven per cent (ii) twenty-three per cent, (iii) twenty-nine per cent. It therefore appears that *Hopea* seed should be sown on its side and well covered with earth to get the best results.

25. *Removal of pulp from seed—Santalum album.*—Seed of *Santalum album* from which the pulp had been removed before sowing gave consistently better results than seed with the pulp left on. In 30 tests of each, the average germinative capacities were—with pulp 10 per cent and without pulp 32 per cent. The pulp of this seed should therefore always be removed before sowing.

26. *Seed, locality test—Santalum album.*—Sandal seed was collected from both the spring and autumn crops from five localities, Coorg, Javadi, North Coimbatore division, North Salem division and the Nilgiris. This seed was tested by monthly sowings.

The autumn crop seed (collected in November) was found definitely better in germinative capacity than spring seed (collected in April). Both seed crops kept equally well in air-tight jars or in gunny bags for nine months but after this very quickly lost their vitality.

27. *Seed storage.*—Routine storage tests were made with 14 species with different methods of storage. Results showing the lengths of time that seed of the different species remains fertile are given in the table in paragraph 236, in which previous years' results are included. It should be noted that the table gives indications of the probable longevity of the seed but many more tests are necessary before reliable results can be obtained.

28. *Seed weightings.*—Routine seed weightings were carried out. The results are given in paragraph 237 in the form given in the "Note on the weight of seeds" (Revised) by S. H. Howard (Forest Bulletin No. 41—1928).

29. *Sorting seed according to size—Teak.*—Previous years' experiments were repeated both for germination and planting out tests and results are confirmed.

Seed was selected in the following four groups, (A) district random sample, (B) selected biggest seed, (C) selected medium seed, (D) selected smallest seed.

Results were as follows:—

Locality.	Year.	Average germination percentage of 1,000 seed in 10 test of 100 each.			
		District sample.	Selected biggest.	Selected medium.	Selected smallest.
Dhoni Experimental— Garden Experiment No. 94	1935	44	61	66	44
Topslip Experimental— Garden Experiment No. 109	1935	63	59	61	57
Begur Experimental— Garden Experiment No. 46	1935	46	69	39	13
Average of 1935 experiments		53	63	55	38
Do. 1934 do.		44	49	49	30
Do. 1933 do.		41	36	..	24
Average of 1933, 1934 and 1935 experiments		46	49	52	31

30. Planting out tests in three centres in 1934 were remeasured at the end of the second year and still showed no appreciable difference in survival percentage or significant difference in mean height growth.

Thus the sorting out and rejection of teak seed on account of size appears to be an unjustified expense.

(For full experimental data see paragraph 238.)

31. *Size, age, and condition of seed bearers—Teak.*—Seed was collected separately from large overmature trees (13' to 15' girth) middle sized trees approaching maturity (4½' to 6' girth) and small immature trees below 3' girth. This was done at three centres and the seed was collected from ten trees of each class at each centre.

Each test of each class at each centre consisted of five sets of 100 seeds. Germination results were as follows:—

Locality.	Germination percentage of seed from		
	Overmature.	Mature.	Undermature.
Dhoni	31	45	36
Topslip	38	37	28
Begur	37	24	32
Average	35	35	32

Evidence is still insufficient but the above confirms the strong indication that so far as germination is concerned seed from both overmature and undermature teak trees is just as good as that from mature trees provided of course that the tree is old enough to produce fertile seed.

32. *Dalbergia latifolia.*—Only one similar experiment was done with *Dalbergia latifolia* as in two centres the species did not seed.

Results were:—

Locality.	Germination percentage of seed collected from		
	Overmature. 25	Mature. 34	Undermature. 29
Dhoni	55	66	48
Topslip	63	80	87
Begur	55	56	57
Average	59	74	64

There was thus no appreciable difference between the three sets of tests.

33. *Pterocarpus marsupium.*—Similar tests in three centres with *Pterocarpus marsupium* showed a slight superiority of the mature seed bearer class as follows:—

Locality.	Germination percentage of seed collected from		
	Overmature.	Mature.	Undermature.
Dhoni	55	66	48
Topslip	63	80	87
Begur	55	56	57
Average	59	74	64

34. *Terminalia crenulata.*—Three sets of tests in three centres with *Terminalia crenulata* showed practically no difference between the three treatments as follows:—

Locality.	Germination percentage of seed collected from		
	Overmature.	Mature.	Undermature.
Dhoni	44	14	12
Topslip	7	13	27
Begur	23	30	32
Average	25	19	24

Seed origin.

35. *All-India teak seed origin plots.*—We have now two well established long term plots (Experimental plot 129 Nilambur division and Experimental plot 59, South Coimbatore division) each two years old. The Nilambur plot has six origins, Nilambur, Anamalais, Travancore, South Bombay, South Burma and North Burma and consists of 10.2 acres in 24 randomised blocks each block containing approximately 520 plants at 6' x 6' espacement and there are four blocks to each origin. All origins were nearly 100 per cent at the end of the second year and varied in mean height from 13.41' to 15.17'.

The South Coimbatore plot has four origins, Nilambur, Anamalais, Mysore and South Burma and consists of 4.0 acres in 16 randomised blocks, four per origin. All origins were roughly 90 per cent at the end of the second year and the mean height varied from 4.46' to 7.80'. The order of origins in these plots in height growth is given below. These plots will be measured each year until the time of first thinning when permanent sample plots will be laid out in each origin.

In addition to these long-term plots there is a short-term plot Experimental plot 123 at Nilambur consisting of six origins and now three years old. It will be measured until the time of first thinning and then closed as its lay out is not suitable for long term measurements.

After establishing the above plots, plants were available, so a short-term garden experiment was carried out—Topslip Experimental Garden, Experiment No. 106 with four origins.

36. The following table shows the order of origins in mean height growth expressed as percentages of the best origin :—

Nilambur Experimental Plot No. 123.		Nilambur Experimental Plot No. 123.		South Coimbatore Experimental Plot No. 59.		Topslip Experimental Garden No. 106.	
Three years old.		Two years old.		Two years old.		One year old.	
Travancore	100	South Bombay	100	Mysore	100	Nilambur	100
Anamalais	97	South Burma	100	Anamalais	96	Mysore	91
Nilambur	95	Travancore	97	Nilambur	87	Anamalais	88
South Bombay	94	Anamalais	95	South Burma	57	South Burma	57
North Burma	92	Nilambur	92				
South Burma	87	North Burma	80				

The above table shows that there is comparatively little difference in mean height growth of the various origins with the exception of South Burma in both the South Coimbatore division plots.

Nilambur Experimental plot 129 suffered a severe defoliation by grasshoppers in June 1935 and a less serious defoliation by caterpillars in September 1935.

Periodical measurements of selected plants in each origin were taken weekly (for results vide paragraph 200).

(iv) NURSERY WORK.

37. *Effect of shade on germination, survival, and growth in nursery beds.*—Previous years' experiments were repeated at Emmanur Experimental Garden with 19 species. Considering seedling survival and height growth the species showed the following preferences :—

(A) Preferring shade.

Anacardium occidentale.

Cassia fistula.

Cassia marginata.

Cassia siamea.

Dolichandrone crista (slight).

Holoptelia integrifolia.

Santalum album.

Terminalia chebula.

(B) Preferring open.

Acacia auriculiformis.

Acacia ferruginea.

Acacia leucophloea.

Acacia sundra.

Albizia amara.

Albizia lebbek.

Chloroxylon swietenia.

Prosopis juliflora.

Soyimida febrifuga.

(C) Indifferent.

Pithecolobium dulce.

Pterocarpus santalinus.

In most cases germination was much the same under shade and in the open and it is in seedling survival that most species have shown decided preferences.

(For full experimental data see paragraph 239.)

38. *Effect of sheltering and shading on germination and survival—evergreen species.*—Many of the evergreen species suffer in the nursery from the very heavy rain of the south-west monsoon and later from the hot sun after the monsoon. Experiments were therefore made to try and minimize the losses.

Experiments were done with four species in which three treatments were applied, (A) control-open, (B) hundred per cent top shade 2' above the beds, (C) fifty per cent top shade 2' above the bed. The results given below show that *Hopea parviflora* and *Cedrela toona* are indifferent to shade treatment, *Artocarpus hirsuta* benefits by shade but is indifferent to its extent and *Dysoxylum malabaricum* needs a little shade but will not stand too much.

Species.	Germination per cent.			Plant per cent.		
	Open.	100 per cent shade.	50 per cent shade.	Open.	100 per cent shade.	50 per cent shade.
<i>Artocarpus hirsuta</i> ..	46	68	71	36	60	65
<i>Hopea parviflora</i> ..	21	21	21	8	7	7
<i>Dysoxylum malabaricum</i> ..	7	4	9	5	3	9
<i>Cedrela toona</i> ..	27	28	22	13	13	12

39. The experiment was further extended for *Artocarpus hirsuta* which is very susceptible to heavy rain and high humidity by trying four kinds of sheltering. This consisted of (A) open control, (B) side sheltering to 1' 6" from the ground, (C) top sheltering 2' above the ground and (D) top and side sheltering (i.e., B and C combined). Results show that complete sheltering is most beneficial.

The actual figures obtained are :—

Artocarpus hirsuta (A) 23 per cent, (B) 36 per cent, (C) 44 per cent, (D) 49 per cent.

The experiment was started after germination was complete and the figures therefore show the effect of sheltering on survival only.

40. *Effect of repeatedly using the same nursery beds—Teak.*—

A set of experiments has been started in four centres to determine the effect of repeatedly using the same nursery beds for teak and also to see whether the fertility of the beds can be kept up by artificial manure or green manure crops.

In each experiment there are 16 standard beds which are allotted to four treatments on the basis of their outturn of stumps in the first year. The treatments are (A) beds sown each year—no manuring, (B) beds to be left fallow in alternate years, (C) a

green manure crop to be grown in the beds and dug in, in alternate years, (D) beds to be sown each year but manured with wood ash and leaf mould.

In the Nilambur experiment the average outturn of stumps per standard 40' x 4' bed sown with 40 lb. of seed was 1,353 usable stumps of 0.3" to 0.8" diameter and 2,675 unusable stumps below 0.3" diameter.

41. *Nursery methods for the production of teak stumps.*—The work of the last two years (reported in last year's annual report paragraphs 36 to 40) compared (A) dense sowing of about 80 lb. of seed per 40' x 4' nursery bed, (B) transplanting very small seedlings at 4" x 4", (C) notching germinating seed at 4" x 4" and (D) sowing soaked seed at 3" x 1½" (about 15 lb. of seed per 40' x 4' bed). The results of this work showed that dense sowing gave much the greater number of usable stumps (over 0.3" diameter) but was wasteful of seed. The next best treatment was sowing seed at 3" x 1½", i.e., a very light sowing but this tended to give poorly stocked beds although it gave the greatest economy of seed.

42. During this year three experiments were done at Dhoni, Topslip, and Begur and four treatments used:

(A) Sowing seed at the rate of 60 lb. per 40' x 4' bed.

(B) Sowing seed at 60 lb. per standard bed and pricking out seedlings into (E) beds at 4" x 4" leaving the original (B) beds spaced 3" x 3".

(C) Sowing seed at 40 lb. per standard bed.

(D) Sowing seed at 20 lb. per bed.

Each treatment consisted of four sub-beds 10' x 4' the arrangement being randomized. In mid April 1936 the outturn of stumps per treatment was enumerated as (i) unusable stumps under 0.3" diameter and (ii) usable stumps over 0.3" diameter.

43. Results re as follows

Data for a standard 40' x 4' nursery bed.

Locality.	Number of usable stumps per treatment.				
	A.	B.	C.	D.	E.
Begur	2,051	1,173	1,553	1,293	5,001
Dhoni	1,112	728	928	1,051	12,586
Topslip	2,231	1,472	2,236	2,315	4,886
Average ..	1,816	1,124	1,573	1,553	7,491*
Average number of unusable stumps below 0.3" diameter	3,031	670	2,687	1,550	1,635 †

* In 8 standard beds or 936 per bed.

† In 8 standard beds or 204 per bed.

Average diameter of stumps per treatment (in inches).

Locality.	A.	B.	C.	D.	E.
Begur	0.50	0.46	0.49	0.49	0.44
Dhoni	0.44	0.48	0.42	0.44	0.46
Topslip	0.38	0.39	0.38	0.3	0.39
Average ..	0.44	0.44	0.43	0.44	0.43

Thus (1) the average diameter of usable stumps produced was practically the same with all treatments.

(2) In treatments A, C and D (sowing of 60, 40 and 20 lb. of seed per bed) the average number of usable stumps produced was greatest for A but not very different from C and D. The quantity of seed used in A and C was out of all proportion to the number of good stumps produced.

(3) Treatment B in which after dense sowing, seedlings were pricked out into E beds showed the poorest outturn in the original beds. A large number of seedlings were pricked up into eight beds in each experiment. Although these E beds produced a fair number of seedlings of the right size they were in general badly grown with bushy root systems and some 50 per cent were not fit to be made into stumps on this account. Further the cost of the extra beds and the labour of pricking out was great and was not justified by the results.

The indication is, therefore that the best procedure is to sow evenly about 20 to 30 lb. of seed per standard bed and do no pricking out of seedlings at all. This is most economical in both cost and quantity of seed.

This one bed sown with 20 lb. of seed produces enough good stumps of usable size to plant 1 acre at 6' x 6'. The plants that are too small in the first year can be left to the second year and there is also a certain amount of seed that has lain dormant in the first year that will germinate in the second year.

Begur Experimental Garden—Experiment No. 36				
Dhoni	Do.	do.	do.	89
Topslip	Do.	do.	do.	108

44. *District work.*—Work on the effect of diameter of stumps on early growth shows that the best results are obtained with stumps of 0.4 to 0.8 inches diameter. Stumps of 0.3 to 0.4 inches diameter give fair results but are decidedly not in the best class.

In order to find out what proportion of the stumps used by the districts were in this best range of diameter class, five of the main teak districts were asked to record the outturn of stumps from their nursery beds. Of these five districts, two replied that their plants were small and being kept for the second year.

The data given by the other three districts are as follows:—

Data for a standard nursery bed 40' x 4' — 1 year old.

District.	Quantity of seed sown. lb.	Number of stumps less than 0.4" diameter.	Number of stumps 0.4"/0.8" diameter.	Number of stumps over 0.8" diameter.
Nilambur	43	1,525	1,262	65
South Mangalore	17	3,218	1,300	..
Wynaad	25	870	810	..

Thus of the stumps produced only 38 per cent were in the 0.4"/0.8" diameter class. It must be remembered however that the balance 62 per cent includes the 0.3" to 0.4" diameter-class which are usable if sufficient stumps of the bigger class are not

available, and also those stumps which are rejected on account of bad growth form, etc. In general practice, the number of these stumps rejected from district planting are small. The above figures are data from 3 or 4 standard beds per district.

45. In addition to the above, Wynaad division, gave data from three, two-year old beds which averaged are as follows :—

Age of bed.	Quantity of seed sown.	Number of stumps less than 0.4" diameter.	Number of stumps 0.4" to 0.8" diameter.	Number of stumps over 0.8" diameter.
	lb.			
2-year old	25	234	814	28
1-year old	25	870	810	..

These figures show that keeping the bed intact till the second year has not produced appreciably more stumps of the best size, the weaklings having merely died out. Had the bigger stumps been used in the first year and the remainder left for the second year the total outturn would probably have been greatly increased.

(v) ARTIFICIAL REGENERATION.

(a) Mixed deciduous timber forests.

46. *Development of artificial regeneration in gaps.*—Gap regeneration in this type of forest is being fairly extensively practised. The idea underlying this method of regeneration is that such gaps can be left to themselves after they have been regenerated and intensively tended for two years. Whether this is really the case is not known and in consequence during the year two experiments (Experimental plot 64, South Coimbatore division and Experimental plot 28, Wynaad division) have been started in which 10 to 15 typical gaps of 1933, regenerated and tended by the districts have been taken over and enumerated. No tending at all will be done and their development and ultimate fate will be observed.

Comparison of direct sowing, entire transplanting and stump-planting.

47. *Teak.*—No experiments were done with teak during the year as it was considered that the superiority of stump-planting over direct sowing and entire transplanting as a method of regenerating this species had been sufficiently well-demonstrated during the last five years.

48. *Dalbergia latifolia.*—Four experiments in four localities were done during the year with rosewood and confirmed previous years' results that stump-planting is the best of the three methods of regeneration for this species. Owing to the failure of rains differences were not so marked as usual and in one case (at Top-slip) transplanting did better than stump-planting.

The averaged results of these four experiments are given below and in addition for comparison the results of the previous two years are also shown.

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1935	54	63	68	7.7	8.3	10.2	Four experiments at 4 centres averaged.
1934	53	58	89	6.8	6.2	15.6	Three experiments at 4 centres averaged.
1933	77	68	97	11.2	7.5	15.5	Three experiments at 4 centres averaged.
Average	63	63	85	8.2	7.3	13.8	Average of 10 experiments over 3 years 4 centres.

(For full experimental data see paragraph 240.)

49. *Pterocarpus marsupium.*—Four experiments done in four localities during the year again confirmed the results of previous year's work, that of the three methods tried stump-planting is easily the most successful method of regenerating *Pterocarpus marsupium*.

The averaged results of these four experiments are given below together with the results of the previous two years for comparison.

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1935	39	65	79	7.7	5.8	10.3	Four results at 4 centres averaged.
1934	68	82	90	10.1	7.3	16.2	Three results at 3 centres averaged.
1933	36	82	79	14.2	10.9	19.5	Three results at 3 centres averaged.
Average	71	80	83	10.7	8.0	15.3	Average of 10 experiments over 3 years at 4 centres.

(For full experimental data see paragraph 241.)

50. *Pterocarpus dalbergioides*—(Andaman Padauk).—An experiment with this species was done at Kannoth. Sowing was a complete failure and stump-planting very poor indeed while transplanting gave very fair results as is seen from the table below.

Survival percentage.			Mean height in inches.		
Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
..	59	2	..	14.0	6.5

(For full experimental data see paragraph 242.)

51. *Terminalia crenulata.*—Four experiments with *Terminalia crenulata* were done at four centres. Three of these experiments confirmed previous year's results that stump-planting is the best

method for the species and in one (at Topslip as with *Dalbergia latifolia*) transplanting showed the best results.

The average results of these four experiments are shown below together with the results of the previous two years for comparison.

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1935	35	64	50	13.8	13.8	22.3	Four results at 4 centres averaged.
1934	36	56	86	16.4	13.0	27.7	Three results at 3 centres averaged.
1933	65	86	75	20.7	20.5	29.7	Three results at 3 centres averaged.
Average ..	45	69	70	25.5	28.7	39.9	Average of 10 experiments at 4 centres over 3 years.

(For full experimental data see paragraph 243.)

52. *Xylia xylocarpa*.—Results at two centres again confirmed previous years indications that for *Xylia* direct sowing is the best of the three methods. The average results of the year's work are given below together with the results of the previous two years for comparison.

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1935	81	50	14	6.0	4.1	2.4	Two results at 2 centres averaged.
1934	72	16	53	6.6	4.2	4.1	Three results at 3 centres averaged.
1933	78	69	89	7.0	4.2	4.8	Do.
Average ..	77	45	52	6.5	4.2	3.8	Average of 8 experiments at 3 centres over 3 years.

(For full experimental data see paragraph 244.)

53. *Artocarpus hirsuta*.—An experiment was done with this species at Kannoth after clear felling and burning mixed deciduous forest. Results were good and confirm the previous year's indication that stump planting is the best method of regenerating the species.

Results are given below together with those of 1934 for comparison.

Year.	Average survival percentage.			Mean height growth in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
1935	54	26	82	5.6	6.5	6.4
1934	12	2	33	11.2	12.0	14.9
Average ..	33	14	58	8.4	9.3	10.6

(For full experimental data see paragraph 245.)

54. *Swietenia macrophylla*.—As previous year's work had shown that this species only stumps very poorly, this year's work was confined to comparing direct sowing with transplanting of various sizes of transplants.

Four experiments were done during the year and in addition an experiment of the previous year was remeasured.

Three of the four experiments showed transplanting definitely superior to dibbling of seed, while in one experiment (at Topslip) the latter method gave the best results. It must be noted however that owing to unfavourable weather conditions results at Topslip this year are generally abnormal.

Comparing sowing and transplanting average results are only given for survival percentage as the height growth of transplants largely depends on their initial size.

Year.	Average survival percentage.			Remarks.
	Sowing.	Transplanting.	Stump planting.	
1935	49	60	Not done.	Four experiments at 4 centres averaged.
1934	38	63	8	Two experiments at 2 centres averaged.
Average ..	44	62	8	Average of 6 experiments at 4 centres over 2 years.

55. Comparing the results of using different sizes of transplants it is seen that in the first year small transplants up to about 6" high give a very fair survival percentage and their growth shows that they feel the shock of transplanting far less than the larger sizes. This is also seen by the measurements taken at the end of the second year. It is to be noted that the larger transplants appear to be more susceptible to borer attack and that this is particularly so under evergreen cover (vide paragraph 163).

Averaged results are—

Initial height (in inches).	Height after one year (in inches).	Survival percentage.
2 to 5	12.5	70
9	11.2	39
15	18.6	89
21	24.3	98
33	29.8	91
Initial height in inches.	Height after two years.	Survival percentage.
9	54.4	50
18	52.9	54
30	64.0	50

(For full experimental data see paragraph 243.)

56. *Pre-monsoon stump-planting—General*.—1935 was the second abnormal year having a prolonged hot weather and failure of early showers. Results this year are therefore a confirmation of the indications of the risks likely to be run in pre-monsoon stump-planting.

In general, the results have substantially confirmed those of previous years and have shown that pre-monsoon stump planting succeeds even in abnormally difficult weather conditions. The following table shows the general result of this year's experiments.

Species.	Best date of stump-planting.	Average survival percentage.	Average mean height growth in inches.	Survival per cent best date/Survival per cent 1st June.	Mean height best date/ Mean height 1st June.
Teak	15th April ..	73	19.9	1.1	1.9
Dalbergia latifolia ..	Early May ..	58	10.8	1.3	1.4
Pterocarpus marsupium. .	April ..	63	11.8	1.2	1.6
Terminalia crenulata ..	15th April to 15th May.	67	20.5	1.0	1.2

(For weather conditions see rainfall statement in paragraph 234.)

It should be noted that all experiments at Kannothe were done in a ponam crop of hill paddy.

57. *Teak*.—Five experiments were done at five centres. Abbreviated data are as follows:—

Percentage survivals after one season.

Experimental garden.	Experiment number.	Year of formation.	1st April 1935.	15th April 1935.	1st May 1935.	15th May 1935.	1st June 1935.
Dhoni	88	1935	81	93	90	96	74
Topslip	107	"	55	58	58	29	39
Walayar	3	"	22	40	29	32	58
Begur	27	"	86	89	73	81	68
Kannothe	9	"	41	85	84	85	81
Average ..			57	73	66	65	64

Mean height growth after one season (in inches).

Experimental garden.	Experiment number.	Year of formation.	1st April 1935.	15th April 1935.	1st May 1935.	15th May 1935.	1st June 1935.
Dhoni	88	1935	24.2	27.5	19.4	16.8	13.0
Topslip	107	"	24.0	15.8	15.6	15.2	13.2
Walayar	3	"	14.6	14.9	14.0	13.7	10.7
Begur	27	"	32.8	31.8	16.8	18.2	11.1
Kannothe	9	"	11.7	9.4	8.7	9.4	4.7
Average ..			21.5	19.9	14.9	14.7	10.5

It is seen from the above tables that the best date of stump-planting was April 15th which gave an average survival percentage of 73 and an average mean height growth of 19.9" after the first growing season.

58. Previous years results are recapitulated:—

Year.	Number of experiments.	Best date.	Percentage of survivals.	Mean height growth in inches.	Proportion of height growth of best date to 1st June planting.	Rains.
1932	3	16th April.	100	43.3	2.0	Normal.
1933	3	1st April.	91	35.3	2.4	Do.
1934	5	16th April.	88	18.6	1.6	Abnormally dry.
1935	5	15th April.	73	19.9	1.9	Do.

Height growth in such a year was of course much smaller than in a year of normal rains but even so planting on April 15th gave a better percentage of survivals and a height growth 1.9 times that of normal early June planting.

59. As in the last year which was also abnormally dry with a late monsoon, the stumps sprouted much later than usual. The time of sprouting is seen from the following table. It is even later than occurred last year and at the time of normal monsoon planting (about 1st June) only 35 per cent of the stumps had sprouted

and yet the final survivals were 73 per cent and as already mentioned the height growth of these late sprouting stumps was nearly twice that of stumps planted fresh at the outbreak of the monsoon.

Date of observation.	Percentage of stumps sprouted in experiments at					Average in 1934 experiments
	Dhoni.	Topslip.	Walayar.	Begur.	Kannothe.	
25th April 1935 ..	12	..	3	8	..	2
1st May 1935 ..	31	..	3	56	..	15
16th May 1935 ..	40	..	3	79	25	27
1st June 1935 ..	53	1	3	81	52	35
25th June 1935 ..	80	6	10	81	82	46
16th July 1935 ..	93	38	15	88	88	62
1st August 1935 ..	93	57	35	91	89	73
Final survivals ..	93	56	40	89	85	73

60. This late sprouting of early planted stumps was not realized by all districts doing early planting although it was brought to notice in last year's annual report—paragraph 54. In some districts all stumps that had not sprouted were treated as casualties and replaced early in June and again in July. In many cases all the stumps eventually sprouted and excess plants had to be pulled out and the expense of the heavy casualty replacement that had been done was blamed on to early planting which was said to have failed! I would bring to notice that in replacing casualties at the outbreak of the monsoon in an early planted area stumps that are still green although without sprouts should not necessarily be treated as casualties. This was successfully done in several districts and the eventual casualty replacements that had to be done was very small even with early planting in an abnormally bad year.

61. The conclusions drawn from these experiments during the last five years are—

(1) Even in unusually dry hot seasons, stump planting as early as the middle of April in our main teak areas having a West coast type of climate gives a sufficiently good stocking (88 per cent and 73 per cent in bad years and 100 per cent and 91 per cent in normal years) and an immense gain in height growth as compared with normal monsoon planting early in June (60 per cent and 90 per cent increases in the bad years and 140 per cent and 100 per cent increases in normal years).

(2) Success is not dependant upon what is generally considered good planting weather.

(3) The great advantage of the increased height growth of the teak in its struggle with weeds or field crops more than outweighs any risk of poor stocking and this risk can be insured against cheaply by providing a reserve of plants for normal monsoon stumping if necessity arises. If the necessity does not arise these plants can be used in the following year and experiments have shown that their survival percentage and height growth are not impaired in the smallest degree.

(For full experimental data see paragraph 247.)

62. *Pre-monsoon stump-planting—Teak—District work.*—During the year, a number of districts did early planting in their regeneration areas. In the Ootacamund circle, results from 16 regeneration areas in three districts where planting was done partly in the first half but mostly in the second half of April 1935 showed an average survival percentage of 68 per cent in the original planting. The total of these 16 areas is approximately 100 acres.

The average results of small scale experiments in five similar areas (vide paragraph 57 above) was 70 per cent.

The above district work is thus a striking confirmation of experimental results. The closeness of the confirmation is all the more surprising as the figures given by the districts of the average size of stumps produced in their nurseries (vide paragraph 44) show that 62 per cent of district stumps are below the best range of diameter. In pre-monsoon experimental work only stumps of the best size are used, but in district work, the stumps used are on the average smaller as districts cannot afford to waste stumps and have to use even their smallest stumps provided they are well-shaped.

63. Experiments to find the best date of stump-planting teak in Upper Godavari division was done by that district in three ranges. Abridged results of the three experiments are—

Survival percentage of stumps planted on—

15th April 1935. 30th April 1935. 15th May 1935. 30th May 1935. 15th June 1935. 30th June 1935.

19 18 23 25 99 85

The monsoon rains in the district started on 3rd July and the experiments therefore show that teak is best stump-planted about a fortnight before the break of the monsoon.

64. A similar experiment in Kurnool East division was done with *Pterocarpus marsupium* as there was not sufficient stock of Teak plants available. Two sizes of stumps were used (from plants 12 inches to 15 inches and 8 inches to 10 inches high) and one-half of the area was fenced. Results in January 1936 showed early July as the best time for stump planting.

Survival percentage of stumps planted on—

	4th May 1935.	18th May 1935.	3rd June 1935.	18th June 1935.	5th July 1935.	18th July 1935.	3rd August 1935.	18th August 1935.
Big stumps	0	1	2	27	66	82	70	71
Small stumps	8	3	1	0	64	66	54	74

There was very little difference between the results from big and small stumps and also between the fenced and unfenced areas.

Experiments in Kurnool West division last year showed late June as the best time for stump-planting.

Many repetitions of these experiments are necessary to give reliable conclusions in these districts which are not at present covered by regular experiments and also where rainfall is somewhat uncertain in season.

65. *Pre-monsoon stump-planting of Dalbergia latifolia, Pterocarpus marsupium, Terminalia crenulata and Artocarpus hirsuta* gave the following results:—

Dalbergia latifolia.—Four experiments at four centres gave the following abbreviated results:—

Experimental garden.	Experiment number.	Percentage of survivals of stumps planted on				
		1st April 1935.	16th April 1935.	1st May 1935.	16th May 1935.	1st June 1935.
Dhoni ..	78	51	51	61	89	51
Topslip ..	93	0	31	3	12	29
Begur ..	38	65	44	66	60	6
Kannoth ..	10	44	54	90	80	92
Average ..	40	40	46	55	60	45

Mean height growth in inches after one season.

Dhoni	..	78	17.2	15.0	12.0	16.1	9.7
Topslip	..	93	0	6.1	5.0	5.8	5.0
Begur	..	38	9.5	9.9	7.6	8.3	4.8
Kannoth	..	10	16.8	13.8	16.4	14.4	11.4
Average		..	10.9	11.2	10.3	11.2	7.7

It is thus seen that considering both height growth, and survivals planting in early May has given the best results—an increase in survivals of 27 per cent and an increase in height growth of 40 per cent over normal early June stump-planting.

It is to be noted that this best date is slightly later than that obtained in previous year's experiments (April 16th) and is accounted for by the abnormal year but even planting on April 16th was considerably better than normal June planting in mean height growth (an increase of 46 per cent) and practically the same in survival percentage.

(For full experimental data see paragraph 248.)

66. *Pterocarpus marsupium.*—Four experiments at four centres gave the following abbreviated results:—

Experimental garden.	Experiment number.	Percentage of survivals of stumps planted on				
		1st April 1935.	15th April 1935.	1st May 1935.	15th May 1935.	1st June 1935.
Dhoni ..	81	38	58	79	82	68
Topslip ..	92	32	40	42	19	23
Begur ..	40	76	86	78	61	32
Kannoth ..	11	86	60	82	74	82
Average ..	58	58	61	70	59	52

Mean height growth in inches after one season.

Dhoni	81	20.4	21.2	14.4	12.1	10.4
Topslip	92	11.2	7.8	7.3	7.0	7.9
Begur	40	12.5	13.4	12.4	10.5	7.9
Kannoth	11	7.6	6.7	7.1	6.2	4.4
	Average	12.9	12.3	10.1	9.0	7.2

April 15th has given the best results when both height growth and survivals are considered but there is little difference between the results of the period 1st April to 1st May.

April 15th results show an increase of 18 per cent in survivals and 71 per cent in mean height growth over normal early June planting.

(For full experimental data see paragraph 249.)

67. *Terminalia crenulata*.—Two experiments at two centres have given the following abbreviated results:—

Experimental garden.	Experiment number.	Percentage of survivals of stumps planted on				
		1st April 1935.	15th April 1935.	1st May 1935.	15th May 1935.	1st June 1935.
Begur	39	44	56	62	78	61
Kannoth	12	62	48	92	64	72
	Average	53	52	77	71	68

Mean height growth in inches after one season.

Begur	39	24.4	25.7	25.0	26.7	23.6
Kannoth	12	14.8	16.2	15.4	14.3	10.0
	Average	19.6	21.0	20.2	20.5	16.8

Thus it is seen that there is very little difference in the results during the period April 15th–May 15th, but all are very superior to normal June planting showing an increase in mean height growth of 22 per cent. Again this best date is slightly later than that obtained in previous years.

(For full experimental data see paragraph 250.)

68. *Artocarpus hirsuta*.—Two experiments were done at two centres and gave the following abbreviated results:—

Experimental garden.	Experiment number.	Percentage of survivals of stumps planted on					
		1st April 1935.	15th April 1935.	1st May 1935.	15th May 1935.	1st June 1935.	15th June 1935.
Begur	41	8	8	18	18	14	86
Kannoth	13	8	8	42	58	20	70

Mean height in inches after one season.

Begur	41	3.5	3.5	4.0	4.6	3.1	3.7
Kannoth	13	3.5	3.5	5.6	6.4	5.8	4.7

NOTE.—The experiment at Begur was only started on 1st May 1935.

As is seen from the above tables early planting of this species is poor and taken in conjunction with previous year's results the indication is that planting should not be done until late May or early June. If planted earlier than this, although increased height growth is obtained, the danger of poor stocking is great.

(For experimental data see paragraph 251.)

69. *Stump-planting—Effect of diameter and age of stumps—General.*—(1) It has been found that measurement of collum diameter of stumps is not usually accurately done by the ordinary

district staff although it is within the powers of a trained research staff. In consequence, this measurement was given up in favour of the "fat diameter" or diameter at the thickest part. With most species it is not very different from the collum diameter and it is a measurement that the least intelligent of subordinates can make and understand.

(2) In most of the paragraphs on the effect of the diameter of stumps on resultant growth, abbreviated results are given and these are often averaged. As in all experiments all diameters were not used, it is of course, not accurate to do this averaging as some measurements will give undue weight to certain diameters. It has been done (omitting abnormal figures) to give a general idea of the trend of the results. For those who wish to go deeply into the figures, complete experimental data is given in Part II.

70. *Teak*.—Three experiments were done in three centres in continuation of the work of previous years. Considering both survival percentage and mean height growth, results show that stumps do best if within the diameter range of 0.4" to 0.8". Three-year old stumps have not done well but within the diameter range mentioned it does not appear to matter whether the stumps are one or two years old.

Abbreviated results are as follows:—

Locality.	Age of stumps.	Diameter of stumps in inches.						
		0.3/0.4	0.4/0.5	0.5/0.6	0.7/0.8	1.0/1.1	1.2/1.4	1.8/2.0
<i>Survival percentage after one season.</i>								
Dhoni	One year	..	86	77	96	..	..	..
	Two years	..	79	85	90	..	..	..
Topslip	One year	..	42	44	..	..	..	..
	Two years	..	59	75	..	..	..	..
Begur	One year	..	74	81	85	78	..	..
	Two years	..	..	..	83	80	82	..
	Three years	..	..	..	..	..	..	62
	Average	..	74	83	81	89	79	82

* Topslip figures are omitted in the average as abnormal and giving undue weight to lower diameters.

Mean height growth in inches after one season.

Dhoni	One year	..	30.5	23.6	29.7	..	..	..
	Two years	..	25.0	23.5	26.0	..	..	..
Topslip	One year	11.9	12.2	..	..	..	..	..
	Two years	..	8.5	8.9	..	..	..	..
Begur	One year	22.8	..	19.9	22.7	19.1	..	..
	Two years	..	..	..	19.2	19.2	16.6	..
	Three years	..	..	..	..	..	..	13.6
	Average	22.8	27.3	22.3	24.4	19.2	16.6	18.6

Topslip figures are omitted in the average as abnormal and giving too much weight to the smaller diameters.

(For full experimental data see paragraph 252.)

71. *Dalbergia latifolia*.—Experiments were done at Begur, Dhoni and Topslip but the experiment at Topslip gave too few survivals to be of any use. Results at the first two centres show

that the best stumps of this species are those of 0.2" to 0.6" diameter and within this range there is practically no difference between one year and two year old stumps.

Abbreviated results are as follows :—

Locality.	Age of stumps.	Diameter of stumps in inches.						
		0.0/0.1	0.1/0.2	0.2/0.3	0.3/0.4	0.4/0.5	0.5/0.6	0.6/0.7
<i>Survival percentage after one season.</i>								
Begur	One year	86	92	..	..	..	..	..
	Two years	..	98	96	94	92	82	52
Dhoni	One year	69	86	81	..	..	..	..
	Two years	67	87	87	..	..	..	..
	Average	74	91	88	94	92	82	52
<i>Mean height growth in inches after one season.</i>								
Begur	One year	6.1	9.2	..	..	..	..	..
	Two years	..	9.0	11.2	12.3	12.7	12.2	10.9
Dhoni	One year	10.3	12.2	11.7	..	..	..	..
	Two years	10.1	12.7	14.2	..	..	..	..
	Average	8.8	10.8	12.4	12.3	12.7	12.2	10.9

(For full experimental data see paragraph 253.)

72. *Pterocarpus marsupium*.—Three experiments were done at three centres. Results show that stumps from 0.3" to 0.8" diameter do best and that within this range it does not matter whether the stump is one year or two years old. We do not appear to have reached the upper limit in size and there is no reason to suppose that stumps bigger than 0.8" diameter will not do well.

Abbreviated results are as follows :—

Locality.	Age of stumps.	Diameter of stumps in inches.						
		0.1/0.2	0.2/0.3	0.3/0.4	0.4/0.5	0.5/0.6	0.6/0.7	0.7/0.8
Survival percentage after one season.								
Begur	One year	56	80	84	..	86	..	..
	Two years	..	..	96	..	96	94	90
Dhoni	One year	..	..	91	96	97	..	..
	Two years	..	..	80	92	96	..	..
Topslip	One year	30	54	60	..	..	..	..
	Two years	..	14	32	..	..	..	..
	Average	56	80	88	94	94	94	90
Mean height growth in inches after one season.								
Begur	One year	6.4	10.1	12.1	..	15.3	..	..
	Two years	..	..	10.2	..	13.4	14.5	13.8
Dhoni	One year	..	..	19.4	18.7	21.7	..	..
	Two years	..	..	16.4	18.6	21.3	..	..
Topslip	One year	7.4	9.5	10.2	..	..	..	..
	Two years	..	8.1	9.1	..	..	..	..
	Average	6.9	9.2	12.9	18.7	17.9	14.5	13.8

* Topslip figures are omitted in the average.

(For full experimental data see paragraph 254.)

73. *Terminalia crenulata*.—Results with this species showed that stumps from 0.4" to 0.8" diameter do best and within this range there is little difference between one year and two years old stumps.

Smaller and larger diameters than this range gave poorer results either in survival percentage or in mean height growth or in both.

Abbreviated results are as follows :—

Locality.	Age of stumps.	Diameter of stumps in inches.						
		0.3/0.4	0.4/0.5	0.5/0.6	0.6/0.7	0.7/0.8	1.0/1.1	1.2/1.4
<i>Survival percentage after one season.</i>								
Begur	One year	92	..	98	..	86	30	..
	Two years	..	..	99	..	80	56	38
Dhoni	One year	..	51	47	60	..	..	..
	Two years	..	36	60	69	..	..	..
Topslips	One year	2	10	16	..	..	..	..
	Two years	2	4	23	..	..	..	..
<i>Mean height growth in inches after one season.</i>								
Begur	One year	23.7	..	24.3	..	25.0	19.2	..
	Two years	..	..	19.8	..	19.0	14.8	12.5
Dhoni	One year	..	32.3	31.8	31.1	..	..	..
	Two years	..	29.7	27.9	28.4	..	..	..
Topslip	One year	15.0	21.6	16.1	..	..	..	..
	Two years	17.0	28.5	20.2	..	..	..	..
	Average	18.6	28.0	23.9	29.8	22.0	17.0	12.5

(For full experimental data see paragraph 255.)

74. *Artocarpus hirsuta*.—Stumps one and two years old from 0.1" to 0.6" diameter were experimented with. Results indicate that within this range the older and bigger the stumps the better are the results. The best diameter is probably above this range.

(For full experimental data see paragraph 256.)

75. *Stump-planting—Effect of length of root—Teak*.—Three experiments were done at three centres in repetition of the work of the past few years. The experiments were with two diameters of stumps, 0.3" to 0.4" and 0.7" to 0.8" and root lengths of 4", 6", 8" and 10" for each of the two diameter classes. The present normal stump root length of 8 inches was taken as control.

This year's results again confirm previous year's work that there is no appreciable difference in survival percentage and no significant difference in mean height growth between the different root lengths. In this year's experiments also there were slightly better survivals with the bigger diameter class of stumps but no appreciable difference in mean height growth.

This is best seen from the averaged results of the three experiments :—

Diameter of stumps.	4" root.		6" root.		8" root.		10" root.	
	Survival per centage.	Mean height.	Survival per centage.	Mean height.	Survival per centage.	Mean height.	Survival per centage.	Mean height.
0.3" to 0.4" diameter	61	19.0"	69	20.5"	60	17.2"	62	19.1"
0.7" to 0.8" diameter	62	17.9"	78	19.6"	81	20.9"	87	20.1"

(For full experimental data see paragraph 257.)

76. *Stump-planting—Effect of coolie variation—Teak*.—The experiment reported in paragraph 77 of last year's Annual Report was repeated at Nilambur. The treatments used were (A) stumps tightly planted by expert district planting coolies, (b) stumps intentionally loosely planted (by the research ranger), and (c) stumps nipped tightly round the top with the base left loose in the crowbar hole (by the research forester).

The three treatments were done twice, on 9th April 1935 in dry soil in dry weather and on 17th June 1935 in wet soil and in wet weather.

Measurements on 31st December 1935 at the end of the first growing season showed that for each of the two planting dates, there was practically no difference in survival percentage and no significant difference in mean height growth between the three treatments.

(For full experimental data see paragraph 258.)

77. In this experiment (although not its main object) a comparison of treatments (A) for the two dates gives an indication of the risks of extreme early planting at Nilambur in an abnormally poor year for pre-monsoon rains. It should be noted however that 9th April 1935, the date of early planting, is at least one week earlier than our experiments indicate as the best date of early planting in any centre.

These results are—

Date of planting.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
9th April 1935	61	26.40±1.86	+ 5.50±2.17	S
17th June 1935	94	20.90±1.12	Control.	..

Thus although the survival percentage of the early planted stumps is not nearly as good as that of the late planted stumps yet their mean height growth is significantly superior to the extent of 26 per cent.

As already noted above this is an indication of the extreme risks run in early planting.

78. *Stump-planting—Storage of stumps—Teak.*—In each of three centres, two experiments on the storage of teak stumps were done. In all these experiments teak plants were dug up in the nursery at intervals of five days; made into stumps, tied into bundles and stored in well-ventilated rooms. The period of storage ranged from 0 to 35 days. In one set of experiments the stumps were dug up before the plants had sprouted in the nursery and were planted on 10th April 1935 and in the other set the plants were dug up after they had sprouted and were planted on 5th May 1935.

The stumps dug up before sprouting took place stored well for 15 days and then very rapidly deteriorated, while those dug up after sprouting, deteriorated by 50 per cent in 15 days and by 75 per cent in 30 days. There was practically no difference at all in the resulting height growth of all survivals of all periods of storage.

In 1933 which was a good year climatically, stumps kept for four weeks, in 1934 (a poor year) for three weeks, while in 1935 (an abnormally poor year) they kept for two weeks and still gave reasonable survivals. This indicates that even under exceptionally adverse weather conditions they will keep long enough to be sent from any one part of the Presidency to any other without fear of serious deterioration.

(For full experimental data see paragraph 259.)

79. *Stump-planting—Transport of stumps—Teak.*—In 1934 teak stumps were sent from Nilambur to the following districts:—

Upper Godavari, Lower Godavari, Tinnevely, Wynaad, South Mangalore and North Mangalore.

The objects of this experiment were to find out (1) whether teak stumps would travel long distances without deterioration, and (2) whether teak stumps raised in one locality would thrive in a distant locality under very different climatic conditions. The stumps sent to North Mangalore division failed almost completely owing to a very abnormal hot weather, the local stumps put in with them as controls also failed. At the end of the second year in Wynaad, Lower Godavari and two of the three South Mangalore experiments the Nilambur stumps were significantly ahead of the local stumps in mean height growth to the extent of 26 per cent, 21 per cent, 84 per cent and 26 per cent, respectively, while in the Lower Godavari experiment local stumps were significantly better by 33 per cent and in one of the South Mangalore experiments local stumps were ahead by 6 per cent (not significant).

In the Tinnevely experiment local stumps were significantly ahead in mean height growth by 8 per cent at the end of the first year. Second year measurements have not yet been received.

There was no appreciable difference in percentage of survivals between treatments in any of the experiments.

The longest journey was to Upper Godavari where the stumps took a fortnight to travel, approximately 1,000 miles.

80. Thus teak stumps will travel long distances without deterioration and thrive in climates very different from where they were raised.

Abbreviated results at the end of the second year are:—

District.	Treatment.	Survivals per cent- age.	Mean height in feet.	Difference from control.	Signifi- cance.
Wynaad	Local stumps ..	92	6.56±0.22	Control.	
	Nilambur stumps.	99	8.27±0.16	+1.71±0.27	S.
Upper Godavari ..	Local stumps ..	99	5.95±0.19	Control.	
	Nilambur stumps.	97	4.47±0.17	-1.48±0.25	S.
Lower Godavari ..	Local stumps ..	94	7.45±0.09	Control.	
	Nilambur stumps.	96	8.98±0.14	+1.53±0.17	S.
South Mangalore Experiment 2.	Local stumps ..	93	10.51±0.28	Control.	
	Nilambur stumps.	84	9.91±0.28	-0.60±0.39	N.S.
South Mangalore Experiment 3.	Local stumps ..	85	1.95±0.10	Control.	
	Nilambur stumps.	90	3.55±0.15	+1.60±0.18	S.
South Mangalore Experiment 4.	Local stumps ..	79	6.47±0.53	Control.	
	Nilambur stumps.	89	8.16±0.49	+1.69±0.73	S.
Tinnevely	Local stumps ..	95	5.98±0.12	Control.	
	Nilambur stumps.	97	5.50±0.14	-0.48±0.17	S.

Note.—The results given for the Tinnevely experiment are those at the end of the first year.

81. *Stump-planting in swampy areas—Pterocarpus marsupium and Terminalia crenulata.*—An interesting experiment was done in Palghat division in the regeneration of old paddy plots which

Division.		Experiment number.	Area.	Year of casualty replacement.	Number of casualties replaced in the second year.	Percentage of original planting replaced.
	(1)	(2)	ACS. (3)	(4)	(5)	(6)
Palghat	..	135	2	1933	316	13
Do.	..	140	↑	1934	198	33
Do.	..	145	↑	1935	114	19
			↑	1935	110	18
			↑	1934	121	20
Coimbatore South	..	61	↑			
At end of second year of plantation.				At end of third year of plantation.		
Percentage casualties surviving.		Average height of replacements to average height of plantation.		Percentage casualties surviving.		Average height of replacements to average height of plantation.
(7)	(8)	(9)	(10)			
77	1/6	62	1/2			
48	1/6	26	1/2			
85	1/5	..	..			
85	1/7	..	..			
17	1/5	17	1/3			
At end of fourth year of plantation.						
Percentage casualties surviving.		Average height of replacements to average height of plantation.				
(11)	(12)					
50	1/2					
....						
....	In flat country.					
....	In hilly country.					
....						

	Crop.		Height growth.	
	First year.	Second year.	First year.	Second year.
A	Dhall ..	Dhall ..	116	93
B	Ragi ..	Sunn-hemp ..	74	84
C	Do. ..	Boga ..	75	89
D	Do. ..	No crop ..	83	93
E	Control ..	Sunn-hemp ..	93	92
F	Do. ..	Boga ..	92	103
G	Do. ..	Control ..	100	100

The general result of the experiment is that all the crops used cause a retardation in the growth of the teak, but of all the crops

used this retardation is greatest with a crop of ragi. It is a dense crop and causes intense competition with the teak.

(For full experimental data see paragraph 260.)

87. *Comparison of early and late stump-planting of teak with and without a ponam crop of ragi.*—Observation of Experimental Plot No. 18, Wynaad Division (reported in last year's Annual Report—paragraph 94), was continued to see whether the advantages obtained by early planting lasted in the second year. The plot had four treatments in the first year: (A) early planting with a ponam crop, (B) early planting without ponam crop, (C) late planting with a ponam crop and (D) late planting without a ponam crop.

The early planting was done on 21st April 1934 and the late planting on 23rd May 1934. Ragi was sown in A and C on 26th June 1934 and reaped in November 1934. Survivals were much better in the early planting than in the late planting. Results are best seen in the table given below in which the mean height growth is expressed in terms of treatment D:—

Treatments.		End of first year.	End of second year.
A.	Early planting (with ponam)	235	263
B.	Do. (without ponam)	224	248
C.	Late planting (with ponam)	108	93
D.	Do. (without ponam)	100	100

It is thus seen that the effects of the first year treatment are practically unchanged at the end of the second year although all plots received the same treatment in the second year. These results again clearly demonstrate the benefits of early planting.

(For full experimental data see paragraph 261.)

88. *Effect of planting distance on the height growth of the teak and on weeding costs.*—Experimental Plot No. 21, Wynaad, in which planting at 3' x 3' is compared with that at 6' x 6' was remeasured. It is now two years old. There is no appreciable difference in survival percentage but the 3' x 3' teak is significantly ahead in mean height growth to the extent of 14 per cent. Weeding costs in the 6' x 6' area is in the proportion of 1.7:1 to those in the 3' x 3' area.

Both sets of plants are now definitely above weed growth except for occasional plants and the indication is that the extra cost of planting at 3' x 3' is not offset by the saving effected on weeding by the closer planting. The effect on height growth up to two years is small. The third year will probably see a much greater difference.

(b) Evergreen rain forests.

89. All the artificial regeneration experiments done in evergreen rain forests with the exception of one (Experimental Plot No. 27, Wynaad—Raising of evergreens after clear-felling and burning with and without cover crops) have been planting under shade and are therefore reported in part (ix) of this chapter "Underplanting" below (paragraphs 153 to 168).

(c) Dry fuel forests.

90. Research in the problems of the artificial regeneration of dry fuel forests is being continued and during the year the Experimental Garden at Emmanur (Coimbatore North Division), has been extended and developed.

It was pointed out in last year's report (paragraph 98) that in the dry fuel areas, the rainfall is very variable both in quantity and season year by year and that in consequence all results and indications must be accepted with caution as they need many repetitions for confirmation.

This is again brought to notice this year. The rainfall was abnormal in that the South-West monsoon was late in starting and although light, its showers continued nearly up to the North-East monsoon, which is the main source of rain in these districts. In consequence there was practically no dry hot spell in August and September and the usual inter-monsoon casualties were few. A perusal of this year's results in comparison with those of last year will show many differences due to this climatic condition.

91. During the year there have been several criticisms of the smallness of research survivals and height growths compared with district work. I would like to bring to notice that in a research experiment, on sowing, a limited number of seed are sown on a particular date and there is no resowing and no individual attention given to plants, such as thinning out or soil-working by the forest guard as occurs in district "rabs."

The height given is the mean height, i.e., the average height of every plant that survives. In a district rab, seed is sown and resown, as the plants develop they are thinned out so that in the end only the best plants are left and it is the best of these that strikes the eye of an inspecting officer and gives him his idea of height growth.

92. Research into the problems of these dry fuel forests is still only in an initial stage and in general, detailed working of significance has not been considered necessary as at present the experiments are only intended to give us indications of the direction of further work. Further it is not for two or three years that plants can be considered established.

93. *District work.*—"Rab" regeneration work continues to be done on an increasing scale in the dry districts. During tours it has been very noticeable that while many districts are getting excellent results, in other districts results are poor, and this is generally due to the lack of experience (and also sometimes apathy) of the district staff, generally in districts which have sandal or timber work to do and regard their dry fuel forests as side lines.

In consequence, during the year a questionnaire was sent out and the following short note embodies what the districts have found to give the best results during the last three or four years. It is the result of experience (not backed by research) and is

intended to give those districts experiencing difficulty an idea of what is being done successfully elsewhere.

94. *Size of plot.*—It is general experience that small patch work is invariably lost in a few years. The best plots have been found to be in flat country 50' x 20', on medium to steep slopes 75' minimum length and 10' minimum width, the plots running along the contours. The number of plots per acre varies with local conditions such as the general stocking of the coupe and brushwood available. It is usually 2 to 5 per cent of the area.

95. *Burning.*—Brushwood, etc., heaped 4'-5' and beaten down to about 3 feet high. Burning to be done in the evening, against the wind, early in the year before the hazardous fire season starts (February or early March).

96. *Soil-working and preparation of the area.*—Immediately after the burn the area to be soil-worked about 6 inches deep and the ash thoroughly mixed with the soil. This avoids the ash being lost by wind or rain before sowing. Opinion differs as to whether the soil-working should be in strips about 2 feet to 3 feet apart or general over the whole plot. If done in lines, the line to run along the contour.

97. *Bunding.*—As soon as the soil preparation is done the plot has to be protected against the wash of pre-monsoon thunder showers. This is done by bunding slopes and depressions, etc., with either stone bunds or small branches pegged down. This at first sight appears to be a rather unnecessary operation but all districts that have tried it are convinced of its great utility and it must be remembered that many of the seeds of dry fuel species are small and light and owing to the uncertainty of rains often lie for months in the soil before germinating.

On gentle slopes earth bunds have been found quite effective.

98. *Seed collection.*—Most districts use local seed and it is collected from selected and marked mother trees of moderate size, good form and general health. Local seed should be used whenever possible except when the local strain of a species is not as good as elsewhere.

99. *Sowing.*—Nearly all districts consider direct sowing the best method to use for most species. Opinions differ as to the time of sowing but the general practice is to sow with the first showers of the south-west monsoon (May-June) and to go on resowing at reasonable intervals until a full stocking is obtained. This is because the rain is very variable in quantity and season. Many of the seedlings resulting from the south-west monsoon germination die off in the hot dry spell between the monsoons and full stocking is only usually obtained by the north-east monsoon (October-November). It is useless to resow after about October 15th as any seedlings that result usually die in the following hot weather.

The main object is to get a full stocking as soon as possible. Seed is cheap and easy to collect and for most species is plentiful.

100. *Method of sowing.*—Most districts use untreated seed. This is because treated seed although giving a much higher germination, owing to the uncertainty of rains, it often germinates at the wrong time and heavy casualties result.

Sowing is usually done in lines 2'-3' apart, the quantity of seed used depending on the species and local conditions. The seed is sown at a depth of about $\frac{1}{2}$ " because of wash.

101. *Tending.—First year.*—(1) *Bunds* must be watched, repaired and extended if necessary to prevent young seedlings being washed away.

(2) *Soil-working.*—About one month after germination soil-working starts and, if possible, is done just before and just after rain. It is done often and starts by being about 1"-2" deep and by the end of the north-east monsoon has got to about 3"-6" deep. In soil-working the soil must not be disturbed within 3" of a seedling and the deeper working is often 1' away. A final soil-working is done about February half way between the lines of plants and this is the deepest one.

(3) *Thinning out.*—The growing seedlings must have sufficient space and thinning out by pulling up excess seedlings and later by cutting them must be done. Otherwise many casualties occur during the hot weather due to the intense competition for soil moisture, etc. This operation is usually done from October-February.

102. *Tending.—Second year.*—If tending has been properly done in the first year little has to be done except thinning out. *Cassia siamea* is usually grown on the edges of plots to form a protecting surround against browsers and in consequence if excess plants are lopped at about 3' height the hedge is not broken and yet the best plants are given sufficient growing space.

Poorer plots may need 1 or 2 deep soil workings. Under no circumstances should any leaf litter be removed from the plot. (This is often done by the local Forest Guard as it makes the plot look neater!)

103. *Replacing casualties.*—All districts are agreed that attempts to replace casualties in the second year are a waste of time.

104. *Lay out of species in the plots.*—Browsing is the main damage the plots suffer from and general method that has been evolved is to raise a living non-browsed hedge (usually *Cassia siamea*) all round the plot. Inside the plot the other species are arranged in lines. As many of the more valuable species are very light foliaged, the lines usually alternate light foliaged species and heavy foliaged species for soil protection.

105. *General characteristics of species.*—(1) *Seldom browsed*—

Cassia siamea.

Cleistanthus collinus.

Pterospermum suberifolium.
Wrightia tinctoria.
Zizyphus jujuba.
Dolichandrone crista.
Dodonea viscosa.
Pongamia glabra.

(2) Generally browsed—

Pterocarpus marsupium.
Pterocarpus santalinus.
Albizzia amara.
Albizzia lebbek.
Azadirachta indica.
Dalbergia latifolia.
Hardwickia binata.
Tamarindus indica.
Anogeissus latifolia.
Chloroxylon swietenia.

(3) Suitable for stiff soils—

Pterocarpus marsupium.
Hardwickia binata.
Albizzia odoratissima.

(4) Suitable for hill slopes—

Pterocarpus santalinus.
Azadirachta indica.
Dolichandrone crista.

(5) Suitable to degraded areas with stunted *Acacia sundra*—

Acacia sundra.
Acacia leucophloea.
Azadirachta indica.
Zizyphus jujuba.
Albizzia lebbek.
Albizzia amara.
Dolichandrone crista.

(6) Examples of light foliated species—

Acacia sundra.
Acacia leucophloea.
Acacia ferruginea.
Azadirachta indica.
Zizyphus jujuba.
Albizzia lebbek.
Albizzia odoratissima.
Albizzia stipulata.
Pithecolobium dulce.

(7) Examples of heavy foliated species—

Dolichandrone crista.
Dolichandrone falcata.
Wrightia tinctoria.
Cleistanthus collinus.

106. Species and the percentage of districts that consider them successful in "rab" plots—

	PER CENT.
<i>Cassia siamea</i>	100
<i>Albizzia lebbek</i>	75
<i>Azadirachta indica</i>	
<i>Dolichandrone crista</i>	
<i>Acacia sundra</i>	60
<i>Albizzia odoratissima</i>	
<i>Pterocarpus santalinus</i>	45
<i>Pterocarpus marsupium</i>	
<i>Albizzia amara</i>	30
<i>Dalbergia latifolia</i>	
<i>Hardwickia binata</i>	
<i>Wrightia tinctoria</i>	
<i>Zizyphus jujuba</i>	
<i>Pithecolobium dulce</i>	
<i>Cassia fistula</i>	15
<i>Cassia marginata</i>	
<i>Acacia leucophloea</i>	
<i>Acacia ferruginea</i>	
<i>Albizzia stipulata</i>	
<i>Cleistanthus collinus</i>	
<i>Dolichandrone falcata</i>	
<i>Tamarindus indica</i>	

107. Height growth.—In general the height growth of *Cassia siamea* is about 5'-10' in two years and of most of the other species 2'-5' in two years.

108. Supervision and cost.—The districts that are producing the best results with their rab work agree very closely in their opinions of cost and supervision and think that a Forest Guard can look after 25,000-30,000 square feet of rab regeneration in addition to all his other duties.

The cost of rab work is 6 to 7 annas per 1,000 square feet of regeneration. This money is spent chiefly on the initial soil preparation and the final deep soil working which is done about February. Heaping of slash is done by the coupe contractor as part of his contract, and all other works are done by the Forest Guard in charge.

109. A certain amount of uncertainty has been experienced in deciding which is the best season for artificial regeneration operations in these dry fuel forests which have a little of both the south-west and north-east monsoons and in consequence many of the experiments done in Emmanur Experimental Garden during the year have had this point as one of their main objects.

110. Direct sowing in a burned over area—Best season.—Re-measurement of Experiment 1 (i) Emmanur Experimental Garden showed that the best season for direct sowing in 1931 was early October. The following species were experimented with, *Acacia*

sundra, *Albizzia amara*, *Anacardium occidentale*, *Cassia siamea*, *Acacia ferruginea*. Variations in mean height growth had largely evened out during the second year but the survival percentage still showed a definite indication of the best date.

(For full experimental data see paragraph 262.)

111. A repetition of the above experiment was made in 1935 with six species *Acacia auriculaformis*, *Acacia ferruginea*, *Acacia sundra*, *Albizzia amara*, *Anacardium occidentale* and *Cassia siamea* (Experiments 13 to 18, Emmanur Experimental Garden). Measurements on 20th January 1936 showed a very much higher survival percentage and mean height growth than was obtained last year. With nearly all the species tried the best date of sowing was found to be August 1st but several of the species showed a secondary best date in early October, though these results were not quite as good as the August sowings. The August best date is due to the abnormal monsoon mentioned in paragraph 5.

(For full experimental data see paragraph 263.)

112. *Direct sowing—Comparison of dry and watered beds.*—Experiment 1 (ii) Emmanur Experimental Garden supplementary to Experiment 1 (i) had as its object to see whether the best date of direct sowing was different when the beds were watered. Re-measurements of the survivals this year confirmed last year's indication that although the stocking in the beds sown in the south-west monsoon was greatly improved by watering, it was in general not as good as that obtained in beds sown in the north-east monsoon. Many of the inter-monsoon casualties were saved and of course a greatly increased height growth was obtained.

(For full experimental data see paragraph 264.)

113. This experiment was repeated in 1935 in Experiments 19–24 Emmanur Experimental Garden with six species and just as in experiments 13–18 the best date of sowing had moved forward, often being as early as 1st August. Most species also showed a secondary best date on 1st October. The abnormality of the rainfall has also shown an interesting result as the mean height of plants in the watered beds is only two per cent better than that of the dry beds. The species experimented with are *Acacia auriculaformis*, *Acacia ferruginea*, *Acacia sundra*, *Albizzia amara*, *Anacardium occidentale* and *Cassia siamea*.

(For full experimental data see paragraph 265.)

114. *Direct sowing—Comparison of (A) not burning but soil working, (B) not burning and no soil working, (C) burning and soil working and (D) burning and no soil working.*

(Note.—In the experiments described in this section the soil working is that done before sowing and is not soil working or soil "aeration" done after germination.)

In Experiment No. 5, Emmanur Experimental Garden of 1934 four treatments were applied in two of which the area was burned and the ash worked into the soil before sowing and in the remaining two, no burning was done. In each of these two pairs of

treatments in one the soil was worked 9" x 9" x 6" at each patch before sowing and in the other only enough soil working to sow the seed was done.

Re-measurement in January 1936 showed that the percentage survivals and mean height of all four species were much better in the two treatments which were burned than in the two unburned areas.

With regard to soil working, taking all four species together the percentage survivals in the area not soil worked was 60 per cent better than that in the area soil worked but the mean height growth was 40 per cent better when the soil had been worked before sowing.

The species concerned were *Acacia leucophloea*, *Albizzia amara*, *Cassia siamea* and *Tamarindus indica*.

(For full experimental data see paragraph 266.)

115. The experiment was repeated in 1935 (Emmanur Experimental Garden, Experiments 42–47) with six species. Measurements in January 1936 show that both in percentage of survivals and mean height growth the plants of all six species were much better in the burned areas than in the unburned areas.

With regard to soil working, taking all six species together the plants in the soil worked areas were 100 per cent better in survival per cent and 10 per cent better in mean height growth than the plants in the area not soil worked before sowing.

(For full experimental data see paragraph 267.)

116. Combining all the above results we have very definite indications that burning is essential and that soil working before sowing is decidedly beneficial.

117. *Direct sowing—Comparison of sowing untreated seed and germinating seed.*—Re-measurement of Experiment No. 6, Emmanur Experimental Garden in February 1936 described in paragraph 105 of last year's report still showed that there was very little difference in mean height growth in the plants resulting from the two treatments but that in the case of *Acacia ferruginea*, *Prosopis juliflora* and *Acacia sundra* the survival percentage of the germinating seed was definitely greater than that of the untreated seed.

In practice the difference in survival percentage can be overcome by sowing more seed per patch and as seed of these species is plentiful and cheap to collect it is doubtful whether the treatment is worth while.

(For full experimental data see paragraph 268.)

118. *Comparison of sowing, entire transplanting and stump-planting.*—Experiment 4, Emmanur Experimental Garden in which nine species were experimented with by the above three methods of regeneration was re-measured in January 1936. This re-measurement shows that stump-planting is not a suitable method for regenerating these species.

For *Albizzia amara*, *Cassia siamea*, *Acacia ferruginea* and *Tamarindus indica* direct sowing has given the best results in survival percentage and mean height growth while for *Acacia leucophloea*, *Azadirachta indica*, *Holoptelia integrifolia*, *Prosopis juliflora* and *Soymida febrifuga* transplanting has given the best results.

(For full experimental data see paragraph 269.)

119. The experiment was repeated in 1935 (Emmanur Experimental Garden Experiments 48 to 67) with 20 species. Results of sowings are very much better than last year owing to weather conditions which have already been mentioned. For all species except *Holoptelia integrifolia* sowing gave easily the best result. There were no survivals of stump-planting in any species and only a few survivals of transplanting with eight of the 20 species.

The species experimented with are:—

Acacia arabica.
Acacia auriculiformis.
Acacia ferruginea.
Acacia leucophloea.
Acacia planifrons.
Acacia sundra.
Albizzia amara.
Albizzia lebbek.
Anacardium occidentale.
Azadirachta indica.
Cassia marginata.
Cassia siamea.
Dolichandrone crispata.
Feronia elephantum.
Holoptelia integrifolia.
Pithecolobium dulce.
Prosopis juliflora.
Soymida febrifuga.
Tamarindus indica.
Wrightia tinctoria.

(For full experimental data see paragraph 270.)

120. Comparison of stump-planting and transplanting.—Experiments 26 and 31, Emmanur Experimental Garden had as their objects (a) to find the best season for stump planting, (b) to compare stump-planting and transplanting and (c) to compare transplanting at the commencement of the south-west and north-east monsoons. Six species were experimented with.

Results with both stump-planting and transplanting were very poor compared with those of direct sowing mentioned in paragraph 119 above. In general for all species tried stump-planting gave better results than transplanting. The best date of stump-planting was October 1st for *Acacia ferruginea*, *Albizzia lebbek*, *Cassia marginata* and *Cassia siamea* and August 1st for *Cloroxylon swietenia* and *Pterocarpus santalinus*.

For *Acacia ferruginea*, *Albizzia lebbek*, and *Pterocarpus santalinus* transplanting at the beginning of the north-east monsoon was better than that at the beginning of the south-west monsoon, *Chloroxylon swietenia* did best when transplanted in the south-west monsoon and *Cassia marginata* and *Cassia siamea* gave no results with transplanting at all.

The indications of this experiment taken in conjunction with the results of the experiments on direct sowing are that (1) sowing is better than transplanting or stump-planting and (2) if the latter two methods are used the beginning of the north-east monsoon is the best time to do them.

These results are somewhat different from those of last year (vide paragraphs 107 and 108, Annual Report for 1934-35) and need many repetitions to become conclusive.

(For full experimental data see paragraph 271.)

121. Stump planting—best date.—In previous years (and in this year also) stump-planting of one year old plants has met with very little success and it was thought that this was possibly due to using stumps which were not old enough. In experiments No. 31-41, Emmanur Experimental Garden ten species were experimented with and two year old stumps were planted on the 1st of each month from July to November. The best date proved to be October 1st but results were very poor indeed except for *Wrightia tinctoria* which gave 33 per cent survivals by February 1936.

This result confirms those of previous years that stump-planting is not a suitable method in dry fuel forests at all events for the many species tried so far.

(For full experimental data see paragraph 272.)

122. Direct sowing of *Santalum album* in the open and under bushes.—Last year's experiment was repeated and in Experiment 68, Emmanur Experimental Garden seed of *Santalum album* was sown with and without dhall and in the open and under bushes. The best results were obtained without dhall under bushes but only 8 per cent of the survivals look as though they will survive the rest of the hot weather.

123. *Santalum album*—stump planting.—As mentioned in paragraph 114 of last year's report in North Salem division a great deal of propagation of sandal is done by stump planting natural forest plants of known age.

This method has been so successful that it was thought that sending stumps from North Salem might solve the problem of districts that experience difficulty in establishing sandal propagation centres.

To test this supposition a consignment of 400 stumps was sent from Denkanikota to Emmanur Experimental Garden early in the south-west monsoon. The stumps were planted three days after digging up at Denkanikota and ten days after, half were watered,

half were not watered. They were planted with established hosts, others were planted at the same time as good hosts and again others were planted into previously sown dhall.

The result was that not a single stump sprouted.

The experiment was repeated during the north-east monsoon with exactly the same result.

124. Parallel with the repetition, two similar sets of stumps were planted at Denkanikota after being kept for varying times up to three days with a fair success as shown below:—

Stumps kept.	Percentage survivals.	
	I set.	II set.
Two hours	83 %	100 %
One day	95 %	78 %
Two days	100 %	55 %
Three days	70 %	72 %

The experiment is being repeated using longer periods of storage.

125. *Soil working in the first year.*—Experiments in recent years in our good teak areas have shown that soil working by forking (the mis-called soil "aeration") is of great expense and very doubtful utility. In the last few years in the development of "rab work" in dry fuel forests opinions have differed as to the merits of soil working in these dry areas. During the year seven experiments have been done to test its efficacy and below are given the preliminary indications of these experiments which are striking.

Two sets of experiments were done. In the first set, plants were raised on a very poor soil without a burn so that they would be small and need all possible efforts to make them survive the hot weather. In the second set plants were raised on an average soil, regeneration being preceded by a burn, so that the plants would be of reasonable size at the end of the north-east monsoon.

Soil working was done once a month from early December onwards. The operation was done in lines between the plants, care being taken that the soil within 3" of each plant was not disturbed. The first operation was a scratching of the soil to a depth of about 1" to 2" and each further soil working proceeded deeper and slightly farther away from the plant line until a depth of about 9" had been reached. (This is district practice in some of the districts producing the best "rabs"):

126. Results have been worked out up to the end of May and show that the differences in height growth produced in favour of soil working are appreciable (increases of 80 per cent and 20 per cent with 2" and 9" plants respectively) but only significant in four out of seven experiments. With regard to hot weather mortality the operation has produced no differences with the 9" plants. Survivals of this size were high and at the end of the hot weather varied from 70 to 90 per cent. The great benefit of the soil working however showed itself in the saving of hot weather mortality

f the small plants, the mortality with soil working being 14 per cent only while that without soil working was 35 per cent.

The experiments are being continued and extended and it must be remembered that the above are only preliminary indications of the first sets of experiments done in this subject and need many repetitions for confirmation.

Abbreviated results are given in the tables below:—

Emmanur Experimental Garden Experiments 3 (a), (b) and c) December 1935 to May 1936—(Plants initially 2" to 3" high).

Species.	Hot weather mortality.		Control.		Soil worked.	
	Control. (Per cent).	Soil worked. (Per cent).	Initial mean height in inches.	Mean height in May 1936 (in inches).	Initial mean height in inches.	Mean height in May 1936 (in inches).
Acacia ferruginea ..	39	11	3.05	4.14	3.09	3.72
Albizia amara ..	38	14	2.21	3.95	1.65	3.50
Cassia siamea ..	27	16	1.62	3.52	0.62	3.05
Average ..	36	14	2.96	3.87	1.79	3.42
Increase in mean height ..			0.91"		1.63"	

Emmanur Experimental Garden Experiments 78 to 81—(Plants initially about 9" high).

Species.	Hot weather mortality.		Control.		Soil worked.	
	Control. (Per cent).	Soil worked. (Per cent).	Initial mean height in inches.	Mean height in May 1936 (in inches).	Initial mean height in inches.	Mean height in May 1936 (in inches).
Acacia ferruginea ..	1	0	12.07	16.80	12.05	15.73
Anacardium occidentale.	4	1	5.83	8.03	6.55	10.69
Cassia siamea ..	5	3	8.19	16.38	7.9	17.64
Pithecolobium dulce ..	2	6	11.11	19.17	8.78	18.73
Average ..	3	3	9.30	15.10	8.84	15.70
Increase in mean height ..			5.80"		6.86"	

(vi) AFFORESTATION.

127. *Grassland catchment areas.*—Experiments to examine the possibility of re-afforesting some of the important catchment areas of the Nilgiris were continued. The indigenous sholas of these areas are rapidly disappearing, chiefly due to fire and grazing, and in many places have completely degenerated to grass land.

These grass land areas are very poor and very exposed and regeneration is difficult as we get heavy frosts, followed by a severe drought in the hot weather.

128. *Jacko's Nullah and Brooklands Experimental Gardens—1934 sowings.*—Work in these gardens in 1934 was confined to sowings. Of the nurse species tried Broom, (*Cytisus scoparius*), Gorse (*Ulex europaeus*), *Cassia tomentosa* and *Dodonea viscosa* showed promise of success. The use of gorse has however been given up owing to the possibility of its becoming a pest as it has done in some other countries. *Cassia tomentosa* and *Dodonea viscosa* are also rather frost tender but can be raised with protection.

Acacia melanoxylon was the only one of the tree species showing promise from sowings in 1934 which was a bad year for frost.

1935 sowings—Nurse species.—Broom, *Dodonea viscosa* and *Cassia tomentosa* have done quite well.

Tree species.—Seven species were tried, *Acacia melanoxylon*, *Acacia dealbata*, *Daphniphyllum glaucescens*, *Eugenia arnottiana*, *Hakea saligna*, *Callitris rhomboidea* and *Michelia nilagirica*. Enumeration in May 1936 showed the following survivals:—

	PER CENT.
<i>Acacia melanoxylon</i>	46
<i>Hakea saligna</i>	42
<i>Eugenia arnottiana</i>	32
<i>Acacia dealbata</i>	23
<i>Callitris rhomboidea</i>	11

Daphniphyllum seed does not usually germinate until the second year. Work this year has very definitely indicated the advantage obtained by digging up the soil and sifting it to remove all grass roots before sowing. Small patches about 10 to 20 feet square have been found to be much more successful than line or pit sowings.

1935 planting—Entire transplants—Nurse species.—Broom has given very nearly 100 per cent success with transplants.

Tree species.—Enumeration in May 1936 shows the following success:—

	PER CENT.
<i>Acacia dealbata</i>	46
<i>Acacia melanoxylon</i>	33
<i>Cupressus macrocarpa</i>	63
<i>Hakea saligna</i>	42
<i>Eugenia arnottiana</i>	47
<i>Callitris rhomboidea</i>	24

Stump-planting—Nurse species.—*Rubus moluccanus* and *Hypericum mysorense* have been successfully regenerated by stump-planting showing 44 per cent and 35 per cent survivals in May 1936 respectively.

Tree species.—Of tree species *Acacia melanoxylon* and *Mahonia leschenaultii* have been stumped successfully showing 35 per cent and 40 per cent survivals in May 1936 respectively.

1935 branch cuttings.—Branch cuttings were tried of many of the main shola species and common exotic species of the Nilgiris but of them all, only *Rubus lasiocarpus* and *Prinsepia utilis* show any prospect of success by this method.

129. Regeneration of tree species in *Gaultheria* patches.—In these grass lands, patches of *Gaultheria* often occur and in consequence regeneration was tried in these patches, hoping that they would provide a natural nurse and protection against frost and drought.

1934 sowings.—Three species were tried, *Ternstroemia japonica*, *Eugenia arnottiana*, and *Daphniphyllum glaucescens*. The first two of these species germinated well and showed promise but were killed out by the exceptional frosts which killed the *Gaultheria* as well. The *Daphniphyllum glaucescens* only germinated in the second year and now at the beginning of the third year shows 30 per cent success.

1935 sowings.—In 1935, three species were tried by sowing and of these, the *Daphniphyllum glaucescens* has not germinated yet and *Eugenia arnottiana* and *Acacia melanoxylon* showed 60 per cent and 17 per cent success respectively at the end of May 1936.

1935 planting—Entire transplants.—Transplanting in *Gaultheria* patches was done with nine species. Enumeration in May 1936 showed the following success:—

	PER CENT.
<i>Hakea saligna</i>	63
<i>Eugenia arnottiana</i>	50
<i>Neolitsa zeylanica</i>	50
<i>Ternstroemia japonica</i>	44
<i>Acacia melanoxylon</i>	25
<i>Acacia dealbata</i>	20
<i>Daphniphyllum glaucescens</i>	20
<i>Microtropis ovalifolia</i>	18

130. General.—(1) Of the work done so far, regeneration in patches of a natural nurse (*Gaultheria*) show the most promise and in such patches transplanting is more successful than sowing. It is probable also that even better results will be obtained by stump planting those species that can be regenerated by this method.

(2) In open grass land the greatest success has been obtained by removing the grass in small blocks and sifting the soil to remove the grass roots. In these patches transplanting and stump planting have been more successful than sowing and the indication is that a nurse species should be raised before the tree species.

(3) In wet places even in open grass land *Salix* species can be raised with ease from cuttings provided they are protected from browsing.

Swamp edges and stream banks—Willow planting.

131. *Salix caerulea* var *alba* (Cricket bat willow).—Last year, cuttings of the cricket bat willow were got out from England for experiments in the Nilgiris. After a journey under the most unfavourable conditions (vide last year's report, paragraph 120) they eventually arrived and were planted in four different places in several types of localities in early June. Within ten days of planting 87 per cent produced shoots. At the time of dropping their leaves and starting their winter rest period at the end of October, 40 per cent were alive and healthy. They put out their new leaves at the end of February.

In the middle of May 1936, after the start of premonsoon thunder showers and therefore the end of drought, 25 per cent are alive and healthy and have shoots 9" to 18" high. They have thus successfully withstood the very feeble south-west and north-east monsoons after they were planted, the frost of the winter, and the severe drought of this hot weather.

Present indications are that they are likely to thrive under Nilgiris conditions. They appear to need good drainage and plenty of moisture but no stagnation.

132. *Salix babylonica*.—Cuttings of a *Salix* used for basket making and alleged to be *Salix babylonica* (though not yet definitely identified) were planted in the Nilgiris at the end of October 1935. The maximum sprouting was 70 per cent and in the middle of May 1935, 65 per cent were alive and looking very healthy with shoots up to 3' long. This species looks particularly promising in the localities tried.

133. *Salix tetrasperma*.—Cuttings of this indigenous willow (which can also be used for basket making) were tried with a fair success. With this species no trees had been pollarded, and in consequence young switchy pollard shoots (which usually make the best cuttings) were not available and quite old branch cuttings had to be used. In spite of this, at the end of May 1936, 20 per cent were alive and healthy.

In May/June 1935 a consignment of cuttings of this willow was sent up to the Anamalais where a species suitable for basket making was required to be grown in the swamps in tea plantations at an elevation of approximately 5,000'. In May 1936 this consignment showed 75 per cent success, the plants looking well-established with shoots 1½' to 2' long.

134. *General*.—We have thus had a very fair success with *Salix* species. They must however be protected from browsing to which they are very tender. One of their possibilities is for growing along the bare banks of some of the Nilgiris fishing streams to encourage insect food for the fish which in many places is at present lacking. If pollarded they could also be used for

skat making as is done with a similar species in the Thames ley without in any way interfering with the grazing and watering of cattle.

(vii) TENDING, THINNING, CLEANING, ETC.

135. *Weeding practice—Teak plantations—First year*.—In continuation of the many garden and small scale experiments already done in first year teak plantation weeding practice, two large scale Experimental plots (134, Nilambur division and 146, Palghat) were started. These experiments are both arranged in large randomized blocks in the form of latin squares and each covers an area of approximately two acres.

In the Nilambur experiment measurements in February 1936 showed that there was no appreciable difference in percentage of survivals between the four treatments which were (A) clean scraping (B) scraping in 4' strips (C) hand pulling of weeds when possible and when not possible weed cutting (this is the control), (D) forking in 4' strips.

In mean height growth (A), (B) and (D) were all significantly better than the control (C). In this experiment also forking in 4' strips was significantly inferior to scraping in 4' strips.

The actual cost of weeding only were in the proportion.

Clean scraping : 4' forking : 4' scraping : 3.9 : 2.5 : 1.

The cost of the control weeding is not given as a misguided attempt to do a hand pulling of weeds when a weed cutting was indicated made a comparison with the costs of the other treatments impossible.

Detailed measurements are as follows:—

Treatment	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A. Clean scraping	97	24.10 ± 1.09	+ 4.50 ± 1.36	S.
B. 4' scraping	99	26.48 ± 1.09	+ 6.88 ± 1.36	S.
C. Hand pulling and weed cutting.	95	19.60 ± 0.82	Control.	
D. 4' forking	99	22.60 ± 0.89	+ 3.00 ± 1.21	S.

Comparison of (B) and (D)				
Treatment.	Mean height in inches.	Difference of means.	Significance.	
B. 4' scraping	26.48 ± 1.09	Control.		
D. 4' forking	22.60 ± 0.89	- 3.88 ± 1.41	S.	

136. In the Palghat Experiment 5 treatments were used (A) forking in 4' strips (B) scraping in 4' strips (C) clean scraping (D) hand pulling of weeds when possible and when not possible weed cutting (E) weed cutting control. Measurements in February 1936 showed no appreciable difference in percentage of survivals between treatments.

In mean height growth all treatments were significantly better than the control and clean scraping gave the best results of all. Forking in 4' strips was slightly (1 per cent) but not significantly better than scraping in 4' strips.

The actual costs of weeding only were in the proportion:—

A : B : C : D : E :: 3.9 : 2.2 : 3.6 : 2.2 : 1.

Detailed measurements are as follows:—

Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A. 4' forking	79	15.18 ± 0.60	+ 4.03 ± 0.78	S.
B. 4' scraping	75	15.00 ± 0.68	+ 3.85 ± 0.84	S.
C. Clean scraping	77	17.80 ± 0.89	+ 6.65 ± 1.02	S.
D. Hand pulling	75	14.86 ± 0.77	+ 3.71 ± 0.92	S.
E. Weed cut control	85	11.15 ± 0.50	Control.	

Comparison of (A) and (B).

Treatment.	Mean height in inches.	Difference of means.	Significance.
A. 4' forking	15.18 ± 0.60	+ 0.18 ± 0.91	N.S.
B. 4' scraping	15.00 ± 0.68	Control.	

137. The above two large scale experiments again clearly demonstrate that for two of our main teak areas the very slight increase (if any) in mean height growth obtained by forking as opposed to scraping as weeding methods in the first year of a teak plantation is in no way commensurate with the extra cost of forking. When all previous work is taken into consideration this result may be generalized for our main teak areas which have a west coast type of climate.

We do not know whether this result applies under exceptional conditions such as swampiness, etc., and such conditions will be the object of further experiment but in general where such conditions apply, the area is not really suited to teak in the first place.

In both the above experiments at the end of the first year the general average height of the plants in all treatments is poor 15" at Palghat and 24" at Nilambur compared with that obtained in a more propitious year climatically. In consequence they are both being continued through the second year, treatments will be applied in mid April and measurements taken in early July, and after monsoon about mid September, a final treatment applied followed by a final measurement in the following February when growth has stopped.

This further treatment will decide whether forking is more beneficial than scraping in the first hot weather after formation of the plantation.

138. Experimental Plot No. 60, South Coimbatore division was observed during the second year (although all plots were given the same weeding treatment) to see whether the differences at the end of the first year due to different weeding treatments were maintained. Measurements in January showed that both the scraped and forked treatments had improved their positions with regard to the weed cut control.

Detailed measurements are:—

Treatment.	Percentage survivals.	Mean height in feet.	Difference of means.	Significance.
A. 4' scraping	82	7.20 ± 0.26	+ 0.57 ± 0.38	N.S.
B. 4' forking	90	6.23 ± 0.24	+ 1.63 ± 0.37	S.
C. Weed cut control	85	6.63 ± 0.23	Control.	

In this experiment the forked area was significantly better than the scraped area in mean height growth at the end of two years to the extent of 14 per cent but it had cost approximately twice as much in weeding charges. This is also a large scale experiment covering two acres.

139. *Weeding practice—Teak plantation—Second year.*—Previous experiments have shown that in the second year also forking generally produces a slight but not significant increase in height growth of 5–10 per cent over scraping.

In Experimental Plot 133, Nilambur 4' scraping was compared with clean scraping as weeding methods in the second year of a teak plantation. At the beginning of the year the area to be clean scraped was 15 per cent and at the end of the year only 4 per cent poorer in mean height growth than the area scraped in 4' strips.

In this experiment the increase in mean height growth (and in cost also) due to clean scraping as opposed to strip scraping is almost the same as to be expected between strip forking and strip scraping. The indication is therefore that in the second year of a teak plantation no weeding method more costly than strip scraping is necessary. In this case the plantation was 5' high at the beginning of the second year and 14' high at the end of the year and it is probable that no weeding other than the cheapest (i.e., weed cutting) would have been really necessary.

140. It should be noted that these results on weeding practice showing that the small beneficial effect of forking is not economically justified have all been obtained in clear-felled areas in mixed deciduous forest of good quality with a light friable loamy soil and rainfall of 60 to 100 inches per annum. We do not know whether they apply to dry areas with a small rainfall and a prolonged hot weather. Experiments on soil working in dry fuel forests are in progress and preliminary results are given in paragraph 125.

141. *Effect of burning and cutting back a teak plantation in the first hot weather after formation.*—The experiments in this subject were repeated in Experimental Plot 24, Wynaad division and 63, Coimbatore South division. Treatments applied were four (A) control—left alone (B) cut back but not burned, (C) burned and cut back after the teak had started to sprout and (D) burned and cut back before the teak started to sprout.

The results of previous years have again been confirmed. Although all treatments were initially comparable, in the Wynaad experiment there was no appreciable difference in survivals and no significant difference in mean height growth between treatments. None of the treatments were as good as the control but there was very little difference between them.

In the Coimbatore South division experiment the control was in mean height growth 34 per cent better than the burned and

cut back treatment and 58 per cent better than the treatment which was cut back but not burned.

Thus although cutting back and burning does not benefit the teak yet it is better than cutting back without burning. Therefore should an area have to be cut back because of elephant damage or other calamities it is better to burn it as well if it is practicable.

(For full experimental data see paragraph 273.)

142. *Leucæna glauca* as a cover crop in a teak plantation.—In Experimental Plot 25, Wynaad, *Leucæna glauca* was tried as a cover crop in the first year of a teak plantation. The teak was stump planted in mid April and the cover crop sown in June. The *Leucæna glauca* needed a very great deal of attention to prevent its being smothered by weeds and even by the end of the year when it was 4½' high it had still had no effect as a weed suppressor.

Measurements in January 1936 showed that the *Leucæna* teak was significantly ahead of the control teak in mean height growth to the extent of 34 per cent while there was no appreciable difference between treatments in survival percentage.

Incidentally after these measurements were taken the plot was visited by deer and bison and the *Leucæna* browsed right down to ground level. It is to be seen whether this first year difference in height growth is maintained through the second year.

(For full experimental data see paragraph 274.)

143. *Thinning Research—Teak*.—The work of laying out plots in accordance with the scheme drawn up in consultation with the Central Silviculturist for the initiation of research into the best age, grades and cycles of thinning for teak plantations was continued. The following paragraphs give an idea of the work done so far.

I. NILAMBUR.

144. (a) *Best date of first thinning*.—Nine plots each 0.2 acre in extent were laid out in Panangode, measured and grouped into three groups to give the best initial comparability. The first group was first thinned in its fourth year, the second group is being thinned this year (in its sixth year) and the third group will be first thinned in its eighth year. Subsequent thinnings will be on a five-year cycle in accordance with current Nilambur practice. The quality of these plots is Nilambur I quality. All thinnings are approximately "C" grade thinnings which aim at a removal of about 40 per cent of the stock.

(b) *Best intensity of thinning*.—Eighteen plots each 0.5 acre in extent were laid out in Edacode and measured. These plots were first thinned at five years old with a "C" grade thinning. This thinning was however slightly adjusted to give the best initial comparability of the plots possible. The plots will be allotted to treatments and treatments applied in their tenth

year according to their comparability at that time. Treatments will be four in number—

- (a) "C" grade thinning but with the further control that approximately 40 per cent of the stock will be removed.
- (b) "D" grade thinning but with the further control that approximately 50 per cent of the stock will be removed.
- (c) "E" grade thinning but with the further control that approximately 60 per cent of the stock will be removed.
- (d) An exceedingly heavy "X" grade thinning aiming at the isolation (at 10 years old) of the final crop.

Subsequent thinnings will be made at five yearly intervals in accordance with current thinning practice at Nilambur. The quality of these plots is Nilambur I quality.

Out of these 18 plots it is hoped to get 16 or 12 comparable plots in the tenth year for the application of the four treatments.

(c) *Best periodicity of thinning*.—Sixteen plots each 0.5 acre in extent were laid out in Ellenjeri and measured. At 5 years old the first thinning was carried out with a "C" grade intensity. This thinning was however adjusted slightly to give the best initial comparability of the plots possible. The plots will be measured and allotted to treatments in their tenth year according to their comparability at that time. Treatments will be three in number—

- (a) Five-year cycle to be thinned at 5, 10, 15, etc., years old.
- (b) Eight-year cycle to be thinned at 5, 13, 21, etc., years old.
- (c) Twelve-year cycle to be thinned at 5, 17, 29, etc., years old.

Thinnings will be of "C" grade intensity and at 10 years old it is hoped to get 12 or 9 really comparable plots for the application of the three treatments. The quality of the plots is Nilambur I quality.

II. WYNAAD.

145. (a) *Best date of first thinning*.—At Begur, 11 plots each 0.2 acre in extent were laid out and measured. Of these, 9 plots were selected to give the best initial comparability and allotted to three treatments. The first group was first thinned at 5 years old, the second will be thinned at 7 years old, and the third group at 9 years old. Subsequent thinnings will be at five yearly intervals. All thinnings are approximately "C" grade thinnings and the quality of the plots is Nilambur II quality.

(b) *Best intensity or best periodicity of thinning.*—Eighteen plots, each 0.5 acre in extent were selected at Begur and measured. These plots were thinned at 5 years old with a "C" grade thinning adjusted to give as close an initial comparability as possible. The plots will be measured at 10 years old and according to the comparability established at that time will be allotted as a set of 16 plots or 9 plots for experiments on the best intensity or periodicity of thinning (as at Nilambur). The quality of these plots is Nilambur II quality.

Further work has now to wait for the establishment of sufficiently regular plantations of different qualities for the laying out of further sets of plots.

146. It has been decided that the above experiments do not afford a test of the applicability to teak plantations of the theory of thinning of Dr. Craib, developed in South Africa with wattle plantations. This theory is that thinning should always precede suppression and not follow it, and that trees once suppressed, however slightly, never really respond to thinning. (That thinnings at Nilambur in the past have probably been too late and too light is borne out by the fact that in the plantations one rarely sees a teak tree with a reasonable crown, and also the recent trade depression has shown that the market is not keen on long thin plantation teak poles as the final crop.)

In consequence, a set of six plots has been laid out in Aruvallikava at Nilambur to test the theory. They have been divided into two sets and one set of three plots will be thinned normally at 5, 10, 15 years old, etc., in accordance with current district practice. In the second set of plots the first thinning has been carried out and consisted of a 50 per cent mechanical thinning at 2 years old. This set will subsequently be thinned as often as is found necessary in order that suppression should never be allowed to occur.

147. *Effect of pruning young Swietenia macrophylla.*—An experiment (Experimental Plot 135, Nilambur division) was started during the year to determine whether pruning of 8-year old Mahogany is beneficial and to see whether applying coal tar to the wounds prevents rot. During the first six months of this experiment the untarred wounds had closed by 35 per cent and the tarred wounds by 21 per cent of their original average diameter. There is no sign of rot yet.

148. *Effect of soil working and of trenching on the growth of natural seedlings of Hopea parviflora.*—Observations were continued on the two experiments done in Coimbatore South division. Experimental Plot 47 is under full evergreen shade and in Experimental Plot 46 all but the top canopy was removed. In each experiment three treatments were applied—(A) soil aeration by forking 3" deep, (B) removal of root competition by digging narrow trenches 9" deep and 3' apart with similar cross trenches at

4' intervals and cutting all roots met with and (C) no treatment at all. The treatments have been applied each year in January.

In the plot under full shade after three years there is no appreciable difference in survivals and no significant difference in mean height growth between the three treatments although the average annual increment of the mean tree during the period has been 2.24".

In the plot under top canopy shade only, although initially comparable, the soil worked plot is 55 per cent and trenched plot 12 per cent ahead of the control in mean height growth, both differences being significant. There is no appreciable difference in the survival percentage. In this plot the average annual increment of the mean tree has been 4.17".

The trenching is more expensive to do and less effective.

The indications are therefore (1) that young *Hopea* regeneration needs only top canopy shade and (2) that soil working is beneficial.

(For full experimental data see paragraph 275.)

149. *Effect of burning a Eucalyptus globulus fuel plantation after coppicing.*—In Experimental Plot 3, Nilgiris division, a blue gum fuel area was burned immediately after coppicing. Measurements taken one year after applying the treatment show—

- (a) The treatment has had no appreciable effect on the size or the number of shoots produced per stool.
- (b) In the burned area the average height from the ground of the point of production of the shoots was slightly less than in the unburned area.
- (c) The mortality of stools in the burned area was 11 per cent and in the unburned area 5 per cent.
- (d) The number of natural seedlings that appeared in the burned area was one-fifth of that produced in the unburned area.

If this treatment were to be applied on a large scale other practical difficulties would arise. In most coupes it takes from six months to one year to complete the felling and in consequence coppice shoots up to about one year old would be burned. Further, with burning, fuel could not be stacked in the coupe as is the current practice. The treatment is thus contra-indicated.

150. *Effect of cutting thorny bushes in dry fuel coupes at the time of felling.*—Observation of the experiment done by the Working Plans Officer, Vellore, and mentioned in last year's annual report, paragraph 145, was continued and it was found that during the second year the increase of the pest noticed in its first year was decreasing and the bushes appear to be settling down to much the same condition as they were before felling.

The species concerned are *Indigofera paucifolia*, *Zizyphus enoplia*, *Carissa carandas*, *Randia dumetorum*, *Zizyphus jujuba* and *Gymnosporia montana*.

(viii) MIXTURES—Nil.

(ix) UNDER PLANTING.

(a) Teak plantations.

151. *Underplanting in teak plantations.*—No new underplanting has been done. In the old plots at Nilambur in which *Cephalostachyum pergracile* (Experimental Plots 100, 104 and 105 of 1930 and Experimental Plot 106 of 1931) *Bambusa arundinacea* (Experimental Plot 101 of 1930) *Swietenia macrophylla* (Experimental Plots 98 and 102 of 1930) *Cedrela toona* (Experimental Plots 99 and 103 of 1930) were introduced, the two bamboos show promise, are now well established and growing fast. The *Swietenia* and *Cedrela* have suffered from browsing and bark stripping by deer but the larger plants are well established and growing quite well.

In Experimental Plot 8, Wynaad division *Cephalostachyum pergracile* sown in 1932 under teak 33 years old was badly browsed and on this account was fenced last year. The bamboo has greatly gone ahead during the year.

A new Experimental Plot (138, Nilambur division) has been established during the year to watch the development of *Hopea parviflora* introduced by the district staff in 1929 in a teak plantation of 1888 which had completely failed and in which natural *Xylia xylocarpa* had taken the place of the original teak. This is on a lateritic slope and the *Hopea* is well established and looks promising.

152. The following table shows the progress made by the species mentioned above.

Division.	Experimental plot number.	Species.	Date of under planting.	Mean height in January 1936 in feet.	Increment during the year in feet.
Nilambur	98	<i>Swietenia macrophylla</i> .	1930	5.1	0.8
	102	Do.	1930	2.0	0.25
	99	<i>Cedrela toona</i> ..	1930	6.0	1.7
	103	Do.	1930	5.6	1.6
	101	<i>Bambusa arundinacea</i> .	1930	11.4	2.1
	100	<i>Cephalostachyum pergracile</i> .	1930	23.1	6.3
	104	Do.	1930	22.5	6.9
Wynaad	105	Do.	1931	23.2	4.0
	106	Do.	1931	21.4	15.6
	8	Do.	1932	2.4	1.9
	138	<i>Hopea parviflora</i> ..	1929	4.4	.. *

* First measurement.

(b) Evergreen rain forests.

153. *Underplanting under shade.*—Experimental Plots 36 and 37, Palghat division in which *Mesua ferrea* and *Calophyllum elatum* were transplanted under evergreen forest shade in 1924 were closed as regeneration experiments during the year.

Parts of each plot have been reopened as Experimental Plots 147 and 148, Palghat division to watch the development of the plants from the sapling to the pole stage. One hundred plants in

each plot were numbered and measured in December 1935. *Mesua ferrea* shows a mean height of 56.5" and *Calophyllum elatum* a mean height of 50.2". The plants are well grown and look very healthy.

154. *Fate of gaps regenerated in evergreen forest.*—In Experimental Plot 36, South Coimbatore division five gaps in evergreen forest were regenerated. The following plants were put in in 1930 in all the gaps added together:—

<i>Artocarpus hirsuta</i>	..	..	80	
<i>Bischofia javanica</i>	..	..	70	
<i>Hardwickia pinnata</i>	..	..	70	
<i>Pericopsis mooniana</i>	..	..	70 + 21	replacements.
<i>Palaequium ellipticum</i>	..	..	70 + 35	do.
<i>Gluta travancorica</i>	..	..	70 + 28	do.
<i>Vateria indica</i>	..	..	70 + 21	do.

In 1931 the following were put in:—

<i>Araucaria cunninghamii</i>	..	..	45	
<i>Acrocarpus fraxinifolius</i>	..	..	80	
<i>Swietenia macrophylla</i>	..	..	45	
<i>Artocarpus hirsuta</i>	..	..	60	

Enumeration in January 1936 showed the following plants still existing:—

<i>Araucaria</i>	..	..	..	37	quite healthy.
<i>Artocarpus</i>	..	..	..	1	miserable.
<i>Swietenia</i>	..	..	..	3	fair.
<i>Hardwickia</i>	..	..	..	17	fair.
<i>Vateria</i>	..	..	..	2	poor.

This result is in accordance with general district experience, gaps that start off reasonably well fade out in a few years.

The *Araucaria* however looks promising but would obviously have done better in the open than in a small gap.

155. *Effect of burning before artificial regeneration in gaps in evergreen forest.*—In Experimental Plot 52, Coimbatore South division ten gaps were selected for regeneration in evergreen forest and half were burned over before regeneration. Three species were used, *Acrocarpus fraxinifolius*, *Artocarpus hirsuta* and *Swietenia macrophylla*.

Observations at the end of the third year showed that there was very little *Acrocarpus* left, a fair amount of *Artocarpus* and *Swietenia* has done well. The survival percentage of all species is much the same for both treatments but in mean height growth the burned gaps have done better than the unburned gaps for all three species.

Results are best seen in the table below:—

Species.	Increase in mean height growth of burned over unburned gaps.		
	1st year.	2nd year.	3rd year.
<i>Acrocarpus fraxinifolius</i>	14%	17%	18%
<i>Artocarpus hirsuta</i>	10%	10%	53%
<i>Swietenia macrophylla</i>	2%	10%	42%

This beneficial effect of burning is contrary to the results obtained in artificial regeneration of these species under evergreen shade but in agreement with those obtained in clear fellings of mixed deciduous forest.

(For full experimental data see paragraph 276.)

156. *Regeneration of evergreens after clear felling*.—A considerable amount of information has been gathered from experiments on regenerating evergreens under various degrees of shade. To complete the series of conditions Experimental Plot 27, Wynaad division has been started which has the following treatments for the regeneration of evergreens :—

- (A) Clear-felling and burning—no cover crop.
- (B) Clear-felling and burning—with cover crop.
- (C) Clear-felling—no burning—no cover crop.
- (D) Clear-felling—no burning—with cover crop.
- (E) Felling all but the undergrowth no burning.

So far treatments (A) and (C) have been applied and cover crops have been grown so that the remaining treatments will be applied in the 1936 regeneration season.

Results in (A) and (C) show a fair degree of success by the end of January but by then the full effect of the hot weather had not been felt. The species tried are *Artocarpus hirsuta*, *Swietenia macrophylla*, *Hopea parviflora*, *Gluta travancorica*, *Cedrela toona*, *Chickrassia tabularis*, *Dipterocarpus indicus*, *Dysoxylum malabaricum* and *Hardwickia pinnata*.

In no species has the burning produced any appreciable beneficial effect. In general the percentage of survivals in the burned area is less than in the unburned area and the same is the case in mean height growth, in two instances of which the superiority of the unburned area reached significance.

157. *General*.—The general difficulties experienced in regenerating evergreens under evergreen shade have been found to be (1) generally poor initial stocking, (2) slow initial growth, (3) browsing. In studying the following results it must be remembered that Experimental Gardens are fenced and browsing is not allowed to occur.

The general results obtained are—

- (1) We definitely can make a success of raising artificially about half a dozen of our valuable evergreens.
- (2) The best shade conditions are those of top canopy only.
- (3) The best method of regeneration is transplanting for most species. For the most tender species transplanting in baskets shows promise.

- (4) Sowing generally gives poorer results than transplanting.
- (5) Stumping is not a suitable method to use except in the case of *Artocarpus hirsuta*, *Cedrela toona* and *Chickrassia tabularis*.
- (6) Weeding is worth while as it gives a small gain in initial height growth and survival percentage.
- (7) Pitting before planting is also worth while as although the beneficial effect is very small in the first year it becomes more prominent in the second year as the roots and their needs both get bigger.
- (8) Burning before regeneration is not necessary. It not only produces no beneficial effect but it is found often to kill trees that have been left in the top canopy to give shade.

It should be noted that the two evergreen research centres Chandanathode (in the Wynaad) and Karian shola (in the Anamalais) have rather different climates. Chandanathode has an annual rainfall of 153" and most of this comes from the south-west monsoon while Karian shola gets 62" each year and this is fairly evenly distributed between the two monsoons (vide paragraph 234 for rainfall statement).

158. *Best light and shade conditions for regeneration*.—Experiments during the past few years have covered all shade conditions for regenerating evergreens from full evergreen shade to full light but these experiments have been done in different places and in different years. To correlate the indications obtained, Experiment 65, Chandanathode Experimental Garden was started in 1934 in which it was attempted to experiment under all shade conditions in the same experiment and in the same year. Five species were introduced by transplanting nursery seedlings in randomized lines and four shade conditions used for each species as follows :—

- (i) Top canopy only left;
- (ii) top canopy and high middle storey left;
- (iii) all but undergrowth and low middle storey left;
- (iv) complete evergreen shade.

During the experiment however some of the trees left in the top canopy in shade condition (i) died and this has affected (i) and (ii) rendering them as (i) slightly less than top canopy only (about 75 per cent) (ii) slightly more than top canopy only.

The following list shows the shade preferences indicated by the end of second year :—

<i>Dipterocarpus indicus</i>	<i>Swietenia</i>	I and II	..	(Top canopy only).
<i>macrophylla</i>				
<i>Cedrela toona</i>	..	..	II ..	(Slightly more than top canopy).
<i>Hopea parviflora</i>	..	..	II and III ..	(Top canopy and some middle storey).
<i>Gluta travancorica</i>	..	..	III and IV.	(Practically full evergreen shade).

(For full experimental data see paragraph 277.)

159. *Effect of burning in evergreen forests before artificial regeneration.*—Two experiments (Chandanathode, No. 77 and Karian shola, No. 47) were done under top canopy shade in which areas were burned in randomized strips and then artificially regenerated with evergreen species. Seven species were experimented with, *Artocarpus hirsuta*, *Cedrela toona*, *Dipterocarpus indicus*, *Dysoxylum malabaricum*, *Hopsea parviflora*, *Mesua ferrea*, and *Swietenia macrophylla* and they were introduced by sowing, transplanting and stump-planting as far as stock was available.

The work done thus covers 16 sub-experiments and 3,200 plants. In general there was no appreciable difference in survival percentage and no significant difference in mean height growth between the burned and unburned treatments for any species and any method of introduction. The only case of a significant difference in mean height growth was that of *Hopea* sowings and the difference was 28 per cent in favour of not burning the area before regeneration. The averaged results of these 16 sub-experiments are:—

Area burned.		Area not burned.	
Percentage survivals.	Mean height in inches.	Percentage survivals.	Mean height in inches.
58	7.08	56	7.31

The above results confirm those of previous years that burning before artificial regeneration under evergreen cover is neither beneficial nor harmful and is therefore not economically justified. There is also a serious drawback to burning under evergreen cover. Experiments have shown that the best shade conditions required for regenerating most of the species tried so far is top canopy only. Many of the top canopy trees in our evergreens are very susceptible to fire and three times in the last two years we have had to abandon areas after the burn as the fire had killed some 40 per cent of the trees intended to be left as the top canopy shade.

(For full experimental data see paragraph 278.)

160. *Direct sowing—Best date (under top canopy only).*—Experiments were done at each of two centres. In Chandanathode Experimental Garden Experiments Nos. 71 and 70, *Cedrela toona* and *Acrocarpus fraxinifolius* were experimented with and both species showed early June as the best date for sowing at Chandanathode. In Karian shola experimental garden experiments 40 and 39 *Acrocarpus fraxinifolius* and *Swietenia macrophylla* were used. Mahogany showed early June as the best date and *Acrocarpus* did best in the mid-September sowings but with this species survivals were really too few to draw reliable conclusions. It is to be noted that 1935 was a drier year than usual and plants were less affected by heavy rains and the best date of sowing is found to be about one month earlier than usual.

(For full experimental data see paragraph 279.)

161. *Entire transplanting—Best date (under top canopy only).*—Five experiments with four species were done with the object of finding out the best date for entire transplanting under top canopy only. Transplanting was done once a fortnight from the middle of June until the middle of September.

Results indicate the best time for transplanting as:—

Chandanathode ..	..	<i>Hopea parviflora</i> ..	Mid July.
Do. ..	..	<i>Swietenia macrophylla</i> ..	Do.
Karian shola ..	..	<i>Cedrela toona</i> ..	August to mid-October.
Do. ..	..	<i>Swietenia macrophylla</i> ..	Mid-July to mid-August.
Do. ..	..	<i>Artocarpus hirsuta</i> ..	July.

It is to be noted that due to the dry year at Chandanathode (which is normally much wetter than Karian shola) plants were not affected by the heavy rain and the best date of transplanting has moved forward about one month earlier than usual but at Karian shola owing to lack of sufficient rain the best date is about one month later than usual.

Chandanathode experimental garden experiments 74 and 73, Karian shola experimental garden experiments 41, 42 and 43.

(For full experimental data see paragraph 280.)

162. *Stump-planting—Best date (top canopy only).*—Two experiments were done at Karian shola with *Acrocarpus fraxinifolius* and *Cedrela toona*, both of which species stump fairly well. With both species, early July proved to be the best date. Again this date is earlier than usual.

(For full experimental data see paragraph 281.)

163. *Comparison of sowing, transplanting small, medium and large transplants, mossed or basketed plants, and stumping with small and large stumps (under top canopy cover).*—Thirteen experiments were done with five species to compare these various methods of raising evergreens under evergreen top canopy cover. With all species except one, transplanting was found to be the most successful method and with the exception (*Artocarpus hirsuta*) stump-planting generally gives the best results.

With regard to the size of transplants to be used, the following tentative conclusions are drawn as to the approximate size of transplant likely to do best when percentage of survivals and increase, decrease or maintenance of initial difference in mean height growth of the various sizes of transplants are taken into consideration:—

<i>Artocarpus hirsuta</i> ..	..	..	..	8"
<i>Cedrela toona</i> ..	..	..	..	14"
<i>Dysoxylum malabaricum</i> ..	..	..	..	12"
<i>Gluta travancorica</i> ..	..	..	..	14"
<i>Hopea parviflora</i> ..	..	..	..	9"
<i>Mesua ferrea</i> ..	..	..	..	10"
<i>Swietenia macrophylla</i> ..	..	..	..	6"

(does well if basketed).

(In all cases the larger sizes grew much slower than the smaller ones and suffered many more casualties.)

Previous years' results are included and the figures given are the approximate middle of a small range of size found to be suitable to the species.

(For full experimental data see paragraph 282.)

164. *Transplanting (under top canopy cover)—Comparison of natural forest seedlings and nursery transplants.*—Two new experiments in this subject were started and two old ones remeasured. The species experimented with are *Hopea parviflora*, *Mesua ferrea*, and *Palaequium ellipticum*. These experiments combined with previous years' results indicate that generally natural forest plants do better in the first year than nursery transplants but in the second and third years suffer heavier casualties and their growth becomes slower. There thus appears to be no advantage in using natural forest plants.

(For full experimental data see paragraph 283.)

165. *Comparison of entire transplanting with naked transplants and basketed plants—Dipterocarpus indicus (under top canopy only).*—In Karian shola experimental garden experiment 33 started in 1934, naked root transplants and basketed transplants of the same age were compared. At the end of two years the basketed plants show a very much higher percentage of survivals. In mean height growth initially the naked root transplants were significantly superior to the basketed plants by 11 per cent but now the basketed plants are superior to the extent of 19 per cent, the difference however not being significant.

Thus basketing has proved the more efficient method of regeneration. This method, although of course more expensive, is likely to be very beneficial in the cases of important evergreen species with which difficulty is experienced in getting good initial stocking.

(For full experimental data see paragraph 284.)

166. *Propagation by cuttings—Cedrela toona (under top canopy only).*—While making stumps of *Cedrela toona* it was noticed that the top ends of the plants which had been cut off and thrown down on the ground quickly rooted themselves.

Experiment 79, Chandanathode, was therefore done to see whether this species could be successfully propagated by cuttings. In making stumps, the top end of about one foot in length which was cut off was divided into two and the two parts planted. There were four treatments—

- (A) 6" shoot cuttings planted vertically.
- (B) 6" shoot cuttings planted slanting.
- (C) 6" top ends planted vertically.
- (D) 6" top ends planted slanting.

The method was found very successful as shown below, the shoot cuttings planted vertically doing much the best—

Treatment.		Survival percentage.	Mean height in inches.
A 6"	Cuttings vertical	96	12.60
B 6"	" slanting	64	7.43
C 6"	Top ends vertical	84	8.55
D 6"	" slanting	72	6.57

Measurement in January 1936.

This comparatively high percentage of survivals from material which is normally wasted is a valuable asset. The experiment is being repeated with other species.

167. *Entire transplanting—Under full canopy—Effect of weeding.*—Observation of Karian shola experimental garden, experiments 21 and 22 started in 1933, was continued. The species concerned are *Hopea parviflora* and *Swietenia macrophylla*. Measurements in January 1936 show that there is a much better survival percentage (differences of 13 per cent and 19 per cent) and also mean height growth (differences of 25 per cent and 6 per cent) in the weeded lines.

Although this gain appears to be small weeding is well worthwhile in evergreen forest where initial growth is slow and initial stocking usually comparatively poor.

168. *Effect of repulsive smears on browsing incidence.*—In Experimental Plot No. 26, Wynaad division, in evergreen forest young plants were subjected to three treatments to see whether the browsing incidence would be reduced by the application of repulsive smears. The treatments were, (A) control, (B) plants smeared with fresh cattle blood, (C) plants smeared with neem oil.

The browsing incidence was the same in all three treatments, thus confirming previous years' indications that these repulsive smears do not deter game.

(x) SILVICULTURAL SYSTEMS—Nil.

(xi) MISCELLANEOUS.

Spike Disease Research.

Introduction.

169. The investigation was continued during the year by the Research Ranger, Denkanikota, under the directions of the District Forest Officer, North Salem, in consultation with the Conservators of Forests, Working Plans and Salem Circles, with the technical advice and general supervision of the Provincial Silviculturist.

A. New outbreaks dealt with by the Research staff.

170. The first outbreak was reported near Kambugudi in the Inner Javadi by the District Forest Officer, West Vellore. This was inspected by the Research Ranger, Denkanikota, in September 1935. The age of the spike appeared to be not less than two years and the extent 200 acres. The country is difficult but the soil rich, with a plentiful supply of hosts which accounts for the quick and virulent spread of spike not only among individual trees

but also from tree to tree through self-haustorisation. Spike among root suckers was quite common. This is an isolated attack in a sandal block of over 100 square miles. It was considered essential to adopt anti-spike measures to attempt to control the disease and these have been carried out by the district staff.

The second outbreak was noticed by the Research Ranger, Denkanikota, in September 1935 in Patrakad Reserve Forest, Vellore East Division, and consisted of only a few spiked trees. It is 24 miles as the crow flies from the Kambugudi area mentioned above. Control operations have been done by the district staff.

Apart from these "outstation" attacks, three new outbreaks have occurred in the North Salem Division, two in Denkanikota Reserve Forest and one in a private garden. All are within one to two miles of the nearest spiked area. In the first 2 areas only solitary spiked trees were affected. In the third area 11 trees showed the disease and the age of the spike was over one year. With the consent of the owner of the garden, control operations have been started in this area also.

In all five areas no recrudescence of the disease has occurred up to the end of the year but it is of course far too early yet to judge results of the operations. All the 5 areas are close to cultivated fields, thus strengthening the evidence we already have that new outbreaks very often occur close to agricultural operations.

The actual operations undertaken are, (i) immediate killing by poison of all trees showing spike, (ii) lopping of all sandal trees in a belt about 100 to 200 yards wide round the affected area to force out the symptoms in disease-masking trees. As soon as the symptoms appear the tree is killed, (iii) all trees killed are removed as soon as is practicable.

B. Transmission experiments with insect masses, families or groups.

171. (i) *Cloth cages*.—In the six-acre regeneration plot at Javalagiri, 115 sandal plants artificially raised in a spiked area were protected by covering the above ground portions of the plants with cloth cages from April 1932 to April 1935 (i.e., for three years). Not even one caged plant got spiked, whereas among the controls 14 per cent got the disease. These results indicate that the infecting agency is not in the soil but is one operating above ground. The experiment is being repeated by caging another set of 144 plants from May 1935 after testing by lopping that they contain no masked infection. Among the 115 plants originally caged in April 1932, 73 died as the result of caging during the course of experiment. The remaining 42 have been left open since May 1935 to see if they now get the disease. No spike has yet appeared on any of these plants.

The experiment detailed above also indicates that the air passing through cloth screens did not carry the agency of infection or at any rate the meshes of the cloth were sufficiently small to screen off the infective agency.

172. (ii) *Wire mesh cages*.—To confirm the above indication and also to see what sized mesh screen would allow the infective agency to reach the plant, 849 plants were selected in an infected area in Noganur Reserve Forest, tested to contain no masked disease and then allotted as follows:—

800 for controls—			
10 caged with wire gauze of 20 meshes to an inch.			
10	Do.	10	do.
9	Do.	4	do.
10	Do.	2	do.
10	Do.	1	do.

Of the above, cages of 10 and 20 meshes and 3 of 4 meshes, were started in the year 1933, 10 of 1" netting, 9 of $\frac{1}{2}$ " netting were started early in 1934, and the remainder in 1935. Every time before caging, the plants were tested for masked symptoms, by pruning. In October 1935 one plant of 1" netting showed spike. Among the uncaged controls, 162 plants or 20.25 per cent had become spiked up to the end of January 1936. All these cages including those of 20 and 10 meshes to an inch, freely allowed the settlement of coccids and other insects on the plants, thus indicating that even the small mesh cages have not kept out the insect fauna that can pass in through these meshes. These experiments have eliminated the possibility of infection by air borne infective spores and fungii and have also given the indication that the search for the culprit insect should be made among the bigger classes of insects although the very small insects, such as aphids, thrips and coccids are not conclusively eliminated.

173. (iii) *Pot plants on platforms and on the ground*.—Plants raised in pots in a healthy area (viz., potculture plot at Denkanikota) from seeds collected from the best sandal trees of healthy locality (Hosur Cattle Farm) were transported to the infected area at Aiyur and exposed on 8' to 10' high platforms and also on the ground for varying periods. At the end of these periods of exposure they were transferred back to the healthy area. Of these a certain number of sandal plants as detailed in the statement were found infected.

Number of plants.		Period of exposure.	Number of plants spiked.		
On the platform.	On ground.		On the platform.	On the ground.	Date of manifestation.
14	7	23rd April 1931 to 31st July 1931.	1	....	Feb. 1932.
14	7	4th March 1932 to 6th May 1932.	2	....	Jan. 1933.
14	7	6th October 1932 to 10th December 1932.	2	....	Feb. 1933.
14	7	13th April 1933 to 11th June 1933.	1	....	Jan. 1934.
14	7	13th August 1933 to 30th October 1933.	2	....	July 1934.
14	7	26th January 1934 to 28th March 1934.	1	....	Sep. 1934.
14	14	1st August 1934 to 31st August 1934.	1	....	Oct. 1934.
14	14	1st October 1934 to 31st October 1934.	1	....	Mar. 1935.
112	70		1	....	June 1935.
112	70		12		

This result definitely confirmed the infection by above ground agency. This has further indicated 2 possible effective seasons of infection, one in March to May and the other in August to October. The experiment is being continued to narrow down if possible the seasons to specific months.

It is to be noted that in this experiment the period between exposure to infection and manifestation of the disease varied from 2 to 9 months, the average time being 6 months.

174. (iv) *Mass infection cages*.—Two mass infection cages were started one in May 1934 at Denkanikota and the other in August 1934 at Javalagiri.

The cage at Denkanikota is situated in a spike-free area four miles away from the centre of insect collection whereas the Javalagiri cage is situated right in the midst of a heavily spiked area. The insects were collected at night between 9 p.m. to 5 a.m. classified and counted type-wise, and released in these cages. Night collections were made as the work by Dehra Dun in previous years with day collections had produced a nil result.

Samples of the types were killed and mounted in insect preserving boxes for future check and identification. Other experimental details relating to the cages are given in the statement below :—

	Denkanikota.	Javalagiri.
Dimensions of the cage	24' × 12' × 7'	25' × 12' × 7'.
Mesh of wire gauze	20 to an inch.	20 to an inch.
Date of start	7th May 1934.	19th August 1934.
Number of sandal plants in the cage—		
Healthy	42	37
Spiked	24	35
Total number of types introduced into the cage from commencement to date of first spiking.	190	252
Total number of insects introduced up to 1st April 1935.	41,435	40,275

In December 1934 a fresh batch of 23 healthy sandal plants were introduced into the Javalagiri cage.

On 19th January 1935 one of the healthy plants in the cage at Javalagiri looked suspicious and subsequently exhibited the characteristic symptoms of spike. Material from this plant was taken on 19th February 1935 to Denkanikota and utilized for grafting six healthy plants, two of which developed the disease on 28th May 1935, thus confirming that the spike symptoms produced through the agency of insects were transmissible by grafting as in the case of natural spike. On 8th March 1935 two more plants in the Javalagiri cage showed the disease.

175. It was thought that other plants in the cage might be masking the disease and it was decided to put the matter to test and remove 50 per cent of the plants from the cage and prune them. Accordingly 28 plants, 15 from the plants put in the cage in August 1934 and 13 from those introduced in December 1934 were defoliated on 9th March 1935 and removed to Denkanikota healthy locality. These plants were immediately replaced in the Javalagiri cage, by another set of healthy plants. About the middle of April 1935, five plants among the defoliated and eight among the plants that were left in the cage, all belonging to the series of plants kept in the cage in August 1934 got spiked. Of the remaining plants of the August series, one more showed the disease in September 1935 thus bringing up the total to 17 out of 37 plants or nearly 46 per cent.

In the Denkanikota cage, one plant got the disease in August 1935. By the time the first manifestation of spike took place, insects relating to 265 types had been introduced into both the mass infection cages (viz., The Javalagiri cage and Denkanikota cage). It was therefore decided to introduce no more types after this as the experiment indicated that at least one of the vectors (if there be more than one) must be among the 265 types.

The experiment however definitely established the insect vector theory of spike disease.

176. (v) *Compartment cages*.—It was then thought necessary to find out which of these 265 types are likely to be the culprits. The types of insects introduced were classified with the help of an entomologist (Mr. Mahdihassan of the Indian Institute of Science, Bangalore) into five groups, viz., (1) Jassidæ (2) Pentatomidæ, (3) Fulgoridæ, (4) Locustidæ, (5) Beetles, etc., and the numerical strength of each, which had been released in each cage compared. As a result of the comparison, insects relating to the families of Jassidæ, Fulgoridæ, Pentatomidæ, were found important. These three families are also found suspected together with seven others suggested by Dehra Dun and published on page 5, Part I, Volume XX of the Indian Forest Records. Therefore, to test these families separately, a compartment cage—30' × 6'—was opened with five rooms—5' × 6' each—at Javalagiri, an infected area—in February 1935; each room was stocked with both spiked and healthy sandal plants and insects of the types tabulated below were released in each, from the night collections.

Compartment No. I—Jassidæ.

Types Nos. 18, 19, 20, 21, 26, 27, 28, 29, 38, 77, 109, 112 and 189.

Compartment No. II—Pentatomidæ.

Types Nos. 1 to 4, 14, 15, 16, 25, 51, 71, 152, 182, 185, 186, 188, 193, 200, 204, 228, 238, 240, 246, 248, 250 and 251.

Compartment No. III—*Fulgoridæ* and *Coriædæ*.

Types Nos. 5, 23, 70, 78, 89, 91, 92, 96, 110, 125, 127, 128, 150, 155, 159, 178, 187, 194, 197, 203, 210, 217, 225, 252, 257 and 264.

Compartment No. IV—*Locustidæ*.

Types Nos. 42, 75, 102, 107, 126, 148, 190, 222, 232, 233, 234, 242, 244, 245, 254 and 261.

Compartment No. IV—*Locustidæ*.

Types Nos. 6, 7, 8, 9 to 13, 17, 22, 24, 30, 31, 32, 33, 34, 35, 37, 39, 41, 43, 46, 47, 48, 49, 50, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 67, 68, 69, 72, 73, 74, 76, 79, 80, 81 to 88, 90, 93, 94, 95, 97, 99, 100, 103, 104, 105, 106, 108, 111, 113, 114, 115, 116, 117, 119 to 123, 129 to 138, 140, 141, 142, 144 to 147, 149, 151, 153, 154, 156 to 158, 161 to 165, 167 to 177, 179 to 181, 184, 185, 191, 192, 195, 196, 198, 199, 201, 202, 205, 206 to 208, 211 to 216, 218 to 222, 224, 226, 229, 230, 331, 235, 237, 239, 241, 243, 247, 249, 256, 258, 259, 260, 262 and 265.

(Types Nos. 36, 40, 44, 45, 52, 57, 98, 101, 118, 139, 143, 166, 223, 227, 236, 253 and 255 were omitted as they were either moths or parasites.)

177. The total number of insects released in these rooms during the year is tabulated below:—

Room number.	Family of insects.	Total number of insects released till end of 31st March 1936.
I	Jassidæ	2,345
II	Pentatomidæ	3,135
III	Fulgoridæ and Coriædæ	2,125
IV	Locustidæ	1,875
V	All other insects	2,856

Though a large number of insects was released in each cage the survivals after a few days were not even a quarter of the number released. No spike has been transmitted in these cages from sandal to sandal, but in October 1935, one *Scutia indica* plant in the room No. 3 developed the spike-like appearance.

178. In September 1935, another compartment cage with five rooms was constructed, also at Javalagiri. Healthy and spiked plants were put in this cage and the types of insects released and other details are given in the statement below:—

Room number.	Nature of insects released.	Number of types.	Number of insects released till 31st March 1936.
I	All day insects not so far found in night collections.	I to V	162
II	All insects above the 265 types caught at night.	267 to 276	267
III	All beetles collected in day time (also found at night).	58, 17, 64, 171 and 120.	413
IV	All locustids caught in day time (also found at night).	42, 75, 102, 244, 107, 126, 231 and 205.	1,658
V	All other insects .. .. .	....	7,997

179. No case of transmission has taken place so far in this cage.

With the idea of duplicating the group transmission experiments another cage with five rooms was erected at Denkanikota in December 1935. Leaving one of the rooms for transmission experiments through the medium of field crops, the other rooms are being stocked with healthy and spiked sandal plants. In room No. 1, Jassids have been introduced and in room No. 2, the Pentatomids. Work was not started in other rooms during the year.

C. Transmission experiments with individual species.

180. (i) With the idea of narrowing down the range of suspected insects responsible for transmission, certain individual species were selected. These come under three groups A, B and C.

Group A.—Comprises insects suspected by Dehra Dun and consist of *Petaloccephala* sp, *Acropona*, *Bythoscopus* and *Moonia* of Jassidæ, *Catacanthus incarnatus* of Pentatomidæ, and *Sarima*, *Fambinia* and *Eurybrachys* of Fulgoridæ, and *Otinotus* of Membracidæ.

181. *Group B.*—Consists of insect types worked out as follows:—

The types of insects released in the mass infection cages at Denkanikota and Javalagiri were classified immediately after the transmission of spike was established in Javalagiri mass infection cage into five groups, viz., Pentatomid, Jassid, Fulgorid, Locustid, and other families and the numerical strength released in each area compared. As a result of which the following types of insects were selected by omitting the types of insects that predominated in Denkanikota area where there was no infection till then.

Pentatomidæ—Types 1, 15, 16, 17 and 246.

Jassidæ—Types 21, 29 and 92.

Fulgoridæ—Types 70 and 203.

These types were compared with the separate collections made at Javalagiri Reserve Forest, Samayeri platform experimental area and Kenilworth Castle area. Types 15 and 16 under Pentatomids were eliminated as they were found in the Kenilworth Castle area where there is no natural infection. The rest of the types were selected for the first trials.

182. *Group C.*—During the course of insect collections, if a large number of individuals were collected, instead of killing and mounting, these were utilized for transmission trials in sleeves. Two types, Nos. 4 and 238 of Pentatomids, and type No. 24 of Membracids came under this head.

No case of transmission has been obtained in any of these experiments so far.

It was noticed during the course of these experiments that certain types of insects thrived well with sandal associated with certain hosts, whereas on those with other hosts the mortality was

heavy. This gave us a clue that the best food plants for different types of insects is different. The Dehra Dun investigation has also revealed that the insect types varied according to the nature of associated host plants to sandal.

183. (ii) *Experiments to find the chief plant food of individual species.*—In order to find out the chief food plants of various types of insects an experiment was devised in 1935 by which insect types Nos. 1, 4, 71, 24 and 12 were enclosed in sleeves on various plants, the results of which up to 31st March 1936 are tabulated :—

Type of insects.	Species of plants sleeved.	Probable food plants so far noticed.
No. 1 ..	Sandal, <i>Mundulia suberosa</i> , <i>Strychnos nux vomica</i> , <i>Cassia siamea</i> , <i>Ixora parviflora</i> , <i>Cajanus indicus</i> , <i>Azadirachta indica</i> , <i>Lantana</i> , <i>Erythroxyton monogynum</i> , <i>Zizyphus jujuba</i> , <i>Albizia amara</i> , <i>Pongamia glabra</i> and <i>Acacia suma</i> .	<i>Lantana</i> , <i>Sandal</i> , <i>Strychnos nux vomica</i> , <i>Ixora parviflora</i> .
No. 4 ..	<i>Sandal</i> , <i>Mundulia suberosa</i> , <i>Pongamia glabra</i> , <i>Breynia rhamnoides</i> , <i>Cajanus indicus</i> , <i>Azadirachta indica</i> , <i>Dodonaea viscosa</i> , <i>Lantana</i> , <i>Cassia siamea</i> , <i>Erythroxyton monogynum</i> , <i>Chloroxyton swietenia</i> and <i>Strychnos nux vomica</i> .	<i>Cajanus indicus</i> and <i>Dodonaea viscosa</i> .
No. 12 ..	<i>Sandal</i> , <i>Mundulia suberosa</i> , <i>Strychnos nux vomica</i> , <i>Pongamia glabra</i> , <i>Breynia rhamnoides</i> , <i>Acacia farnesiana</i> , <i>Azadirachta indica</i> and <i>Cajanus indicus</i> .	<i>Mundulia suberosa</i> and <i>Cajanus indicus</i> .
No. 71 ..	<i>Sandal</i> , <i>Mundulia suberosa</i> , <i>Strychnos nux vomica</i> , <i>Cassia siamea</i> , <i>Ixora parviflora</i> , <i>Azadirachta indica</i> , <i>Cajanus indicus</i> , <i>Erythroxyton monogynum</i> , <i>Lantana</i> , <i>Albizia amara</i> , <i>Zizyphus jujuba</i> , <i>Pongamia glabra</i> and <i>Acacia suma</i> .	<i>Breynia rhamnoides</i> , <i>Ixora parviflora</i> , <i>Azadirachta indica</i> .
No. 24 ..	<i>Sandal</i> , <i>Mundulia suberosa</i> , <i>Strychnos nux vomica</i> , <i>Cassia siamea</i> , <i>Ixora parviflora</i> , <i>Azadirachta indica</i> , <i>Cajanus indicus</i> , <i>Erythroxyton monogynum</i> , <i>Lantana</i> , <i>Zizyphus jujuba</i> , <i>Albizia amara</i> , <i>Pongamia glabra</i> , <i>Acacia suma</i> , <i>Leucena glauca</i> , <i>Murraya koenigii</i> , <i>Grewia orientalis</i> , <i>Butea frondosa</i> , <i>Terminalia arjuna</i> , <i>Chloroxyton swietenia</i> , <i>Dalbergia latifolia</i> , <i>Tephrosia candida</i> , <i>Acacia farnesiana</i> , <i>Dalbergia paniculata</i> , <i>Albizia lebbek</i> , <i>Pittosporum floribundum</i> , <i>Dodonaea viscosa</i> , <i>Schleichera trijuga</i> , <i>Bambusa arundinaceae</i> , <i>Argyria cuneata</i> , <i>Pithecolobium saman</i> .	<i>Mundulia suberosa</i> , <i>Cajanus indicus</i> and <i>Acacia suma</i> .

D. Specific Vector Experiments.

184. This was started on 1st September 1935. The object of these experiments is to feed the species on the diseased sandal plants for varying periods and then transfer them on to healthy sandal so that direct transmission may be obtained. The feeding was done

by enclosing the insects in sleeves. The types selected and the details of work done so far are shown below :—

Type of insect.	Duration of feeding.	Number of insects for each period.	Period after transferring the spike fed insects to healthy sandal.	Condition of sandal plants.
No. 4 ..	1 to 6 days at intervals of every 24 hours.	10 insects each time.	4 months ..	Healthy.
No. 18 ..	1 to 15 days at intervals of every 24 hours.	Do.	6 months ..	Do.
No. 24 ..	Do.	Do.	4 months ..	Do.
No. 19 ..	1 to 9 days at intervals of every 24 hours.	Do.	6 months ..	Do.
No. 238 ..	Do.	Do.	3 months ..	Do.
No. 96 ..	1 to 11 days at intervals of every 24 hours.	Do.	4 months ..	Do.

With the above types of insects, no transmission has been obtained so far.

E. Experiment to find out whether infection takes place in the night or day.

185. The results in the Javalagiri mass infection cage pointed out that the vector occurs during the night, and in order to get more data regarding the time of infection, an experiment was started at Aiyur on 24th May 1935. Eight platforms were constructed each at a height of 8 feet from ground level. Thirty-two potted healthy sandal plants raised at Denkanikota potculture plot are transported and placed on the platforms at four plants to each—two plants on each platform are caged in day time, and just at dusk the cages from these are removed and put on the other two which are kept exposed during day time. At the end of every two months, the plants are taken to Denkanikota potculture plot and fresh batches are brought and kept on platforms and experimented with.

The experiment was started on 24th May 1935 and the first set was removed on 31st July 1935. So far (i.e., till the end of March 1936), four more sets have been kept and removed.

The results obtained during the year are as follows :—

One plant among those kept exposed during the day between 24th May 1935 and 31st July 1935, and another among those kept exposed during day time between 30th September 1935 and 30th November 1935, manifested the disease indicating the possibility of infection even during day time. The experiment is being continued.

F. Experiments aiming at Control of the Disease.

186. These were dealt with under two heads (a) prevention and (b) cure.

Under prevention the main work consists of trying to isolate a resistant strain of sandal.

(a) Prevention.

(i) Acquired resistance.

187. During the course of grafting experiments, plants associated with certain types of hosts such as *Azadirachta indica*, *Semecarpus anacardium*, *Ruta graveolens*, etc., did not easily get the disease. In examining the affected areas, trees that got the disease were always found associated with certain types of hosts. It was therefore thought that plants by virtue of their association with certain hosts get the power to resist the disease. In order to prove this, sandal plants were raised in sets of 30 combinations, associated with the following species. When the sandal plants were about 1½ to 2 years old they were infected artificially by grafting. This experiment has been in progress for the last five years. Results obtained so far are tabulated below :—

Name of species associated with sandal.	Number of sandal plants grafted.	Number spiked.
<i>Acacia farnesiana</i>	30	26
<i>Dodonea viscosa</i>	0	2
<i>Ruta graveolens</i>	30	..
<i>Pithecolobium dulce</i>	30	20
<i>Pongamia glabra</i>	30	25
<i>Lantana</i>	30	30
<i>Azadirachta indica</i>	30	..
<i>Cassia siamea</i>	30	..
<i>Semecarpus anacardium</i>	30	..
<i>Strychnos nux vomica</i>	30	..
<i>Zizyphus jujuba</i>	30	2
<i>Murraya koenigii</i>	30	..
<i>Dalbergia sissoo</i>	30	25
<i>Dalbergia latifolia</i>	20	11
<i>Jatropha curcas</i>	20	10
<i>Bambusa arundinacea</i>	30	..
<i>Erythroxylon monogynum</i>	30	..
<i>Albizia odoratissima</i>	30	18
<i>Acacia leucophloea</i>	30	22
<i>Mundulea suberosa</i>	30	28
<i>Cajanus indicus</i>	30	30
<i>Terminalia arjuna</i>	30	10
<i>Zizyphus cenoplia</i>	30	15
<i>Ocimum sanctum</i>	30	26
<i>Ocimum canum</i>	30	10
<i>Chloroxylon swietenia</i>	30	14
<i>Melia azadirach</i>	30	30

188. In order to find out if there is correlation between artificial grafting and the natural infection done by insect agency, and also to find out if acquired resistance can be strengthened to

immunity by allowing the combinations to grow unhindered unlike in pots, the pot experiments were extended to field conditions where all growth in a block of severely infected forest at Javalagiri was felled and burnt. Mounds each $6' \times \frac{4' \times 2'}{2} \times 3'$ were raised and various combinations of sandal were introduced from the year 1931. No artificial infections were done but the plants were exposed to natural infection. The first plant got the disease while ten months old. The results so far obtained are tabulated below :—

Name of species associated with sandal.	Total number spiked.	Total number of combinations.
<i>Acacia farnesiana</i>	6	7
<i>Dodonea viscosa</i>	4	4
<i>Pithecolobium dulce</i>	4	4
<i>Pithecolobium saman</i>	2	4
<i>Lantana</i>	7	7
<i>Pongamia glabra</i>	4	5
<i>Murraya koenigii</i>	4	5
<i>Azadirachta indica</i>	..	10
<i>Cassia siamea</i>	4	15
<i>Semecarpus anacardium</i>	..	3
<i>Strychnos nux vomica</i>	..	4
<i>Zizyphus jujuba</i>	2	4
<i>Dalbergia sissoo</i>	3	4
<i>Erythroxylon monogynum</i>	..	3
<i>Mundulia suberosa</i>	5	5
<i>Cajanus indicus</i>	4	5
<i>Terminalia arjuna</i>	6	8
<i>Zizyphus cenoplia</i>	1	4
<i>Melia azadirach</i>	6	6
<i>Chloroxylon swietenia</i>	3	4
<i>Acacia suma</i>	5	5

It is seen from the above that the results obtained by grafting are more or less corroborated by natural infections, but the few instances that occurred in the combination of *Cassia siamea*, *Zizyphus jujuba*, *Murraya koenigii*, *Dodonea viscosa* indicate that the virus introduced by natural agency is probably more potent.

From the above results, the following species have been considered as "resistant" hosts :—

Azadirachta indica, *Semecarpus anacardium*, *Strychnos nux vomica*, *Cassia siamea*, *Zizyphus jujuba*, *Murraya koenigii*, *Erythroxylon monogynum*, and the rest considered as susceptible hosts.

189. With the idea of bringing the above results into practical sylviculture, an area of 4 acres was opened at Javalagiri in 1930, and divided into four plots of 1 acre each. In two of the plots only resistant hosts were retained and in the other two, only the susceptible hosts were retained. The hosts thus retained

were supplemented with more hosts of the same types both by sowing and planting. Two hundred sandal plants were established in each of the four plots by the end of 1930. It is now six years and the percentage of incidence is—

Resistant plots = 16/400.

Susceptible plots = 56/400.

or 1 : 3½.

This again supports the conclusions already arrived at—that sandal acquires resistance or susceptibility according to the species of the hosts. This experiment is now being given a wide practical application in a block of 40 acres of natural spike-free sandal area in Noganur reserved forest, where the area is divided into eight sections favouring or disfavours the resistant and susceptible hosts; four of the plots are controls. The area selected is in the line of spread of spike and the results are awaited.

190. It has been noticed that the work on the susceptibility of sandal to the disease when associated with various hosts has not been fully appreciated and many of the working plans at present in force still advocate the use of unsuitable hosts in sandal regeneration prescriptions. A large number of individuals of some 30 species of hosts were carefully dug up and the degree of sandal haustorization noted. This was also compared with the ease with which haustorization occurs in artificial regeneration experiments. These observations have been correlated with the work on susceptibility or resistance of sandal associated with various hosts and the following list drawn up for the guidance of practical officers engaged in sandal regeneration operations.

A. Host plants that haustorize easily and well, and also impart a large degree of immunity.

Azadirachta indica.

Cassia siamea.

Murraya Koenigii.

Eugenia jambolana.

Toddalia aculeata.

Dodonea viscosa.

B. Host plants that haustorize fairly well and also impart a large degree of immunity.

Strychnos nux vomica.

Semecarpus anacardium.

Zizyphus jujuba.

Bambusa arundinacea.

Erythroxylon monogynum.

C. Examples of host plants that are commonly advocated but which render the sandal susceptible to the disease.

Cajanus indicus (dhall).

Cassia montana.

Acacia suma.

Pongamia glabra.

(ii) Autogenic resistance.

191. (a) The other result obtained in grafting operations was that certain plants though associated with unfavourable hosts were still found to resist artificial infections. Such plants were separated and subjected to two more infections. After each infection, the plants were pruned and tested for masked symptoms. Seventy-five plants that successfully resisted three infections were sorted out as those of an autogenic resistant strain and planted out in the heavily infected area at Javalagiri four years ago. Of these only two plants got the disease, 42 plants died naturally and the remaining 31 plants are still healthy. A few are seeding, and these seeds are being collected and plants raised for testing. None among the ten resistant sandal plants planted out at the same time as controls in a healthy area—Sanamavu Reserved forest has shown the disease so far.

(b) Apart from this, attempts were made to find out the origin of such autogenic resistant plants. In these trials it was found that seeds of different carpels or venation gave rise to different types of seedlings. Four venated seeds give rise to seedlings with better root systems and haustorizing power. These plants have been raised and 15 plants are now ready for artificial infection.

(c) Sandal plants have also been subjected to immunization by grafting with sub-lethal doses of infective material (i.e., leaf tissue of spiked tree). The work was started only recently. After the first dose of infection, the plants were tested by pruning and no manifestation of spike has taken place.

(iii) Prevention of attack by spraying with insect repellants.

192. Well known insect repellants have been selected and sandal plants in diseased localities sprayed once a month. The following sprays have been used :—

Lead arsenite, Copper arsenite, Nicotine, Asafatida, Cinchona and Derrisol.

It is too early to judge results yet but it does not appear that these sprays have had much effect in reducing spike incidence.

An experiment is also being done on the effect of spraying after lopping but it is too early to give results.

Painting plants with a poisonous lead paint in an attempt to prevent the vectors feeding on the plants and so eliminating the disease, produced poor results. The painting had very little effect in reducing the spike incidence.

(iv) Injection experiments.

193. It is well known that insects are either repelled or attracted by the presence of very minute doses of certain elements in the plants. Also, certain elements present in the plant body are capable of nullifying the effect of the virus introduced. To see if this would prove effective in the case of spike, certain constituents of plants which are insect repellents and certain constituents known to build up resistance to disease were taken up and injection was carried out. The results obtained are tabulated below :—

Date of starting—May 1935.

Chemical used.	Nature of chemical.	Proportion of dose.	Number of plants injected.	Number of plants spiked.
Aluminium sulphate ..	Resistance builders.	1 : 1000	50	3
Zinc sulphate ..	Do.	1 : 1000	50	3
Manganese chloride ..	Do.	1 : 1000	50	3
Pyridine ..	Insect repellants ..	1 : 10000	50	5
Strychnine ..	Do. ..	1 : 10000	50	2
Nicotine ..	Do. ..	1 : 10000	50	3
Water-controls			50	Nil.
Ordinary controls			50	1

It is of course too early to judge results yet.

(b) Cure or control of spike.

194. Various experiments carried out revealed that the sources of spike disease are confined to three :—

- The diseased living trees,
- The disease masking trees, and
- The vectors.

If the above three sources are destroyed, the disease can be controlled. As regards the first source, the trees can be killed out quickly either by Atlas tree killer or by its substitute, also an arsenical compound.

Unless the actual insect responsible for infection is found out, it is impossible to destroy the third source but the infective vectors can be turned into non-infective ones if the first two sources are entirely destroyed.

The destruction of the second source was found to be the most difficult in the absence of a morphological index to identify disease masking trees.

In the course of transmission studies, it was found that a few sandal plants grafted with infective tissue did not manifest the disease symptoms in spite of the success of the graft. After about a year, when these were lightly pruned, nearly 90 per cent of them showed the disease in virulent form with the bursting of dormant buds. The practice of pruning has been found extremely useful in forcing out the disease symptoms.

To get additional experimental evidence on this point, under field conditions, 600 apparently healthy sandal trees were selected in Aiyur locality on 30th June 1935 and numbered. Every odd number was lopped and trees of even numbers left as controls thus randomising the trees lopped throughout the area.

The incidence among the lopped and unlopped trees till the end of December 1935 is 25/300 : 6/300 or 4:1.

This clearly shows that lopping is a useful technique in bringing out the masked symptoms of spike disease even under silvicultural conditions.

195. This technique has now been applied to control the spread of spike in newly affected areas shown below :—

(i) *Denkanikota Reserved Forest*.—During the year under report, three areas two in the Denkanikota Reserved Forest and one in a patta land near Denkanikota Reserved Forest were found newly attacked.

(a) *Gudigunta area*.—This is situated about two miles as the crow flies from the nearest spike area but within two furlongs of cultivation. Seven trees in a group were found affected in June 1935 and these were carefully uprooted with all roots complete. A belt of 100 yards round the infected group of trees was demarcated and all apparently healthy sandal trees and saplings in the belt amounting to 68, were lopped.

None of the lopped trees have shown the disease.

(b) *Jogvenka area*.—One tree, 19" in girth, was found spiked on 3rd October 1935. This spiked tree is situated right on the edge of a stream. This was immediately killed with Atlas and the area was demarcated by a 100 yards belt and all apparently healthy sandal trees and saplings amounting to 88 were lopped in October 1935. None of the lopped trees have shown the disease so far.

(c) *Devastanam Kothanur patta land spike area*.—This area is situated about two miles north of Denkanikota Reserve Forest spike area right in the middle of patta lands. Eleven trees were found spiked in January 1936 and these were killed with Atlas. All the apparently healthy trees amounting to 190 were lopped in February 1936.

None of the lopped trees have yet shown the disease but the shooting is not yet complete in some of the trees.

196. This method involves an average cost of Rs. 2-8-0 per 100 trees for Atlas treatment and a similar amount for lopping 100 trees, and is therefore expensive in dealing with large areas.

In order to find out its efficacy even in large areas, the affected block of Denkanikota Reserve Forest and Manchi unreserve, each comprising about 300 acres, were taken up for control operations. In these areas all spiked trees were killed out with Atlas and all

apparently healthy sandal trees amounting to 18.612 were lopped to bring out the masked symptoms. Those that manifested the disease were also killed with Atlas. A third area, Kodagari, in which only 50 acres had been affected was kept as the control for the above. In this area only spiked trees were killed out and no lopping was done. *The disease has not spread out of the original limits in the first two areas whereas in the third area over 300 acres had become affected by April 1935.* As the results aimed at have been obtained, the third area has now been brought under the full control operations.

197. Technique to find out if an area is susceptible to infection or not; and how far the environmental factors influence the resistance or susceptibility.

With the above object, grafting experiments were carried out in (a) Hosur Kenilworth castle area, (b) Samayeri Reserve Forest evergreen area, (c) Pane Reserve Forest area, (d) Thalli Reserve Forest healthy area and (e) Thalli Reserve Forest adjacent to spiked area. (a) to (d) are far away from spiked areas. The results obtained are tabulated below:—

Locality.	Total number of trees grafted.	Total number that manifested the disease.	Percentage spiked.	Type of flora.
(a) Hosur Kenilworth castle area.	315	118	38	Open scrub type with deep well aerated soil and plenty of undergrowth of lantana and prickly pear.
(b) Samayeri Reserved Forest area.	100	29	29	Mixture of semi evergreen and deciduous type on fairly deep soil with plenty of humus.
(c) Pane Reserved Forest area..	50	1	2	Deciduous big forest type with rocky soil.
(d) Thalli Reserved Forest healthy area.	75	25	33	Mixture of semi-evergreen and deciduous type on poor soil.
(e) Thalli Reserved Forest adjacent to spiked area.	25	11	44	Open scrub type with plenty of lantana, soil gravelly.

The results indicate that spike infection appears to have been influenced by ecological factors.

198. *Experiments in pots.*—Sandal plants from three of the above areas, viz., Kenilworth Castle area, Thalli Reserve Forest healthy area and Samayeri Reserve Forest were brought, stumped and planted with *Acacia farnesiana* hosts, in pots containing soil brought from the respective areas. These plants were grafted with spike tissue; the results of grafting are detailed below:—

Locality from which the plants were obtained.	Total number of plants grafted.	Dosage.	Number manifested the disease.
Kenilworth castle area ..	8	4 leaves and 4 patches.	3 or 44 per cent.
Samayeri Reserved Forest area	8	Do.	Nil.
Thalli Reserved Forest healthy area.	8	Do.	Nil.

It is too early to judge results yet but it appears likely that there will be correlation between these two experiments. The experiment is being extended.

199. *Summary.*—(1) Transmission of spike by insects has been definitely established through mass infection cage experiments.

(2) Night fauna appears to be generally responsible for transmission but indications were also obtained that the day fauna too cannot be ignored.

(3) The platform experiments supported the original evidence that the effective seasons of infection are generally March to May and again August to October.

(4) General classification of insects through which transmission was established indicate that insects of Jassidae, Pentatomidae and Fulgoridae are the probable culprit vectors. Group and individual transmission experiments with these insects are in progress.

(5) Strong evidence was obtained that the food plants of different insects vary but sandal when associated individually with different host plants serves as common food plant to several suspected insects.

(6) Specific vector experiments with a definite number of individuals of a few species, viz., *Petaloccephala* sp, *Moonia* sp, *Acropona* sp, *Sarina* sp, *Chrysocoris* sp, *Flatta* sp, *Catacanthus incarnatus*, *Lantana* aphids, *Ledra mutica*, *Bythoscopus indicus*, *Hotea* sp, *Jassus* sp, *Tambinia verticalis*, *Eurybrachys tomentosa*, and *Plantia fimbriata* are in progress but no results are yet available.

(7) There are indications that susceptibility or resistance to spike is influenced greatly by the ecological make-up of the area.

(8) Further evidence regarding the occurrence of spike in close proximity to agricultural operations was recorded in new outbreaks.

(9) Artificial infection by grafting and natural infections in the field are more or less comparable.

(10) Anti-spike measures taken in three of the new outbreaks near Denkanikota and two of last year's outbreaks in Noganur effectively controlled the disease in all the above centres. In large affected areas of over 300 acres in Manchi, Guthiroyan and Denkanikota Sandal Blocks, further spread was controlled though the disease is not yet wiped out within the affected areas.

(11) Experiments to isolate a resistant strain are in progress. Plants of autogenic resistance appear to exist and further study is in progress. Acquired resistance through hosts plants is only comparative but whether it is transferable from parent to progeny is being investigated.

(b) Periodicity of height growth.

200. *General.*—Measurements were taken weekly at all centres for a number of species to determine the active growing periods and resting periods of the young trees.

201. Results during the year show the following:—

(A) *Evergreen forest*—*Chandanathode*.—All species grew throughout the year very slowly and steadily but with an appreciably increased rate during April and May in both 1935 and 1936. *Cedrela toona* and *Swietenia macrophylla* behaved more like deciduous species with a definite rest period from December to April. *Species*—*Hopsea parviflora*, *Dysoxylum malabaricum*, *Dipterocarpus indicus* *Cedrela toona* and *Swietenia macrophylla*.

202. (B) *Mixed deciduous forest*—(i) *Nilambur*.—One-year old teak continued to grow but very slowly, all through the hot weather of 1936 but 2-year old teak had a very definite rest period from the middle of December 1935 to the middle of April 1936.

(ii) *Kannoth*.—Teak grew rapidly from the middle of June 1935 to the end of December 1935 and then rested until mid May 1936. *Pterocarpus marsupium*, *Artocarpus hirsuta*, *Dalbergia latifolia* and *Swietenia macrophylla* grew slowly but steadily all through the year with a slight increase in rate in early April 1936.

(iii) *Begur*.—All species rested from the first week of November 1935 to the third week of March 1936 except *Chloroxylon swietenia* and *Artocarpus hirsuta* which grew very slowly during the whole period. Growth with all species at this centre was very slow during the year.

Species.—*Tectona grandis*, *Terminalia crenulata*, *Pterocarpus marsupium*, *Swietenia macrophylla*, *Dalbergia latifolia*, *Artocarpus hirsuta* and *Chloroxylon swietenia*.

(iv) *Dhoni*.—All species grew steadily from late June 1935 to the end of December 1935 and then rested completely until early May 1936.

Species.—*Tectona grandis*, *Pterocarpus marsupium*, *Terminalia crenulata*, *Dalbergia latifolia* and *Xylia xylocarpa*.

203. (C) *Dry fuel forests*—*Emmanur*.—All species grew very slowly but steadily throughout the year but showed a definitely increased rate from early November 1935 to the middle of January 1936.

Species—*Prosopis juliflora*, *Holoptelia integrifolia*, *Azadirachta indica*, *Acacia ferruginea*, *Cassia siamea*, *Anacardium occidentale*, *Albizia amara*, *Acacia sundra*.

204. (D) *All-India Teak seed origin plots*—*Nilambur*.—As has been noted in previous years' reports all origins grew steadily in the same way right through the first year without a rest period. In Experimental Plot 129, the growth curves of Nilambur, Anamalais and Travancore (i.e., South Indian origins) were similar to each other but different from the growth curves of South Bombay and North and South Burma which were all similar to each other. (This confirms the second year growth result reported for Experimental Plot 123 in paragraph 218 of last year's Annual

Report.) The South Indian origins grew rapidly from 1st July 1935 to mid December 1935 and then rested until late May 1936 while the other origins although starting their rapid growth period on the same date (early July 1935) continued growing until early February 1936 before resting.

(c) *Weeds*.

205. *Lantana eradication*—(i) *Mechanical methods*—(a) *Uprooting*.—In the past various methods of uprooting lantana have been tried but all have been found to be very expensive and ineffective due to germination of seed that was dormant on the ground.

206. (b) *Cutting and burning*.—The cutting, and cutting and burning of lantana have also been tried. These methods which cost roughly Rs. 3 to Rs. 5 per acre have also failed as burning in particular seems to propagate the species! An experiment is now in progress to see whether the regrowth after cutting and burning can be dealt with cheaply by a light spraying of sodium chlorate. At present it appears unlikely that this combined method even if successful will be as cheap as spraying alone.

207. (ii) *Silvicultural methods*—(a) *Introduction of Bambusa arundinacea and Dendrocalamus strictus under lantana*.—The experiment in North Salem division (described in last year's report, paragraph 219) in which *Bambusa* was introduced under lantana in 1933 continues to show great promise. Various methods of introduction were used and at the end of 1936 hot weather show from 60 to 90 per cent success and the plants look very healthy. This method is fairly reasonable in cost (about Rs. 8 to Rs. 10 per acre).

The 1935 sowings of *Dendrocalamus strictus* have not been a success as the resulting seedlings have apparently not been able to stand the severe hot weather.

208. (b) *Introduction of Cassia siamea in rab patches in lantana*.—*Cassia siamea* has done very well by sowing in rab patches cleared and burned in lantana and after one year averages 3' in height. It remains to be seen whether the lantana will invade the plots in later years, when tending of the *Cassia siamea* stops.

Attempts to raise this, species on ridges or mounds in lines opened in the lantana do not show great promise.

209. (iii) *Chemical methods*—(a) *Spraying with sodium chlorate*.—Spraying lantana with sodium chlorate has been very successful. The solution is made up by dissolving $\frac{3}{4}$ lb. of sodium chlorate in one gallon of water, adding two ounces of Casein as a spreader, and diluting the resulting solution with one gallon of water. This two gallons of solution costs Re. 0-8-0.

Spraying should be done early in the hot weather to have its best effect and not soon after rain or when there is likelihood of rain only small plots have been sprayed so far but it appears that the quantity required is 24 gallons per acre, 16 gallons for the first spray and 8 gallons for the second spray.

The density of lantana in these areas is about 10,000 stems per acre. The effect of the spray is seen on the first day and within five or seven days all leaves wither and top shoots to a length of three to four feet dry up. Regrowth begins to come up after about three weeks and when this regrowth is complete a second spraying is done. This kills the regrowth but in some cases a third but light spraying is also needed as a few stems produce new shoots from the base. About two gallons per acre is sufficient for this third spray if it has to be done.

One of the great advantages of this strength of sodium chlorate spray is that usually only the lantana is affected. A slight withering of the tender shoots of other species occurs but they subsequently recover.

These experiments are being repeated on a large scale to give an accurate idea of costs which at present appear to be about Rs. 8 to Rs. 10 per acre.

210. (b) *Arsenic poisoning*.—One acre of thick lantana jungle containing about 10,000 stems was girdled and treated with Atlas Tree Killer solution. The lantana was completely killed and no basal shoots were produced. However there was some regeneration from seed dormant on the ground and this was killed by a light sodium chlorate spray. This operation cost approximately Rs. 15 per acre.

211. (c) *Other chemical sprays*.—Various other chemicals were used as sprays in small-scale experiments. The chemicals and results are given below :—

Name of chemical.	Strength of solution.	Quantity used.	Remarks.
1 Ammonium thiocyanate.	100 grammes to 1 gallon of water.	1 gallon..	..
2 Potassium chlorate ..	Do.	1 gallon..	..
3 Sulphuric acid ..	1 ounce to 1 gallon of water.	2 gallons ..	..
4 Ethylene chloro-hydrin.	6 ounces to 1 gallon of water.	1 gallon..	..
Sodium chlorate ..	100 grammes to 1 gallon of water.	1 gallon ..	..
Copper sulphate ..	4 ounces to 1 gallon of water.	1 gallon..	..
7 Magnesium chloride ..	Do.	do. ..	..
8 Atlas tree killer ..	1 to 20 parts of water.	10 bottles ..	..
9 Atlas substitute solution.	Do.	do. ..	..
10 Aluminium sulphate ..	50 grammes to 1 gallon.	1 gallon..	..
11 Arsenic acid ..	4 ounces to a gallon of water.	do. ..	..
12 Potassium thiocyanate.	Do.	do. ..	..

Spraying was done only once.

Of the treatments detailed above, items 3, 4, 6, 7 and 10 had no effect. In the case of items 1 and 12, *lantana* shed its leaves but it shot up quickly. In the case of items 2, 5 and 11 it shed its leaves and top twigs up to a length of one foot to two feet on an average were dead, but it shot up from below. In the case of items 8 and 9 the effect on *lantana* was very thorough in the beginning as all the leaves were shed and twigs up to 2½' also dried; but shoots came up from below showing that the roots were not affected.

212. The general indications of this work at present are that (1) underplanting lantana with *Bambusa* is possible at a reasonable cost and one is left with a pure bamboo forest and (2) sodium chlorate spraying is also successful at about the same cost and it leaves the area with whatever else was originally present besides the *lantana* and the area is ready for the introduction of new species.

213. *Climber eradication by poisoning*.—Experiments in this subject were continued. The poison was made up in three strengths—

(A) Strong 1 lb. of AS2 O3 in ¾ gallon of solution.

(B) Medium 1 lb. of AS2 O3 in 3 gallons of solution.

(C) Weak 1 lb. of AS2 O3 in 12 gallons of solution.

and was applied in two ways, by girdling the climber and painting the poison on the girdle and by pouring the poison into a frill made in the stem (for details of making up the poison, etc., vide last year's report, paragraphs 223 to 226).

214. In the experiment with *Zyzyphus oenoplia* some climbers produced shoots from the base with the first rains after the poisoning but these shoots turned out to be feeble and died in the following hot weather. In Experimental Plot No. 14, Coimbatore North division, *Pterolobium indicum* was poisoned on 28th March 1935 and this also produced basal shoots with approximately 40 per cent of the climbers treated and these shoots have most of them persisted. In consequence the experiment was repeated in Experimental Plot No. 17, Coimbatore North division with the same species. The poisoning was done on 30th January 1936 and by the middle of May only 10 per cent had produced basal shoots.

The results of this experiment to date are :—

Pterolobium indicum—(North Coimbatore Experimental Plot No. 17).

Number of climbers treated.	Method of application.	Strength of poison.	Date of application.	Apparently dead.	With green or partly green stems.	Producing shoots from ground level.
10	Stem sera-ped.	Strong ..	January 1936.	10	0	0
10		Medium ..		8	0	2
10		Weak ..		10	0	0
10	Stem frilled.	Strong ..		9	1	0
10		Medium ..		8	1	1
10		Weak ..		7	0	3

It is to be noted that the poisoning has greatest effect and many fewer basal shoots are produced, when the operation is done at the beginning of the hot weather.

215. During the year a short note on the experimental work done so far was circulated, and in consequence district work was undertaken in three forest divisions. In Palghat division, an area of 16 acres was treated with the medium strength solution on 10th February 1936 after girdling. Fairly heavy rain followed within about ten days. At the beginning of May 1936, 10 per cent of the climbers were dead and a fair proportion also appeared to be dying. The general appearance of the climbers indicated that the poison used was not strong enough. The operation cost approximately 4 annas per 100 climbers and it remains to be seen what further mortality occurs. The incidence of climbers was approximately 950 per acre. The species of climbers treated were:—*Pterolobium indicum*, *Acacia intsia*, *Scutia indica*, *Zizyphus ænopia*, *Combretum ovalifolium*, *Ericale paniculata* and *Calycopteris floribunda*.

216. In Ganjam division the medium strength poison was used with girdling on 20th January 1936 and found completely successful with *Butea superba*, *Bauhinia vahlii* and *Zizyphus ænopia*. *Calycopteris floribunda* which was also treated appeared sickly but was still surviving in April 1936.

217. In Upper Godavari division a similar experiment was done in January 1936. By the middle of April, *Butea superba*, *Pterolobium indicum*, *Zizyphus ænopia* and *Vitis pallidæ* were reported to be dead, *Vitis linnae*, *Asparagus rottleri* and *racemosus*, *Cardiospermum helicacabum* and *Scindapsus officinalis* to be dying while an unidentified climber had hardly been affected at all.

218. From the experience gained so far the indication is that a poison intermediate in strength between the strong and the medium solutions and applied after girdling very early in the hot weather, gives the best results. The cost of such an operation is approximately 4 annas per 100 climbers treated.

219. *Strobilanthes eradication*.—Experimental Plots 1, 2 and 22, Wynaad division have as their object the eradication of *Strobilanthes*. The first two of these plots were initiated one year after the *Strobilanthes* flowering and the last one three years after. The following four treatments were applied (A) control—nothing done, (B) cutting above the aerial root, (C) cutting flush with the ground, (D) pulling out by hand. So far practically no plants have appeared in the treated plots. The species is suspected to be *Strobilanthes reticulatus* but this can only be confirmed at the next flowering.

220. *Attempted suppression of Eupatorium on the Nilgiris*.—*Kikiyu* grass has been introduced in a series of plots in the Nilgiris after pulling up the *Eupatorium* to see whether the grass

so established will keep out the weed. The grass is now well established and its "runners" have penetrated well into the *Eupatorium*, but a few plants of the weed have appeared in the grass but look sickly. The struggle between the two is in progress and results are awaited.

221. *Grass suppression in dry fuel coupes*.—Last year's experiment to see whether *Leucaena glauca* would suppress the short rank grass growth which often occurs in blanks in dry fuel coupes and which is such a hindrance to regeneration was repeated. The same result was obtained. Although initial germination was good and showed promise, none of the seedlings were able to survive the hot weather and all of them died out.

II. WORKING PLANS AND STATISTICS.

(i) WORKING PLANS.

222. The Provincial Silviculturist continued to be in touch through the Conservator of Forests, Working Plans Circle, with the Working Plans Officers in the various districts. He was largely consulted with regard to proposed prescriptions on silvicultural matters and statistical work. The experience gained and the results obtained in this branch were availed of by the Working Plans Officers and District Forest Officers.

The following statement shows the working plans under preparation in the Working Plans Circle, at the beginning of the year under review those completed during the year, and the new ones undertaken:—

Number	Working plans under preparation at the beginning of the year.	Working plans completed during the year.	New working plans commenced during the year.
I	East and West Vellore divisions.	East Vellore (a)	West Vellore.
II	North and South Cuddapah divisions.	North Cuddapah (a).	South Cuddapah.
III	Madura division	Madura division ..	Palghat division
IV	The Nilgiris division ..	.....	.....
V	Upper Godavari division.	.....	.....
(a) Field work completed but writing up of the plan still pending at the close of the year.			

The working plan for the Tinnevely division was sanctioned during the year. The working plan for the Salem North division is pending sanction.

The cost of preparation of the Madura Working Plan is As. 2-6 per acre.

(ii) YIELD, VOLUME AND FORM FACTOR TABLES.

223. *Sample plots*.—Seventy-eight sample plots representing 17 species in nine districts were maintained. Three sample plots (Nilambur Teak Nos. 17, 18 and 19) were fully measured before final felling as they were in the district regeneration area of the year. Five other sample plots were remeasured.

The Dehra Dun extensible ladder as an aid to measurement of standing sample trees was borrowed during the year and tried in our sample plots but was found not suitable for Madras conditions. We have had a sling seat and tackle made and will be measuring standing sample trees in the coming year with the aid of climbers. We have not however solved the problem of the measurement of standing sample trees among the Eucalypts, most of which are 180' to 230' high.

224. *Tree increment plots*.—Twenty-seven tree increment plots representing 11 species in six districts were maintained.

225. *Preservation plots*.—In accordance with resolution 22 of the 1929 Silvicultural Conference at Dehra Dun, 12 preservation plots have been opened as shown in the list below and are being maintained by the districts concerned. The establishment of further plots is under consideration.

Circle.	Division.	Locality and reserve forest.	Species and type of forest.
Waltair ..	Upper Godavari.	Rekapalli ..	<i>Xylia xylocarpa</i> , <i>Pterocarpus marsupium</i> , <i>Dalbergia latifolia</i> , <i>Adina cordifolia</i> .
	Lower Godavari.	Sriharikota ..	Mangrove.
		Koringa ..	Do.
Bellary ..	Kurnool South.	Iskagundam ..	<i>Hardwickia binata</i> .
	Cuddapah North.	Lankamalais ..	<i>Dolichandrone crispera</i> .
	Cuddapah South.	Kodivengamma bhavi (Kodur). Pikkilikonda ..	<i>Pterocarpus santalinus</i> . <i>Shorea talura</i> .
Salem ..	Salem South ..	Karavalli Ariyur ..	Hill shola type.
Coimbatore ..	Madura ..	Gundar extension ..	<i>Pinus insignis</i> .
	Coimbatore South.	Tellikall ..	<i>Tectona grandis</i> .
Ootacamund ..	Palghat ..	Dhoni ..	<i>Dalbergia latifolia</i> . <i>Swietenia macrophylla</i> .
	Nilambur ..	Chaliarmukku ..	<i>Swietenia macrophylla</i> .

In addition to the above plots the preservation of fine specimens of single trees of *Xylia xylocarpa*, *Pterocarpus marsupium*, *Diospyros melanoxylon*, *Michelia champaka* and *Tectona grandis* has been undertaken.

The evergreen Arboretum at Topslip in South Coimbatore district was taken over during the year by this division for maintenance.

III. MISCELLANEOUS.

TOURS AND RECORDS.

226. *Tours*.—The Provincial Silviculturist was able to spend the bare minimum number of days on tour. He was not able to tour as much as was to be desired as he was forced to spend a great deal of time at headquarters doing routine computing of figures and compilation of results owing to lack of staff.

Opportunity was taken while en route to South Kanara to visit the research experiments conducted in Coorg in accordance with the orders of the Government to co-operate with the Chief Forest Officer, Coorg, in the conduct of such experiments.

227. All the research range offices of this division have been inspected during the year under report.

228. The following notes and articles were prepared during the year :—

(a) The " Standing Orders for the detection and control of the spike disease of Sandal " were revised to embody the suggestions of various officers and submitted to Government whose sanction is awaited. These orders contain a provision for the grant of rewards to those who detect new outbreaks of the disease.

(b) A short note on the work done so far in " Lantana eradication by means of chemical sprays. "

(c) A note on " Climber poisoning experiments. "

(d) After consultation with the District Medical Officer, the Nilgiris, a note on " The symptoms and treatment of arsenical poisoning " was prepared for circulation to officers likely to use arsenic poisons for trees or climbers after the publication of notes (a) and (c) above.

(e) A note for the Indian Forester on " A brass gauge for improving the stock used in stump planting teak. "

229. In accordance with item 1 (a)-(c) of resolution No. 3 of the Dehra Dun Silvicultural Conference held in 1934, the Madras Government have approved in principle the proposal for the Provincial Silviculturist to visit important research works in other Provinces. It is hoped that a start will be made in such " foreign " tours in the coming year.

230. *Records*.—The specific and general ledger files now number 418 and 149 respectively. The subdivision of the more bulky files and the condensation and publication of information has still not been attended to yet for want of time and lack of staff. The arrears in the office are slowly being worked off and it is hoped to get on with the above work soon.

Half-yearly inspections of the ledger files of this office have been made by the Conservator of Forests, Working Plans Circle.

231. Twenty-seven New Experimental Plots and 116 new experimental garden experiments were opened and 80 Experimental Plots and 293 garden experiments were summarized and closed during the year. This large closure was the result of accumulations due to expansion of work and lack of staff during the past few years. At the end of the year 72 Experimental Plots and 145 Experimental Garden Experiments were open.

232. Two hundred and twelve photographs were added to the collection during the year.

233. *Staff.*—The Extra Assistant Conservator of Forests remained throughout the year in the division as Assistant. The subordinate staff now consists of three Research Rangers, eight Foresters and one Forest Guard.

The office staff of two clerks and one typist was increased during the year by the sanction of one more clerk.

A. L. GRIFFITH,
Silviculturist.

OOTACAMUND,
16th June 1936.