KFRI Research Report No. 452

PROCESSING, STORAGE AND SUPPLY OF SEEDS OF TEAK AND MISCELLANEOUS FOREST TREE SPECIES THROUGH KFSC.

(Final Report of the project : KFRI 518/06)

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ABSTRACT OF PROJECT PROPOSAL

1. Project No.	:	KFRI 518/06
2. Title of the Project	:	**Processing, Storage and Supply of Seeds of Teak and Miscellaneous forest tree species through KFSC.**
3. Objectives	:	1) To receive/collect the seeds, perform the cutting and purity tests to assess the seed quality. 2) To store the seeds in appropriate containers and temperatures depending on the storage - physiology of each species. 3) To supply quality seeds as per the requirement of the Department/Clients. 4) To prepare leaflet on the effective handling of the seeds with hints on pre-sowing treatments and nursery technique.
4. Date of Commencement	:	April 2006
5. Scheduled date of Completion	:	September 2010
6. Funding agency and Total amount of Grant sanctioned	:	Kerala Forest Department (Dev.)
7. Principal Investigator	:	Dr. R.C. Pandalai

ABSTRACT

Teak (*Tectona grandis)* seeds were collected from different Teak Seed Production Areas (TSPA's) identified by the Kerala Forest Department (KFD) from all over the State and were transported to Kerala Forest Seed Centre (KFSC) for cleaning/ processing and quality testing- viability and germination, during the reporting period (2006-2010). The seed processing included mainly cleaning by winnowing, drying and grading. The seeds were stored in appropriate containers depending on the permissible extent of storage possible in the ambient conditions/cold storage rooms of KFSC. Initially 55 tonnes of teak seeds were received at KFSC and after processing (cleaning and grading) 49 tonnes were available for disbursement to Kerala Forest Department (KFD) and other user agencies as per their request.

Viability tests included Rapid viability test (Cutting test) and conventional test (germination test). In order to facilitate and ensure uniform germination percentage of teak seeds supplied from KFSC, standardization of pretreatment and duration of pre-treatment techniques were carried out. The results confirmed that seven days of alternate wetting and drying will be the optimum duration for the pre-treatment of teak seeds for maximum seed germination. Yet another conclusion drawn from the germination studies was that the seeds collected during March to May gave maximum germination percentage confirming that the teak seeds exhibited post harvest maturity. This property of the teak seeds makes it necessary for storage of the seeds in ambient condition soon after collection, at least for a period for three months, for obtaining enhanced germination percentage.

In addition to teak, seeds of miscellaneous forest tree species were also processed at KFSC following standard procedures. Seeds of about 70 species were collected, processed and viable seeds stored in different containers at appropriate storage conditions (Ambient; Cold storage at 16^0 C, and 4^0 C at 45% humidity conditions) based on the seed physiological nature of a particular species. Good quality seeds were supplied to KFD, farmers, and entrepreneurs as per their requirement. The seeds which showed poor viability (below 10%) were discarded. Brochures in Malayalam giving information on seed processing, pre-treatment, germination, nursery techniques and allied details were made available for a few species.

for transportation to KFSC. Simultaneous with seed collection, information on source of collection, date of collection, and name of the seed collector were recorded in performa designed at KFSC for the purpose.

2.1.2. Processing: Teak seed processing mainly comprised cleaning, grading and supply/storage of quality seeds depending on the requirement/indent from the clients. As a first step in seed cleaning, the feathery calyx was removed by rubbing the seeds in a gunny bag. The separated fragments of calyx were removed by winnowing. The seeds were then size graded using a seed grader developed at KFSC. Fruits below 9mm size were discarded. The clean seeds were assessed for their quality and viability in the laboratory at KFSC.

2.1.3. Moisture Determination: Three grams of seeds each were taken in three pre weighed stainless steel containers having lids. These containers were then kept for drying in hot air oven maintained at 103^0C for 17 hours. After 17 hours the seeds were transferred to a desiccators containing silica gel and allowed to cool to ambient temperature. The seeds were again weighed and moisture percentage determined using the following equation.

$$\text{M C \%} = \frac{\text{Initial weight (M2) –Final weight (M3)}}{\text{Initial weight (M2)-Container weight (M1)}} \times 100$$

2.1.4. Viability Tests

2.1.4.1. Cutting test: Cutting test was performed using a seed cutter designed at KFSC, in which four replications of 30 seeds each were cut open vertically into two equal halves. The seeds were visually examined and the number of intact seeds, with total seed filling and apparent healthy texture was counted. The observations were recorded in KFSC Form No. S.1.

2.1.4.2. Germination test: Though conventional germination tests were carried out in the laboratory using petridish/filter paper and paper towels as per the guidelines of International Seed Testing Association (ISTA) germination trials on a large scale were carried out using "Vermiculite" medium. The aeration properties combined with the water holding capacity of vermiculite makes it an ideal medium for testing the germination on large scale. The treated seeds were divided into four replications containing 100 seeds each and sown in plastic trays containing vermiculite. The germination trays were kept in the germination rooms at KFSC maintained at 28^0C and were monitored daily. Every day the

number of seeds germinated was counted up to the 45th day and observations were recorded in the germination test sheet.

2.1.5. Pre-sowing Treatments

2.1.5.1. Alternate wetting and drying: In order to get optimum, uniform germination from teak seeds, pre-sowing treatment was essential. The most common and widely accepted method of "alternate wetting and drying" was followed. The seeds were soaked in moist gunny bags during nights and spread out in the open for sun drying during the following day; the procedure was repeated for seven consecutive days. These seeds were then used for different nursery trials and laboratory tests.

2.1.5.2. Termite - aided mesocarp removal: A second pre-treatment tried at KFSC was the termite-aided mesocarp removal method (Chacko, 1998). About 30 kg of teak seeds were spread over a mesh bottomed tray which was placed on a termite-infested area. The termites entered the tray and fed on the mesocarp in about 2 weeks. The seeds were ready for sowing after the pre-treatment.

2.1.6. Storage: Clean graded seeds were supplied to the Central Nurseries, Social Forestry Wing and other customers as per their requirement and availability. The remaining seeds were stored either in the ambient condition or in cold storage. Teak seeds were stored in plastic bins which accommodated around 18 kg of seeds. Prior to long duration storage in the cold rooms, the seeds were treated with Carbon dioxide by inserting a nozzle connected to a cylinder of Carbon dioxide gas. Two to three sprays of the gas were applied to a container of seeds.

2.1.7. Standardization of Seed collection period:

In order to ascertain the best period of seed collection, seeds were collected from the TSPA's of all the six Research Ranges from November 2006 to March 2007 and tested for their optimum germinability.

From each of the seed lot, 100 seeds were taken out randomly and sown in vermiculite with four replications. The observations were recorded from the day of sowing up to the 45 th day when teak seeds usually completed the germination process.

2.1.8. Standardization of Weathering treatment

In order to determine the optimum length of wetting and drying treatment, experimental trials were conducted. Teak seeds from different TSPA's were brought, cleaned and size graded (selecting seeds of size 9mm and above). Nearly 120 kg of size graded seeds were subjected to weathering treatment (Alternate wetting and drying). The seeds were divided in to 24 sets of 5 kg each and were subjected to 6 different treatments (Table 1) having 4 replications each. The results were statistically analyzed using ANOVA .

Table1. Duration and mode of different treatments

Treatment code	**Treatment** (Alternate wetting and drying)	
	Duration	**Mode of treatment**
T0	Control	Without any pre-treatment.
T1	24 hours	Seeds in gunny bag.
T2	24 hours	Seeds heaped and covered with moist gunny bag.
T3	24 hours	Seeds spread in thick bed and covered with moist gunny bag.
T4	12 hours	Seeds in gunny bag.
T5	12 hours	Seeds heaped and covered with moist gunny bag.
T6	12 hours	Seeds spread in thick bed and covered with moist gunny bag.

2.1.9. Standardization of Storage period

Teak seeds were subjected to three different storage conditions such as storage in ambient, 4^0 and 16^0C. After one year of storage, the seeds from each storage condition were subjected to germination tests. About 100 seeds were taken from three different storage conditions and put for germination test with 4 replications.

2.1.10. Evaluation of Seeds from Proposed Teak Seed Production Areas.

Teak seeds were collected from 19 plantations of Nilambur and Kulathupuzha Research Ranges, which were proposed to be designated as TSPAs. The seeds brought to KFSC for testing their germinability and seed viability.

Rapid as well as conventional viability test were carried out. Rapid viability test included the cutting test. Four replications each with30 seeds were used for this test. The second category of viability test performed was germination test with 100 seeds each in 4 replications. Teak seeds were sown both in germination media and in raised nursery beds.

2.2. Miscellaneous forest tree species - Seed collection and assessment of seed quality.

2.2.1. Seed collection and Transportation: Seeds of 70 different tree species were collected from different forest areas and homesteads as per their availability and phenological cycle. (Chacko, 2002). The method of seed collection was either by gathering them from the ground after the seed fall or by plucking with long poles and hand pruners. The collected seeds were pre-cleaned in the field itself to reduce the bulk during transportation. The seeds were brought to KFSC without delay *en route*.

The seeds were transported fresh in order to avoid loss of viability. During transportation, care was taken to keep the seeds in a well ventilated position on a dry surface. Seeds of recalcitrant species like *Syzigium cumini, Aphanamixis polistachya, Dysoxylum malabaricum* and almost all the species of rattans were transported after covering the seeds/fruits in a moist gunny bag to retain the moisture. As soon as the seeds reached KFSC, weighing was made prior to final cleaning and processing.

2.2.2. Processing: The process of extraction of seeds from pods/fruits of miscellaneous tree species depended on the nature of the fruit. Seeds of dry dehiscent fruits like *Xylia xylocarpa, Caesalpinia sappan, Pongamia pinnata, Albizia lebbeck,* etc. were extracted from the pods by drying them under the sun for about a week. However, in species like *Wrightia tinctoria, Oroxylum indicum and Alstonia scholaris,* the follicles/pods were kept covered by a thin cloth in order to prevent them from getting blown away by wind, during sun drying. The

seed drier designed and developed at KFSC was also used for drying the seeds of *Albizia lebbeck, Haldinia cordifolia* and *Phyllanthus emblica.* Fruits of these species were kept above the mesh using different sieve sizes depending on the seed size. Seeds of *Cassia fistula* were extracted by physically opening the pods along the suture with a hammer. In the case of *Eucalyptus grandis*, a species with very minute seeds, a moderate amount of chaff was also retained along with the seeds especially during storage in order to promote aeration in the seedlot.

In *Diospyros ebenum, Melia dubia,* and *Calamus* species the fleshy fruits were depulped to separate the seeds from the pulp. Depulping was done by keeping the fruits in a bucket of clean water for two to three days depending on the ripeness of the fruit. The pulpy fruits were then macerated by squeezing them with hand until the seeds got separated. After repeated washings the clean seeds were dried under shade.

For very minute seeds like *Neolamarckia cadamba,* the extraction was by *froth method.* Here the fruits were allowed to rot in water for 3 to 4 days and converted into a slurry by crushing the fruits in water. The slurry was further diluted and decanted into another container. The process of decanting was repeated till a thick froth developed as a top layer. The froth was then skimmed out and sieved through a piece of cloth and shade dried. The seeds were then sieved through a set of 425, 355 micron sieves. Clean seeds were assessed for their quality and viability (Schmidt, 2000; Chacko, 2002).

The different tests carried out for the quality assessment included purity test, cutting test, moisture determination and germination test.

2.2.3. Purity Test: ISTA (International Seed Testing Association, 1985) rules were followed in testing the purity of seeds. The steps included taking the initial sample weight followed by the weight of pure seeds. Pure seeds were separated from the working sample containing pure seeds, dead seeds and inert materials with the help of purity board. The percentage of purity was determined using the following formula,

$$\text{Purity \%} = \frac{\text{Weight of pure seed (g)}}{\text{Total weight of sample (g)}} \times 100$$

2.2.4. Moisture Determination: Determination of moisture is a pre-requisite for selecting the type of storage for different species. The moisture

content was determined in two different ways. One was by the conventional method detailed under section 2.1.3.

The second method was by using moisture analyzer. This instrument is a combination of an electronic balance and a moisture meter. Under a microprocessor control, the sample will be heated up rapidly and the result computed based on the moisture being lost from the sample.

2.2.5. Viability Tests

2.2.5.1. Cutting test: Cutting test was performed as described under section 2.1.4.1. This method is widely used in seed testing, though it is not an ISTA recognized method. However, it is the quickest and simplest test for identifying viable, dead and immature seeds visually.

2.2.5.2. Topographical Tetrazolium Test (TTZ test): The Topographical Tetrazolium test commonly known as TTZ test is a bio-chemical method adopted widely to examine the seed viability. It provides more accurate assessment than the cutting test. The chemical, 2, 3, 5- Tryphenyl tetrazolium chloride used for the test, readily dissolves in water to form a colorless solution. The tetrazolium salts react with live tissues that respire, and break down to form insoluble tri-phenyl formazan. This stains the live tissues reddish pink, while dead and immature tissues remain unstained. Only those with fully or partially stained embryos or cotyledon are classified as viable. Prior to the TTZ test, the seeds were soaked in water for at least 24 hours. The soaked seeds were then transferred to glass beakers containing TTZ solution, kept at 30^0C (room temperature) in the darkness for 4 to 17 hrs. 1% solution was used for the test. The seeds were kept fully immersed in TTZ solution. The time duration for the treatment was species dependent.

2.2.5.3. Hydrogen peroxide test: The initial germination of the seeds was evaluated through this test. Hydrogen peroxide acts as a respiration stimulant and accelerates the breakdown of reserve food substances, thus providing a rapid supply of energy and oxygen for germination. During this test, seed coats were cut open to expose the radicle. It was then incubated in a 1% H_2O_2 solution for 48 hours in the dark. Radicle growth was measured after 3-4 days for ascertaining the germination percentage.

2.2.5.4. Germination test: Germination, the process of emergence and development of a seedling from a mature seed was also monitored. Different

media like, sawdust, vermiculite, sand/ vermiculite mixture, quartz sand, soil, pot mixture (sand; soil; cow dung in the ratio 2:1:1) were used for testing the germination in different type of seeds.

2.2.5.4.1. Vermiculite method: Vermiculite was used for germination tests at KFSC because of its reusable nature and water holding capacity (419 ml/ L) more than any other media. Moreover, vermiculite being an inert material, media born infections were almost absent. Data on first emergence of the radicle, number of seeds getting germinated every day, etc. were regularly recorded in the prescribed pro-forma – KFSC form No. S.4.

2.2.5.4.2. Polyurethane foam method: Species with very minute seeds like *Neolamarckia cadamba, Haldina cordifolia*, *Eucalyptus grandis*, and *Eucalyptus terticornis* were tested for germination using polyurethane foam sheets. The polyurethane foam sheets were of 1 to 1.5 mm thick and were squeezed thoroughly in water to replace all the air spaces with water. The water soaked sheet was kept immersed in plastic trays of 25cm x 20cm size filled with water. The excess water in the tray was decanted and the seeds sprinkled over the sheet. Since the sheet retained water for a very long period, germination used to be uniform.

2.2.6. Pre-sowing Treatments

Depending on the type of dormancy, pre-treatments were tried. The major types of pretreatment tried were as follows.

2.2.6.1. Mechanical scarification: A portion of the seed was nicked or pierced with a needle so as to allow entry of water into the seed; as in *Samania saman* or a sand paper was used for rubbing off the seed coat of *Acacia nilotica*.

2.2.6.2. Water soaking: In this method seeds were soaked in a container of water. The duration of soaking differed depending on the nature of the seed and it varied from 12 hours to 48 hours.

2.2.6.3. Hot water treatment : Seeds with hard seed coat (*Bauhinia malabarica, Caesalpinia sappan, Gliricidia sepium*) were subjected to hot water treatment. Seeds were put in small cloth bags and were dipped in boiling water for few seconds and then kept in cold water over night.

2.2.6.4. Acid Scarification: Some seeds like *Cassia fistula, Enterolobium cyclocarpum* and *Adenanthera pavonina* required pre-treatment with con.sulphuric acid (98%) for improving the germination. Seeds were soaked in

the acid at room temperature for a fixed length of time (5-20 minutes) depending on the species. The seeds were then taken out of the acid and thoroughly washed in running water several times and kept in cold water for overnight.

2.2.6.5. Hormonal treatment: A Growth regulator like gibberllic acid (GA3) was used for pre treating seeds of certain species like *Santalum album.* Seeds were kept overnight in 0.05% of GA_3 solution.

2.2.7. Storage

Clean, graded seeds of all the species were stored in the ambient/cold storage facility at KFSC according to the seed type till they were distributed.

2.2.7.1 Ambient storage: Seeds (*Melia dubia*, *Tectona grandis*) which have post harvesting maturation were stored either with in gunny bag or plastic container in ambient condition.

2.2.7.2 Cold storage (16^0C): When seeds were to be stored for one or more years they were stored under controlled temperature (16^0C) and humidity (45%). Usually polythene bags and plastic bins were used for storing the seeds. Before storing the seeds they were sprayed with Carbon di-oxide for the prevention of insect infestation and inhibition of respiration during storage. Recalcitrant seeds (*Azadirachta indica*) were treated with fungicide; Bavistine in order to prevent fungal infestation.

2.2.7.3 Cold storage (4^0C): In this method the seeds were stored for a very long duration of more than two years. Ecologically and economically important species were stored even up to five years in very low temperature and humidity. Seeds of *Santalum album*, *Bambusa bambos*, *Calamus* spp. were stored by this method.

3. RESULTS

3.1 Teak –seed collection and assessment of seed quality.

3.1.1. Quantity of Teak seeds Processed

During the reporting period (2006-2010) a total quantity of about 50 tonnes of seeds were brought to KFSC and after cleaning and grading, 45 tonnes of seeds were available. Year-wise quantity of seeds brought to KFSC and cleaned, graded seeds made available are given in Table 2.

Table 2. Teak seeds collected by Kerala Forest Department and processed at Kerala Forest Seed Centre during 2006-2010

Sl NO	Name of TSPA	Area in (Ha)	2006-2007		Ger% ***	2007-2008		Ger% ***	2008-2009		Ger% ***	2009-2010		Ger% ***
			BG*(kg)	AG**(kg)		BG* (kg)	AG**(kg)		BG*(kg)	AG**(kg)		BG*(kg)	AG**(kg)	
KODANADU RESEARCH RANGE														
1	**1951,52,63 Panduppara**		397.900	357.940	**16.67**	423.000	356.000	20.33	264.500	215.560	8.58	177.00	139.160	17.5
TOTAL														
KULATHUPUZHA RESEARCH RANGE														
1	1950 Naduvathum mozhi		-	-		-	-		-	-		243.000	221.220	2.00
2	1955 Naduvathum mozhi		-	-		-	-		-	-		259.000	198.640	10.5
3	1956 Naduvathum mozhi		-	-		-	-		-	-		282.000	198.620	6.25
4	1959 Naduvathum mozhi		-	-		-	-		-	-		96.000	74.040	17.25
5	1960 Naduvathum mozhi		-	-		-	-		-	-		298.000	237.200	5.50
6	1963 Naduvathum mozhi		-	-		-	-		-	-		204.000	161.180	15.75
7	1964 Naduvathum mozhi		-	-		-	-		-	-		282.000	191.560	14.5
8	1965 Naduvathum mozhi		-	-		-	-		-	-		306.000	233.200	1.75
9	1948 Konni parakadavu		-	-		-	-		-	-		298.000	232.230	16.25
10	1949 Konni kummannur		-	-		-	-		-	-		237.000	191.720	7.00
11	1950 Konni vattappara		-	-		-	-		-	-		210.000	169.350	13.00
12	1960 Rajacoup PTSPA		-	-		-	-		-	-		698.000	563.680	21.00
13	1961 Rajacoup PTSPA		-	-		-	-		-	-		434.000	329.770	6.00
14	1962 Rajacoup PTSPA		-	-		-	-		-	-		462.000	367.090	2.25
15	1968 Palaruvi- A PTSPA		-	-		-	-		-	-		361.000	294.030	15.00
16	1968 Palaruvi- B PTSPA		-	-		-	-		-	-		50.000	42.800	5.25
17	1970 Palaruvi PTSPA		-	-		-	-		-	-		271.000	203.300	5.00
TOTAL												**4991.000**	**3909.630**	

***BG = Before Grading **AG = After Grading *** Ger % = Germination percentage**

Table 2. Teak seeds collected by Kerala Forest Department and processed at Kerala Forest Seed Centre during 2006-2010. Contd.

Sl NO	Name of TSPA	Area in (Ha)	2006-2007		Ger% ***	2007-2008		Ger% ***	2008-2009		Ger% ***	2009-2010		Ger% ***
			BG*(kg)	AG**(kg)		BG*(kg)	AG**(kg)		BG*(kg)	AG**(kg)		BG*(kg)	AG**(kg)	
MANANTHAVADY RESEARCH RANGE														
1	1939 Tholpetty	14.00	135.000	122.000		102.700	88.700	9.66	165.000	149.560	14.00	227.000	203.410	36.50
2	1948 Tholpetty	28.940	316.800	277.500	23.00	250.00	223.500	23.00	503.000	433.080	11.83	403.000	355.110	40.00
3	1949 Tholpetty	23.560	598.160	543.180	26.00	256.00	227.800	20.00	453.000	408.930	11.16	383.000	341.040	45.75
4	1953 Camp road	20.00	109.600	94.200	21.00	-	-	-	462.000	418.900	9.29	233.000	207.900	30.50
5	1954 Camp road	20.00	101.700	88.700	21.60	-	-	-	460.000	418.350	13.63	225.000	201.460	18.50
6	1955 Camp road	20.00	129.500	112.900	32.00	-	-	-	466.000	406.780	20.04	390.000	350.420	27.25
7	1956 Camp road	28.300	598.160	543.180	33.00	672.100	601.600	12.66	246.000	224.560	2.00	513.000	456.910	28.25
8	1958 Thetturoad	25.00	120.000	107.600	31.00	546.00	488.550	18.66	247.000	220.480	6.750	531.000	476.610	25.50
9	1962 Tholpetty	31.050	447.600	391.700	21.00				547.000	481.490	22.08	308.000	272.220	20.25
10	1963 Tholpetty	10.650	260.220	224.140	30.00				402.000	362.620	20.29	177.000	154.780	27.50
TOTAL			**2551.580**	**2257.420**		**1826.800**	**1630.150**		**3951.000**	**3524.750**		**3390.000**	**3019.860**	
NILAMBUR RESEARCH RANGE														
1	1930-32 Nellikutha	12.540	127.500	114.960	30.00	280.000	241.700	26.44	1353.000	1195.570	13.50	127.500	114.960	30.00
2	1944 Chanthanpurai	37.00	658.000	611.370	29.00	904.100	807.500	20.78	1039.000	927.540	13.68	658.000	611.370	29.00
3	1945 Chanthanpurai	16.400	129.000	120.060	33.66	249.200	217.100	22.99	417.000	369.180	15.25	129.000	120.060	33.66
4	1951 Kanjirakadavu	17.500	317.500	295.680	30.33	706.100	614.000	24.83	1985.000	1765.070	14.63	317.500	295.680	30.33
5	1961 Sankrankode	79.570	977.400	913.680	23.00	1367.000	1229.000	23.99	3639.000	3255.270	12.23	977.400	913.680	23.00
6	1963 Sankrankode	4.280							122.000	107.600	16.25			
7	1963 Mundakkadavu	22.818							421.000	371.960	15.83			
8	1965 Ezhuthukkal	24.960							1362.000	1227.970	11.42			
9	1966 Ezhuttukkal	6.920							212.000	188.360	13.50			
10	1970 Poolakkapara	31.500							1245.000	1130.780	12.00			
11	1971 Cherupuzha	20.00	292.600	274.030	24.00	300.000	273.850	26.83	548.000	491.320	14.25	292.600	274.030	24.00
12	1972 Nedumgayam	9.092												
TOTAL			**2502.000**	**2329.780**		**3806.400**	**3383.150**		**12604.000**	**11254.020**		**2502.000**	**2329.780**	

***BG = Before Grading **AG = After Grading *** Ger % = Germination percentage**

Table 2. Teak seeds collected by Kerala Forest Department and processed at Kerala Forest Seed Centre during 2006-2010. Contd.

Sl No	Name of TSPA	Area in (Ha)	2006-2007		Ger% ***	2007-2008		Ger% ***	2008-2009		Ger% ***	2009-2010		Ger% ***
			BG*(kg)	AG**(kg)		BG*(kg)	AG**(kg)		BG*(kg)	AG**(kg)		BG*(kg)	AG**(kg)	
OLAVAKODU RESEARCH RANGE														
1	1943 Thoonakadavu	43.00	950.300	916.790	26.00	-	-	--	683.000	649.290	7.08	593.000	565.070	3.00
2	1944 Thoonakadavu	35.00	641.000	620.600	26.60	-	-	--	599.000	564.500	7.375	408.000	354.150	2.75
3	1945 Thoonakadavu	40.00	1416.50	1350.000	24.00	816.00	782.860	22.00	519.000	492.750	9.92	413.000	395.740	5.75
4	1945(IFGTB) Thoonakadavu		-	-	-	497.00	472.480	25.00	186.000	175.020	8.29	-	-	-
5	1946 Thoonakadavu	40.00	774.900	751.900	24.00	-	-	-	510.000	480.040	5.17	353.000	335.540	5.50
6	1947 Thoonakadavu	40.00	773.200	744.120	27.00	-	-	-	172.000	157.800	7.00	716.000	648.480	2.25
7	1953 Thoonakadavu	40.00	1114.00	1054.860	24.00	963.00	915.300	24.00	117.000	110.600	4.66	674.000	629.450	12.50
8	1955 Thoonakadavu	27.00	816.000	782.860	22.00									
			6485.900	**6221.130**		**2276.000**	**2170.640**		**2786.000**	**2630.000**		**3157.000**	**2928.430**	
PEERUMEDU RESEARCH RANGE														
1	1944 Kalaketty		-	-		21.00	18.00	22.33	-	-	-	70.00	56.320	25.50
2	1946 Kalaketty		-	-		26.00	22.00	31.66	-	-	-	-	-	-
3	1954 Kalaketty		-	-		68.00	57.500	20.66	-	-	-	192.00	154.74.00	24.50
4	1955 kalaketty		-	-		62.00	51.00	22.00	-	-	-	123.00	100.88	20.45
5	1967 Padayanippara		-	-		-	-	-	-	-	-	245.00	213.83	18.12
6	1968 Padayanippara		-	-		-	-	-	-	-	-	243.00	211.84	19.62
7	1968 Thekkumala		-	-		-	-	-	-	-	-	172.00	155.580	14.25
	TOTAL					**177.000**	**148.500**					**1045.000**	**893.190**	

BG = Before Grading AG = After Grading Ger % = Germination percentage

Only those teak seeds which gave above 20 % germination alone were used for distribution and different seed biological studies at KFSC.

3.1.2. Standardization of Seed collection period in Teak

Seeds collected from the earlier part of the seeding season gave very poor germination percentage (Table 3). Seeds from Nilambur gave maximum germination percentage right from January 2007 and the trend continued till March. Excepting Kulathupuzha, seeds from all the other Ranges gave maximum germination during March 2007(Fig 1.)

Germination percentages of seeds collected during different months from the 6 Research Ranges of KFD are given in Table 3.

Table 3. Germination percentage of Seeds collected during different collection periods.

SI No	Name of Teak Seed Production Area (TSPA)	Germination (%)				
		Nov-06	Dec-06	Jan-07	Feb-07	Mar-07
Kodanadu research range						
1	1951,52&1963TSPA Panduppara	0.00	0.00	Seeds not obtained from KFD for germination tests.		22.00
Kulathupuzha Research Range						
1	1943 TSPA Muthalathodu	1.70	1.33	13.00	12.00	13.33
2	1943 TSPA Chempalu	2.00	1.00	9.33	13.00	11.00
3	1947 TSPA Kummannur	2.33	1.33	8.00	15.66	10.66
4	1948 TSPA Parakkadavu	2.00	0.33	10.00	15.33	10.00
5	1949 TSPA Kummannur	0.00	0.67	15.33	18.66	12.33
6	1950 TSPA Naduvathumuzhy	3.33	0.00	13.33	12.00	13.00
7	1950 TSPA Vattapara	0.33	0.33	9.00	15.33	16.00
8	1955 TSPA Naduvathumuzhy	3.33	0.33	5.66	13.66	16.00
9	1956 TSPA Naduvathumuzhy	2.00	0.00	10.33	17.66	17.66
10	1959 TSPA Naduvathumuzhy	3.70	3.00	11.66	19.66	20.33
11	1960TSPA Naduvathumuzhy	0.00	0.67	11.00	13.66	15.00
12	1963 TSPA Naduvathumuzhy	4.00	1.67	6.00	16.33	12.33
13	1964 TSPA Naduvathumuzhy	3.70	1.67	12.66	13.33	16.00
14	1965 TSPA Naduvathumuzhy	4.30	0.67	7.33	15.00	12.66

SI No	Name of TSPA	Germination (%)				
		Nov-06	Dec-06	Jan-07	Feb-07	Mar-07
Mananthavady Research Range						
1	1939 TSPA Thettu Road	0.33	0.33	2.66	12.33	24.00
2	1948 TSPA Tholpetty	0.00	0.00	1.00	9.66	23.00
3	1949 TSPA Tholpetty	0.33	0.33	5.33	24.66	25.00
4	1953 TSPA Camp Road	0.67	0.33	0.00	13.66	21.00
5	1954 TSPA Camp Road	0.33	0.33	6.00	10.33	21.60
6	1955 TSPA Camp Road	0.33	0.00	0.00	13.00	32.00
7	1956 TSPA Camp Road	1.33	0.33	2.33	3.00	33.00
8	1958 TSPA Thettu Road	1.33	0.00	1.00	14.00	31.00
9	1962 TSPA Tholpetty	0.33	0.00	6.33	29.00	21.00
10	1963 TSPA Tholpetty	0.33	0.00	6.66	22.66	30.00
Nilambur Research Range						
1	1930-32 TSPA Nellikutha	0.00	0.33	23.00	22.6	30.00
2	1944 TSPA Chathamputhai	0.30	0.33	19.33	24.00	29.00
3	1945 TSPA Chathamputhai	0.00	0.00	23.00	20.00	33.66
4	1951 TSPA Kanjirakadavu	0.00	1.00	21.33	21.00	30.33
5	1961 TSPA Sankarankode	1.33	0.33	19.33	25.00	23.00
6	1971 TSPA Cherupuzha	0.00	0.00	24.00	24.00	24.00
Olavakkode Research Range						
1	1943 TSPA Thoonakkadavu	Nil	1.33	11.00	5.66	26.00
2	1944 TSPA Thoonakkadavu	Nil	0.33	9.66	12.33	26.60
3	1945 TSPA Thoonakkadavu	Nil	1.33	8.66	13.00	24.00
4	1946 TSPA Thoonakkadavu	Nil	0.67	5.00	9.66	24.00
5	1947 TSPA Thoonakkadavu	Nil	0.00	10.33	11.00	27.00
6	1953 TSPA Thoonakkadavu	Nil	0.33	9.60	8.33	24.00
7	1955 TSPA Thoonakkadavu	Nil	0.33	7.00	11.00	22.00
Peerumedu Research Range						
1	1944 TSPA Kalaketty	0.00	0.00	10.67	6.66	22.33
2	1946 TSPA Kalaketty	1.67	0.00	10.67	5.33	31.66
3	1954 TSPA Kalaketty	0.33	3.67	0.00	12.33	20.00
4	1955 TSPA Kalaketty	0.00	5.00	5.67	2.66	22.00

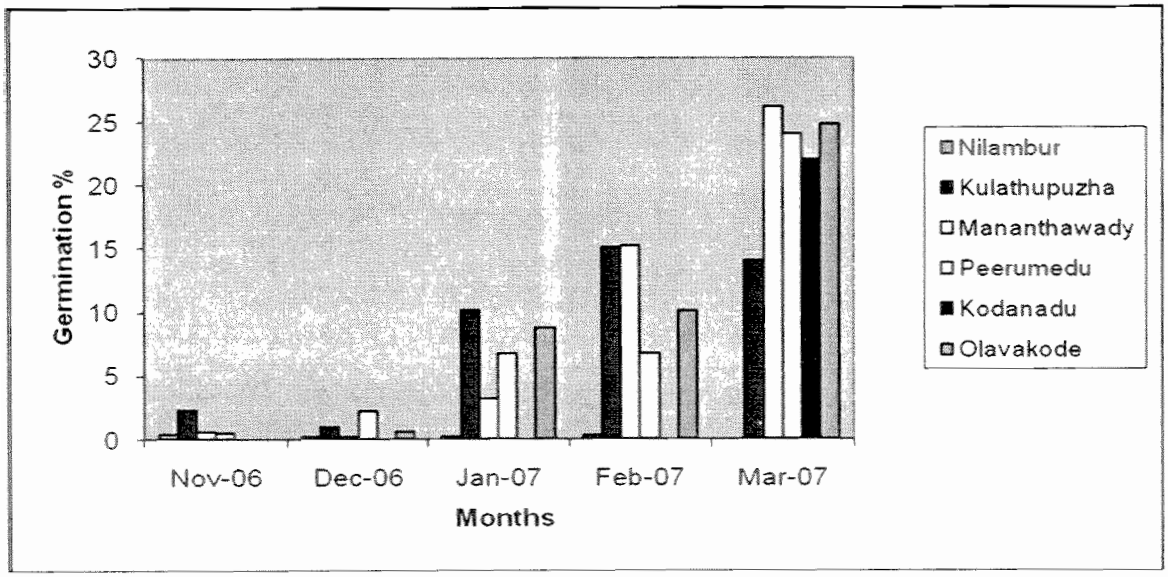

Fig.1 Germination percentage of teak seeds collected during different months.

3.1.3. Standardization of Weathering treatment

The most popular treatment method of alternate wetting and drying was studied in detail for standardization. Seeds subjected to pre-treatment and those in control started germination from the seventh day of sowing. Seeds maintained as control without any pre treatment gave very poor germination of 18%. Uniform and high germination (34%) was obtained when the seeds were heaped after wetting and covered with moist gunny bag in the evening up to subjected to sun drying on the following morning. A 12 hrs period of alternate wetting and drying gave better germination than 24 hrs treatment. (Table 4).

Fig 2.Wetting seeds within sack

Fig 3. Wetting seeds as thick bed

Fig 4 .Wetting seeds in heap and covered with wet gunny bag

Fig 5. Drying seeds in sunlight

Table 4. Germination percentage of teak seeds in different treatments

Treatments (Alternate wetting and drying)	**Duration of Treatment (hrs)**	**7th Day**	**14th Day**	**21st Day**
T1- wetting in gunny bag	24 hrs	29.25^{cd}	21.50^{ab}	18.50^{bc}
T2 – wetting in heap	24 hrs	23.75^{ab}	24.75^{bc}	17.75^{b}
T3 – wetting in thick bed	24 hrs	20.25^{a}	16.50^{a}	11.00^{a}
T4 - wetting in gunny bag	12 hrs	31.25^{de}	23.00^{bc}	17.50^{ab}
T5 - wetting in heap	12 hrs	34.00^{e}	28.50^{c}	26.50^{c}
T6 - wetting in thick bed	12 hrs	25.50^{bc}	27.50^{bc}	17.25^{ab}

*Figures superscribed by the same letters indicate non significance.

Statistical analysis of the data by Anova showed significant difference between the treatments. Duncan's Multiple Range Test (DMRT) revealed that the treatment T5 (seeds heaped and covered with moist gunny bag) and T4 (wetting in gunny bag for 12 hours) were significantly different from all the other treatments. When the treatments were continued for 14 and 21

days, higher germination was observed in T5, which was significantly different from all the remaining treatments (Table 4).

3.1.4. Standardization of Storage period for Teak seeds

Though storage conditions were different (ambient, 4^0C and 16^0 C) seed germination showed uniformity in all the cases initially when tested after one year of storage; at a later stage, there was wide variation in germination percentage. Seeds stored in ambient condition gave lesser germination percentage than those stored in cold storage. Seeds stored in cold room maintained at 4^0C and 45% humidity showed better germination (32%) than those stored in 16^0 C and 45% humidity.

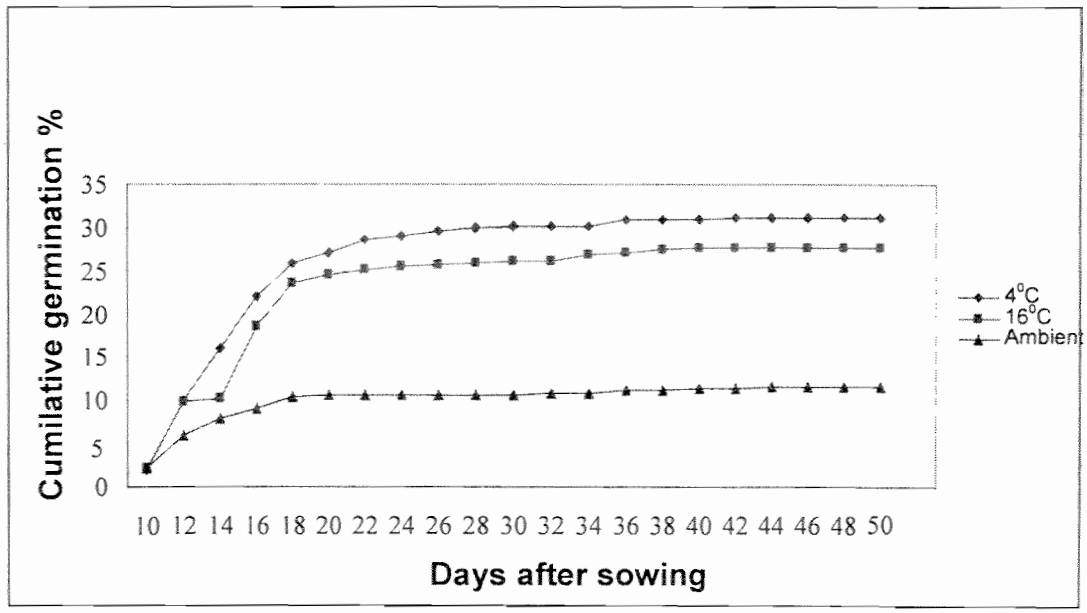

Fig. 6 Germination percentage of teak seeds stored under different storage condition

3.1.5. Evaluation of Proposed Teak Seed Production Areas (PTSPA)

Highest viability was noted in seeds from Nilambur (90%) and Kulathupuzha (89%) as revealed to rapid viability test (cutting test). However, when the seeds were tested for germination under laboratory and field nursery conditions, the viability percentage was 14% (lab condition) and 5 % (field condition) for the Nilambur samples, 6% (lab condition) and 9% (field condition) for Kulathupuzha samples respectively. When

statistically analyzed there was no significant difference in germination of teak seeds in the field nursery beds and laboratory conditions.

Table 6. Viability tests (germination percentage) conducted in seeds collected from teak plantations of Kulathupuzha and Nilambur Research Range.

SI NO	Name of plantation	Extent (ha)	Total quantity of graded seeds from sample plots (kg)	Cutting test	Germination test	
					Lab condition	Field condition
Kulathupuzha Research Range						
1	1960 Teak plantation, Rajacoupe	41.619	211.70	87.95	9.16	9.60
2	1961, Teak plantation, Rajacoupe	19.78	6.30	91.02	7.91	11.50
3	1962 Teak plantation, Rajacoupe	19.878	92.00	90.02	3.24	6.70
4	1968 Teak plantation, Palaruvi	2.310	48.50	89.61	3.65	9.80
5	1968 Teak plantation, Palaruvi	13.960	96.00	89.25	7.22	9.00
6	1970 Teak plantation, Palaruvi	9.700	45.00	90.50	4.33	6.20
Nilambur Research Range						
7	1965, Teak plantation, Ezhuthukal	30.000	99.00	90.91	14.04	18.00
8	1966, Teak plantation, Ezhuthukal	7.489	17.00	91.63	19.50	20.50
9	1967, Teak plantation, Vattikkal	20.000	94.70	86.91	10.91	11.70
10	1972, Teak plantation, Nedumgayam	10.000	38.00	90.55	17.33	11.50
11	1973, Teak plantation, Nedumgayam	37.000	113.90	88.62	14.52	13.80
12	1970, Teak plantation, Nedumgayam	25.000	110.20	89.75	12.53	11.60
13	1963 Teak plantation, Mundakkadavu	20.000	103.00	90.63	17.86	15.80
14	1963 Teak plantation, (Mundakkadavu)	25.000	26.10	91.37	11.74	14.10
15	1969 Teak plantation, Poolakkapara	30.000	138.20	89.98	14.27	14.40
16	1970 Teak plantation, Poolakkapara	30.000	104.65	89.62	11.44	13.10
17	1974 Teak plantation, Kariyamuriyam	20.000	22.00	91.93	13.99	13.70
18	1969 Teak plantation, Edakkodu	25.000	29.50	89.76	16.33	16.10
19	1970 Teak plantation, Edakkodu	30.000	11.73	90.17	11.83	15.70

3.2. Seeds from Miscellaneous forest tree species

Seeds that gave higher germination percentage in viability tests (above 50 % germination) were either stored in appropriate storage rooms or distributed to the clients as per the indent. Poor quality seeds (below 10 % germination) were discarded.

A list of species collected and transported to KFSC by the forest department during the project period (2006-2010) is given in table -7.

Table- 8 gives details on the seeds collected by KFSC during the reporting period (2006-2010). The seeds were processed, subjected to viability test and distributed to the clients as per their request.

Table 7. Miscellaneous seeds received from KFD during the project period 2006-2010

Sl No	Botanical name	Local name	Quantity collected(kg)				Total (kg)	Qty distributed (kg)
			2006-07	2007-08	2008-09	2009-10		
1	*Acacia auriculiformis*	Acacia	-	0.190	-	5.415	5.615	-
2	*Acacia mangium*	Mangium	11.900	40.00		13.000	64.900	51.900
3	*Acacia peregrina*		-	-	-	7.000	7.000	-
4	*Aegle marmelos*	Koovalam	-	0.200	-	-	0.200	0.200
5	*Ailanthus excelsa*	Peemaram	1.000	3.100	-	-	4.100	-
6	*Ailanthus triphysa*	Matti	0.500	-	-	-	0.500	-
7	*Albizia odoratissima*	Kunnivaka						
8	*Bambusa bambos*	Mullu mula	62.940	53.950	-	9.720	126.610	9.110
9	*Bauhinia malabarica*	Aaram puli	5.250	-	-	0.100	5.350	-
10	*Caesalpinia sappan*	Pathimukham	-	29.550	-	8.750	38.300	29.550
11	*Calamus hookerianus*	Velichooral	2.300	-	-	-	2.300	-
12	*Calamus thwaitesii*	Pannichooral	70.950	-	59.000	-	129.950	70.950
13	*Casurina equisetifolia*	Kattadi	-	-	-	0.045	0.045	-
14	*Cassia fistula*	Kani konna	10.700	5.000	3.00	1.000	19.700	19.700
15	*Dalbergia latifolia*	Veeti	-	-	3.570	-	3.570	3.570
16	*Eucalyptus grandis*	Eucaly	-	-	1.000	-	1.000	-
17	*Holoptelea integrifolia*	Aaval	0.500	4.900	-	-	5.200	4.300
18	*Hydnocarpus pentandra*	Marotti	-	-	-	-		
19	*Lagerstroemia microcarpa*	Venthekku	0.200	12.980	4.580	-	17.760	9.760
20	*Lagerstroemia reginae*	Manimaruth	-	0.700	-	-	0.700	-

Table 7. Miscellaneous seeds received from KFD during the project period 2006-2010. Contd.

SI No	Botanical name	Local name	Quantity collected(kg)				Total (kg)	Qty distributed (kg)
			2006-07	2007-08	2008-09	2009-10		
21	*Melia dubia*	Mala veppu	52.250	-	-	-	52.250	52.250
22	*Oroxylum indicum*	Palakappayyani	-	5.200	-	-	5.200	5.200
23	*Pongamia pinnata*	Ungu	7.700	29.300	10.00	36.22	83.220	47.000
24	*Phyllanthus emblica*	Nelli	8.500	-	-	-	8.500	8.500
25	*Pterocarpus marsupium*	Venga	50.800	22.600	1.240	-	74.640	74.640
26	*Santalam album*	Chandanam	10.700	74.500	-	-	85.200	74.500
27	*Sapindus emarginatus*	Soap nut	-	-	-	5	5.000	-
28	*Spondias pinnata*	Kattu ambazham	4.000	-	-	9.400	13.400	4.000
29	*Strychnos nux-vomica*	Kanjiram	8.000	1.000	-	-	9.000	9.000
30	*Swietenia macrophylla*	Valiya mahogany	143.500	468.150	279.06	509.780	1400.490	717.250
31	*Terminalia bellirica*	Thanni	1306.630	-	137.200	190.00	1633.830	1370.630
32	*Terminalia crenulata*	Karimaruth	123.500	164.2	83.620	417.000	788.320	345.700
33	*Terminalia paniculata*	Pulla maruth	3.500	-	5.320	-	8.820	-
34	*Tetrameles nudiflora*	Cheeni	1.150	-	-	-	1.150	-
35	*Wrightia tinctoria*	Dantha ppala	-	4.900	-	-	4.900	4.150
36	*Xylia xylocarpa*	Irul	-	-	0.275	-	0.275	0.275

Table 8. Miscellaneous seeds collected by KFSC during the reporting period 2006-2010

SI No	Botanical name	Local name	Quantity collected (kg)				Total (kg)	Qty sold (kg)
			2006-07	2007-08	2008-09	2009-10		
1	*Acacia auriculiformis*	Acaia	0.345	-	0.780	4.000	5.125	0.945
2	*Acacia mangium*	Mangium	2.468	-	22.460	7.000	31.928	6.473
3	*Acrocarpus fraxinifolius*	Nari venga	-	1.300	-		1.300	1.300
4	*Adenanthera pavonina*	Manjadi	-	-	3.150	0.750	3.900	3.150
5	*Aegle marmelos*	Koovalam	4.150	0.800	3.450	2.630	11.030	7.000
6	*Ailanthus triphysa*	Matti	5.922	13.80	0.480	32.64	52.842	31.882
7	*Artocarpus hirsutus*	Anjili	6.400	-	-		6.400	6.400
8	*Asparagus racemosus*	Sathavari	-	-	-	0.110	0.110	0.000
9	*Azadirachta indica*	Veppu	-	4.400	2.000	-	6.400	6.400
10	*Aphanamixis polystachiya*	Chemmaram				1.000	1.000	0.000
11	*Bambusa bambos*	Mullu mula			90.500	175.210	265.710	48.744
12	*Bambusa gigantea*	Paramula				3.750	3.750	1.000
13	*Bambusa pallida*					15.800	15.800	0.000
14	*Butea monosperma*	Plashu				5.710	5.710	5.603
15	*Caesalpinia coriaria*	Divi Divi				13.000	13.000	0.000
16	*Caesalpinia sappan*	Pathi mukham	34.350	70.860	100.980	116.770	322.960	202.460
17	*Calamus longisetus*					10.000	10.000	0.000
18	*Calamus pseudotenuis*	Chooral	10.000	-	-	-	10.000	10.000
19	*Calamus rotang*	Cheru chooral	-	10.000	-	-	10.000	10.000
20	*Calamus thwaitesii*	Panni chooral	25.000	14.400	180.500	57.100	277.000	246.500

Table 8. Miscellaneous seeds collected by KFSC during the reporting period 2006-2010. contd

Sl No	Botanical name	Local name	Quantity collected (kg)				Total (kg)	Qty sold (kg)
			2006-07	2007-08	2008-09	2009-10		
21	*Cassia fistula*	Kanikonna	-	3.900	25.350	22.000	51.250	17.775
22	*Casuarina equisetifolia*	Kattadi	2.250	38.900	6.000	11.300	58.450	40.200
23	*Dipterocarpus bourdillonii*	Karanjily				14.960	14.960	0.000
24	*Dalbergia latifolia*	Veetti			8.600	23.000	31.600	6.000
25	*Delonix regia*	Gulmohar			3.378	4.000	7.378	2.828
26	*Dillenia pentagyna*	Vazha punna	11.850	-	-		11.850	0.850
27	*Diospyros ebenum*	Ebony				5.450	5.450	2.250
28	*Enterolobium cylocarpum*	Elephant ear tree				2.300	2.300	0.000
29	*Eucalyptus grandis*	Eucaly	-	-	22.340	3.300	26.040	2.942
30	*Eucalyptus globulus*	Eucaly	-	-	5.390		5.390	0.000
31	*Ficus bengalensis*	Peral				2.700	2.700	0.000
32	*Ficus dalhousiae*	Kallal	-	-	2.880		2.880	0.200
33	*Garcinia gummigutta*	Kudampuli				1.000	1.000	0.000
34	*Gliricidia sepium*	Seema konna	2.060	-	-		2.060	0.540
35	*Gmelina arborea*	Kumizhu	-	2.500	-	27.960	30.460	25.960
36	*Haldina cordifolia*	Manja kadambu	0.944	-	1.200	0.180	2.324	2.174
37	*Holoptelia integrifolia*	Aval	1.814	-	8.780	-	10.594	3.214
38	*Hydnocarpus pentandra*	Marotti	2.500	-	-	-	2.500	2.000
39	*Lagerstroemia microcarpa*	Ven teak	11.000	-	2.70	-	13.700	13.000
40	*Lagerstroemia flos reginae*	Maimaruthu	-	-	-	3.800	3.800	0.000

Table 8. Miscellaneous seeds collected by KFSC during the reporting period 2006-2010. contd.

Sl No	Botanical name	Local name	Quantity collected (kg)				Total (kg)	Qty sold (kg)
			2006-07	2007-08	2008-09	2009-10		
41	*Leucana leucocephala*	Subabul	-	-	-	2.000	2.000	0.000
42	*Michelia chapaka*	Chempakam	-	-	-	1.000	1.000	0.000
43	*Melia dubia*	Mala veppu	224.000	-	-	6.500	230.500	28.650
44	*Neolamarckia cadamba*	Attu thekku	1.890	-	0.176	6.000	8.066	1.341
45	*Ochreinauclea missionis*	Attu vanchi	0.750	-	-	-	0.750	0.050
46	*Oroxylum indicum*	Palakappayyani	6.020	-	-	5.900	11.920	11.920
47	*Phyllanthus emblica*	Nelli	1.300	-	0.225	1.600	3.125	3.125
48	*Pongamia pinnata*	Ungu	6.200	5.000	52.280	28.450	98.130	39.940
49	*Pterocarpus marsupium*	Venga	23.800	15.500	3.960	8.820	52.080	41.580
50	*Punica granatum*	Mathalam	-	-	-	0.576	0.576	0.576
51	*Radermachera xylocarpa*	Vedamkorana	-	-	-	1.520	1.520	0.750
52	*Santalum album*	Chandanam	26.750	23.000	26.000	40.900	116.650	114.75
53	*Sapindus emerginatus*	Soap nut	4.790	-	4.000	5.000	13.790	9.890
54	*Saraca asoca*	Asokam	-	2.650	22.000	-	24.65	24.650
55	*Stereospermum colais*	Pathiri	-	-	-	1.000	1.000	0.000
56	*Strychnos nux-vomica*	Kanjiram	25.000	30.000	51.960	-	106.960	56.810
57	*Sweitenia macrophylla*	Mahagany	28.880	46.800	9.000	6.800	91.480	56.400
58	*Swietenia mahagony*	Cheriya mahagony	-	2.600	5.300	6.400	14.300	5.300
59	*Syzygium cumini*	Njaval	-	-	-	8.800	8.800	0.000
60	*Tamarindus indica*	Valan puli	-	-	-	5.300	5.300	0.000

Table 8. Miscellaneous seeds collected by KFSC during the reporting period 2006-2010.contd.

Sl No	Botanical name	Local name	Quantity collected (kg)				Total (kg)	Qty sold (kg)
			2006-07	2007-08	2008-09	2009-10		
61	*Tectona grandis*	Thekku	-	-	-	85.000	85.000	21.200
62	*Terminalia arjuna*	Neermaruth	16.000	-	33.940	55.600	105.540	41.140
63	*Terminalia bellirica*	Thanni	44.000	70.000	-	-	114.000	79.950
64	*Terminalia chebula*	Kadukka	-	15.000	17.860	20.900	53.760	9.410
65	*Terminalia crenulata*	Karimaruth	20.000	66.250	26.860	7.800	120.910	32.23
66	*Terminalia paniculata*	Pulla maruth	9.150	-	-	-	9.150	9.150
67	*Vitex altissima*	Mylellu	-	-	1.540	-	1.540	0.600
68	*Wrightia tinctoria*	Danthapala	3.100	5.200	7.420	7.700	23.420	11.850
69	*Xylia xylocarpa*	Irul	4.850	3.000	1.150	-	9.000	8.900
70	*Zanthoxylum rhetsa*	Mullilam	1.356	-	-	-	1.356	1.056

3.2.1 Seed biological studies

Seeds of 20 species were selected for detailed seed biological studies and the details are as follows.

3.2.1.1 *Alnus nepalensis* D.Don

Fig.6. Extracted Seeds

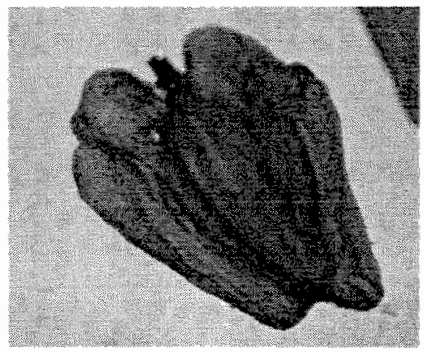

Fig.7. Seed- microscopic view

Synonyms	: *Alnus mairei* A. Léveillé, *Clethropsis nepalensis* Spach
Family	: Betulaceae
Trade name	: The Nepalese Alder
Local name	:
Habit	: Fast growing large deciduous tree up to a height of 30 m. (Mac Dicken,1994)
Distribution	: Native to Pakistan, eastern Nepal, Bhutan, northern India, south-western China, upper Myanmar and parts of Indochina. Introduced to various countries.
Uses	: The wood is an important source of firewood and charcoal.
Seed maturity	: January-March
Collection	: The catkins are collected directly from the tree when they turn yellowish-brown and begin to open.
Transportation	: Fruits collected in plastic/ gunny bag are packed and transported immediately.

Processing	: Cones are sundried and beaten with a stick to release seeds.
Seed description	: Fruits are dark brown catkin 1.5-2 cm long with winged seeds having 1-3mm length.
Seed dimension	: 1 mm length
Seed weight	: 20,00,000 to 20,45,000 / kg.
Seed emptiness	: Low
Insect infestation	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds will lose viability within six months.
Germination type	: Epigeal
Germination	: 50%
Germination period	: 7-30 days
Storage	: Seeds kept in sealed container remain viable for one year.
Viability testing	: Cutting test, Squeezing test and Germination test.

Cutting test done with a blade in 4 replications of 100 seeds. Only 39.5% seeds were good.

In **Squeezing Test** seeds were soaked in water for 24 hours. Then each of them was squeezed with a glass rod. Seeds, from which a white juice came out after squeezing were considered as good. This test was conducted in four replications (4x100). Only 35 % of seeds were viable.

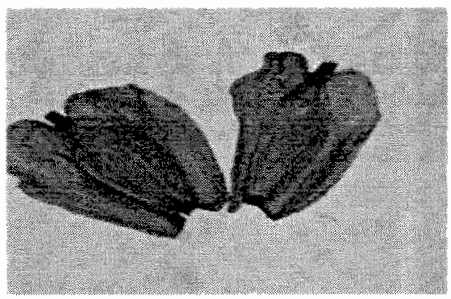

Fig.8. Alnus seed before squeezing

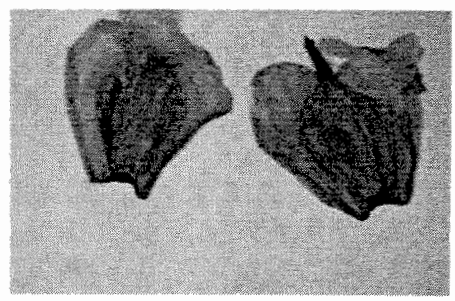

Fig.9. Alnus seed after squeezing off the pulp

Germination test was conducted on polyurethane foam, vermiculite, germination paper and soil. Seeds were sown in each medium without any treatment; it showed better germination on polyurethane foam (32.5%) and poor germination in vermiculite. In soil 30% seeds germinated, and in germination paper germination was only 25 %.

Pre-sowing treatment: The seeds were pre- treated by 0.05 % GA_3 for 15 minutes and sown on polyurethane foam, soil and germination paper. A maximum of 40% germination was obtained on germination paper and minimum (32.5 %) on polyurethane foam. In soil, germination reached up to 35 %. Soaking in water for 24 hours and sown on polyurethane foam, soil and germination paper showed germination percentage 50 %, 17.5%, 15 % respectively.

Seedling production : The seedlings are potted in polythene bags of size 10x20 cm when they are in 2-4 leaf stage. Seedlings maintained under shade for establishment. (Chacko.K.C, 2002)

3.2.1.2 *Aphanamixis polystachya* (Wall.) Parker.

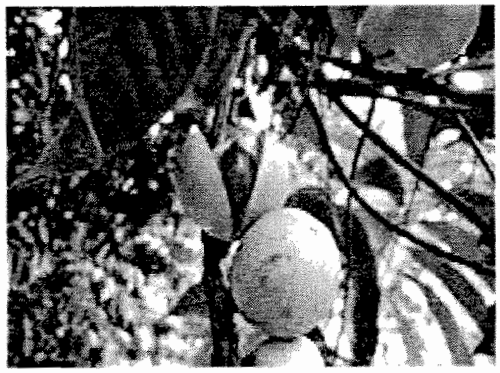

Fig.10 Plant with mature fruits

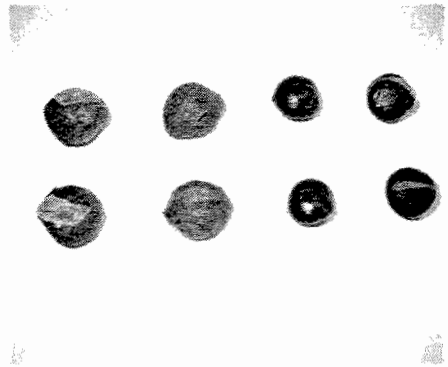

Fig.11 Extracted seeds

Synonyms	: *Aglaia polystachya* Wall. *Amoora rohituka* (Roxb.) Wight. & Arn.
Family	: Meliaceae
Trade names	: Sohaga
Local names	: Chemmaram (Mal), Harin hara (Hin), Malampuluvan (Tam)
Habit	: Mid-canopy tree up to 32 m tall and 37 cm dbh
Distribution	: It is found in moist deciduous to evergreen forests. Natural distribution of the species spans over India, Pakisthan, Nepal, Bhutan, Bangladesh, Myanmar and Sri Lanka. In India, it is distributed throughout except north and north western regions.
Uses	: The wood is used for constructional purposes. The bark is used medicinally against rheumatism. Mashed leaves in water solution are effective antifeedants, able to protect crops against insect herbivory. Oil for making soap is extracted from the seeds.
Seed maturity	: Flowering starts in August-September and fruiting in January – June.
Collection	: Fruits are collected directly from the tree.

Transportation	: Fruits collected in plastic/ gunny bag are packed and transported immediately.
Processing	: Seeds were removed from fleshy fruit by hand and shade dried.
Seed description	: Fruits are sub-globose capsule 20-25 mm diameter, pink-fleshy that split into 3 valves to reveal oval, chestnut-colored *seeds*, which are enclosed in thin membranous coat; seeds are with orange-red aril.
Seed dimension	: 18-23mm
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Recalcitrant
Viability period	: Seeds will lose viability within 6 months.
Germination type	: Hypogeal
Germination	: Up to 60%
Germination period	: 15-25 days
Storage	: No information
Viability testing	: Germination test.
Pre-sawing treatment	: Seeds germinate readily without pretreatment.
Seedling production	: Seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings reached 4 leaf stage, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.3 *Asparagus racemosus* Willd.

Fig.12. Plant with mature fruits

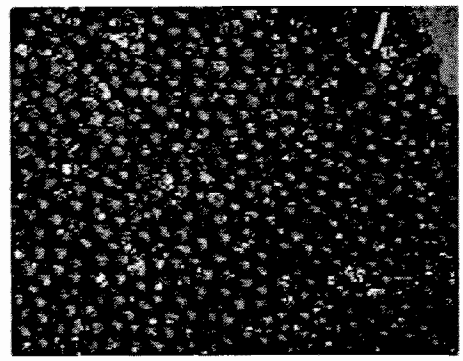

Fig.13. Processed seed

Synonyms	: *Asparagus rigidulus* Nakai, *Protasparagus racemosus* (Willd) Oberm.
Family	: Asparagaceae
Trade names	: Shatavari
Local names	: Shatavari (Mal), Satavari (Hin), Kilavari(Tam).
Habit	: A climbing shrub with needle like leaves, grows up to 2 meters in height.
Distribution	:In tropical, sub-tropical dry and deciduous forests. Distributed throughout in India.
Uses	:Roots are used in Ayurvedic medicine, following a regimen for processing and drying, with the name of Shatavari.
Seed maturity	: Mature fruits generally available during December to January.
Collection	: Dark red ripe fruits are collected from the plant by hand.
Transportation	: Fruits collected in plastic/ gunny bag are packed and transported immediately. Adequate air circulation should be ensured.
Processing	: Ripe fruits are de-pulped by soaking in water and dried in the sun (T. Pullaiah, 2006)
Seed description	: Fruits are small, round berry and turn red in colour at the time of maturity. Mostly each fruit contains a single seed.

Seed dimension	: 4.2 mm
Seed weight	: 20100-20200 /kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds have been reported to possess a low viability and a slow rate of growth (Gupta et al, 2002)
Germination type	: Hypogeal
Germination	: Up to 90%
Germination period	: 20-30 days
Storage	: Seeds can be stored either in polythene bag or air tight containers.
Viability testing	: Germination test.
Pre-sowing treatment	: Seeds are to be soaked in water for twelve hours prior to sowing. Soaking seeds in cow's urine for six hours enhances germination up to 90%.
Seedling production	: Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings attain 5cm height, they are transferred to poly-bag of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they established.

3.2.1.4. *Berrya javanica* (Turcz.) Burret

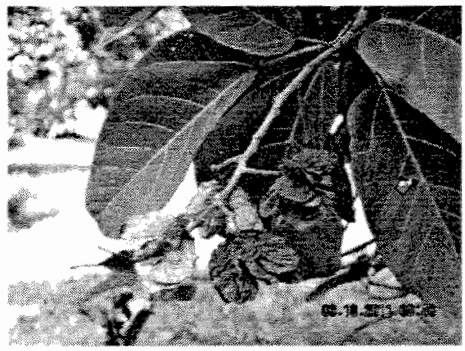

Fig.14.A twig with fruits

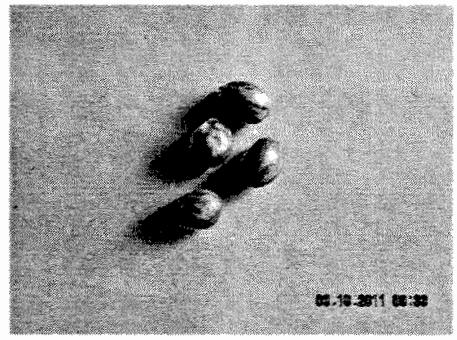

Fig.15. Extracted seeds

Synonyms	: *Berrya quinquelocularis* Teijsm & Binn. ex Koord.& Valet.
Family	: Tiliaceae
Trade names	: Trincomalee wood
Habit	: Small to medium-sized tree up to 18-27 m height, 2 m girth with a clean bole 9 -11m.
Distribution	: Native of Ceylon and Burma and South- East Asia; is commonly present in South India due to introduction.
Uses	: *Berrya javanica* yields a valuable timber used for high quality furniture; suitable for a wide range of uses, including light and heavy construction, flooring, mine props, boat building and vehicle bodies
Seed maturity	: Fruits generally available from December to march.
Collection	: Fruits are collected from the tree using long pole.
Transportation	: Fruits collected in plastic/ gunny bags are packed and transported immediately.
Processing	: The capsules are sun dried for about 4 days.

Seed description	: Fruit is a 6-8 winged capsule, surrounded at the base by persistent flower parts, stellate-hairy, wings up to 2.5 cm × 1.3 cm.
Seed dimension	: 4.9mm x3.6mm
Seed weight	: 21,000/kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds are viable for 6 months in ambient condition
Germination type	: Hypogeal
Germination	: Up to 68%
Germination period	: 12 - 40 days
Storage	: Seeds can be safely stored in sealed polybags at room temperature for 6 months or in a cold condition upto 1 year.
Viability testing	: Germination test.
Pre-sowing treatment	: Acid scarification for 2 minuts or hot water treatment for 5 minuts gives better germination percentage than cold water soaking and control
Seedling production	: Seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.5. *Caesalpinia sappan* L.

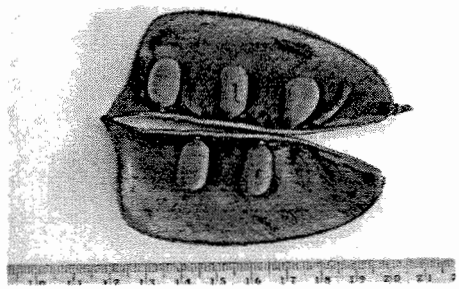

Fig.16. Split open pod

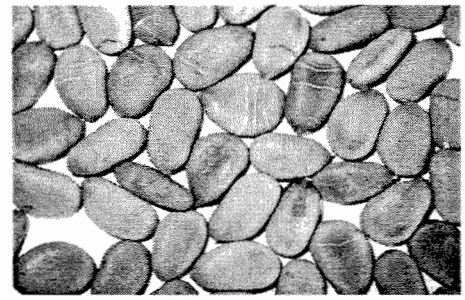

Fig.17. Seeds taken out of the pod

Synonyms : *Biancaea sappan* (L.) Todaro

Family : Fabaceae

Sub family : Caesalpiniaceae

Trade names : False sandalwood, Indian brazilwood, Indian redwood, sappan wood

Local names :

Malayalam : Pathimukham, Chappangam

Hindi : Vakam, Vakum

Tamil : Sappangam

Habit : A small to medium-sized, shrubby tree, 4-10 m tall; trunk up to 14 cm in diameter.

Distribution : Under natural conditions *C. sappan* grows mostly in hilly areas with clayey soil and calcareous rocks at low and medium altitudes. In Peninsular Malaysia it grows best on sandy riverbanks. It does not tolerate too wet soil conditions.

Uses : Wood possesses medicinal abilities as anti-bacterial and anti-coagulant properties. Also produces a valued reddish dye called brazilin, used for dyeing fabric as well as making red paints and inks.

Seed maturity : Mature fruits generally available from December to March.

Collection : Pods are collected from the tree using a long pole.

Transportation	: Pods collected in plastic/ gunny bag are packed and transported; no special care needed.
Processing	: Pods were sun dried for 20 days as a result the pods dehisced liberating the seeds. Dried seeds were again cleaned to remove other impurities.
Seed description	: Fruit a dehiscent pod, glabrous, thick, flattened, obliquely oblong, prominently beaked, woody, polished-brown, 7-10 cm x 3-4 cm, 4-5 seeded. Seeds ellipsoid, flattened, brown.
Seed dimension	: 1.8 cm x 0.8 – 1.2 cm.
Seed weight	: 1500 - 1800/kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for one year under ambient condition.
Germination type	: Hypogeal
Germination	:Up to 87%
Germination period	: 7- 40 days
Storage	: Seeds can be stored in a dry place in plastic containers or polythene bags for more than one year
Viability testing	: Cutting test and germination test.
Pre-sowing treatment	: Seeds are soaked in boiling water for about 1 to 2 minutes followed by soaking in cold water for 24 hours.
Seedling production:	Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out into polythene bags of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they establish.

3.2.1.6 Couroupita guianensis. Aublet.

Fig.18. Fruits in the plant

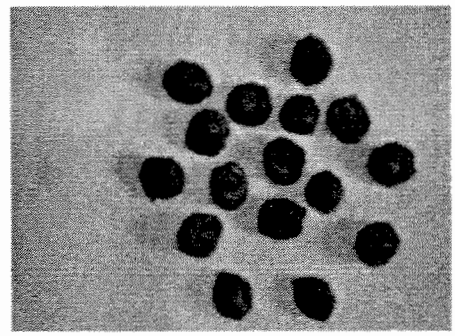

Fig.19.Extracted seeds

Synonyms	:*Couropita acreensis* R. Kunth
	Couropita antillana Miers.
Family	: *Lecythidaceae*
Trade names	: Cannon Ball Tree
Local names	:
Malayalam	: Naagalingam
Hindi	: Nagalinga
Tamil	: Naagalingam
Habit	: Deciduous tree up to 5m height.
Distribution	: The Cannonball tree is native to the tropical forests of northeastern South America, especially the Amazon Basin and in the tropics such as in India and Thailand.
Uses	: The fruit pulp, bark and flowers are used for medicinal applications and have anti- microbial and fungal activity
Seed maturity	: Flowers and Fruits are found almost throughout the year.
Collection	: Fruits are collected directly from the tree .
Transportation	: Fruits collected in plastic/ gunny bag are packed and transported immediately. Adequate air circulation should be ensured.
Processing	: Fruits are de pulped to obtain seeds and shade dried for three days

Seed description	: The tree bears large globose woody fruits which contain small seeds in a white, unpleasant smelling jelly and have hairs on their seed coat
Seed dimension	: 12mm diametre
Seed weight	: 5500-6500 Seeds/ Kg
Seed emptiness	: No information
Insect infection	: No information
Fungal infestation	: No information
Storage physiology	: Recalcitrant
Viability period	: They have a short viable life, cannot be dried well and cannot be withstand low temperature.
Germination type	: Hypogeal
Germination	: Up to7 %
Germination period	: within 20days
Storage	: Seed cannot be stored more due to the recalcitrant nature.
Viability testing	: Cutting test and germination test.
Pre-sawing treatment	: No need of pre treatment for germination
Seedling production	: Pre treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.7. *Enterolobium cyclocarpum* (Jacq)Griseb

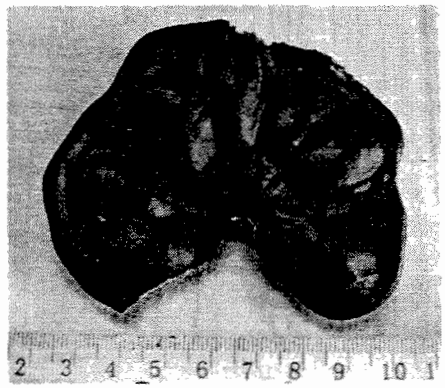

Fig. 20 A pod

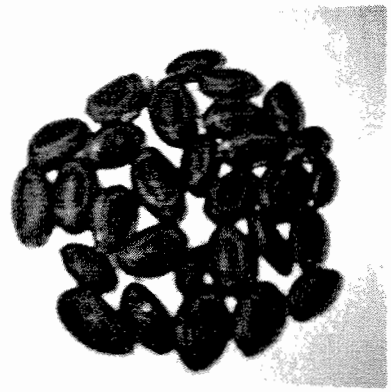

Fig. 21 Seeds are taken out of the pod

Synonyms :*Albizia longipes, Inga cyclocarpa* (Jacq.) Wild, *Pithecellobium cyclocarpum* Mart.

Family : Fabaceae

Trade names : Mexican walnut

Local names : Elephant Ear Tree, Ear pod tree

Habit : A medium-sized to large tree growing to 25–35 m in height, with a trunk up to 3.5 m in diameter.

Distribution : The area of natural distribution is from central Mexico, south through Central America to the northernmost part of Brazil. In its native range it is a conspicuous and well-known tree; it has been adopted as the national tree in Costa Rica and the province of Guanacaste is named after it.

Uses : The species is mainly used as a pasture tree in silvopastoral systems. Pods are used for fodder. The wide spreading canopy of the mature tree makes it an ideal shade tree.

Seed maturity : Mature fruits are generally available during April-May.

Collection : Ripe, dark brown pods can be collected from the ground after natural fruit fall.

Transportation : Fruits collected in plastic/ gunny bag are packed and transported immediately. Adequate air circulation should be ensured.

Processing	: Seeds are spread out on the ground or on a tarpaulin to dry in the sun for one or two days, 3-4 hours per day. When dry, the pods are pounded with sticks or threshed in a machine to open; This is followed by winnowing and sieving to extract clean seeds.
Seed description	: The seeds are 15-20 mm long, flat, dark or red-dish-brown and with a yellow, oval pleurogram on each side.
Seed dimension	: 16.47 mm length x 10.7 mm breadth
Seed weight	: 1500 – 1700 seeds per kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for several years under ambient condition.
Germination type	: Hypogeal
Germination	: Up to70 %
Germination period	: 2-25 days
Storage	: Seed can be stored in cold condition in plastic containers or polythene bag for several years.
Viability testing	: Cutting test and germination test.
Pre-sowing treatment	: Hot water soaking for half an hour in a temperature near to boiling Point followed by soaking in cold water for overnight increases germination percentage. Acid scarification for 20 minutes followed by cold water soaking gives better results.
Seedling production:	Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings are 5 -8 cm in height they are pricked out into polythene bags of size 20 x 10 cm filled with potting mixture (soil : sand: cowdung in 3:2:1 ratio) and kept under shade till they establish.

3.2.1.8. *Eucalyptus urophylla* S.T.Blake

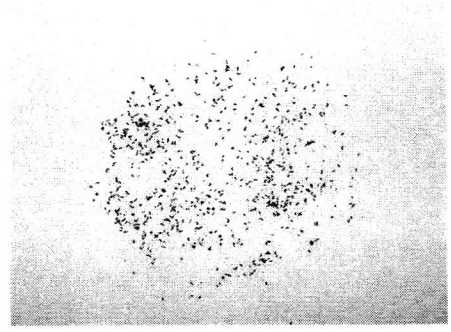

Fig. 22.Trees of *Eucalyptus urophylla* Fig. 23. Extracted seeds

Synonyms : *Eucalyptus alba* Reinw. ex Blume, *Eucalyptus decaisneana* Blume

Family : Myrtaceae

Trade names : Timor mountain gum, Timor white gum

Habit : These trees are normally 25- 45 m tall and with diameter about 1 m. Under very fa- vourable conditions it can reach up to 50 m in height and diameter over 2 m.

Distribution : *E. urophylla* is indigenous to Indonesia where it is distributed in the south-east, scattered on and around the islands of Timor and Flores.

Uses : The wood is mainly used for pulp and boards.

Seed maturity :Mature fruits are generally available during September to November.

Collection : The fruits are cut from the branches by hand and placed in cloth bags before they open.

Transportation : Fruits collected in cloth bag are packed and transported immediately. Adequate air circulation should be ensured.

Processing	: After collection the fruits are spread out in a thin layer on a sheet well, either in the sun or in the shade. The fruits are shaken daily for release the seeds.
Seed dimension	: No information
Seed weight	: 400,000-700,000 seeds/kg.
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for several years under dry and cool condition
Germination type	: Epigeal
Germination	: Up to95%
Germination period	: 2-20days
Storage	: Seed can be stored in cold condition in plastic containers polythene bag for several years.
Viability testing	: Germination test.
Pre-sawing treatment	: Not necessary
Seedling production	: Seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings have two pairs of leaves they are trans-planted into polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.9 *Ficus bengalensis* L.

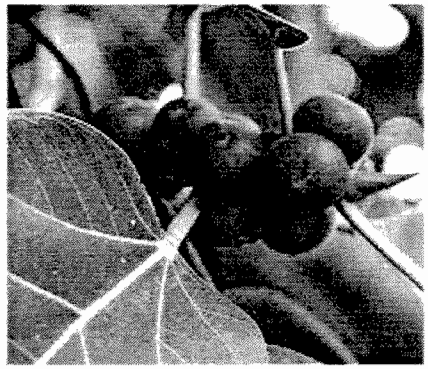

Fig.24. A twig with fruits

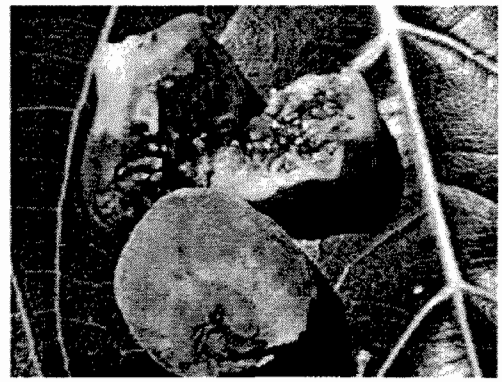

Fig.25. An opened fruit

Synonyms	: *Ficus indica* L.
Family	: Moraceae
Trade names	: Banyan Tree, Bengal Fig, Indian Fig
Local names	:
Malayalam	: Peral, Vadam
Hindi	: Bargad
Tamil	: Aal
Habit	: Very large, fast growing, evergreen tree up to 30 meters, with spreading branches and many aerial roots.
Distribution	: Commonly grown in botanical gardens and as an avenue shade tree. Ripe figs are eaten during famine. Birds and monkeys devour the fruits helping in dispersal.
Uses	: An infusion of bark and young buds is used in dysentry, diarrhoea and diabetes.
Seed maturity	: Mature fruits available during April to July.
Collection	: The fruits are picked from the branches and placed in cloth bags before they open.
Transportation	: Fruits collected in cloth bags are packed and transported immediately.

Processing	: After collection, the fruits are spread out in a thin layer on a sheet, either in open sunlight or in shade. The fruits are shaken daily for release the seeds.
Seed description	: Fruit is sessile, in pairs, axillary, globose, puberulous red when ripe, 1 to 2 cms in diam., with 2 to 4 broad, rounded basal bracts. Seeds are minute.
Seed weight	: 17,000 to 24,000 /kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for more than one year under ambient condition.
Germination type	: Hypogeal
Germination	: Up to 35%
Germination period	: 7-60 days
Storage	: Seeds can be stored in cold condition in plastic containers or polythene bag up to 5 years.
Viability testing	: Cutting test and germination test.
Pre-sowing treatment	: Cold water soaking for 12 hours increases germination percentage.
Seedling production	: Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out into polythene bags of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they establish.

3.2.1.10. *Garcinia gummy – gutta* (L.) Robs

Fig.26. A twig with fruits

Fig.27. Extracted seeds

Synonyms : *Cambogia gummigutta* L.
Garcinia cambogia (Gaertn.)Desr

Family : Clusiaceae

Trade names : Malabar tamarind

Local names :

Malayalam : Kudam puli

Hindi : Bilatti amli

Tamil : Kodukkaippuli

Habit : An evergreen, small or medium-sized tree, 5 – 20 m tall, about 70 cm dbh.

Distribution :Quite common in homesteads and moist deciduous forest areas of Kerala; naturally occurring in penisular India, Sri Lanka, and Thailand.

Uses : The processed rind of the fruits is extensively used as condiment, coagulant and for polishing gold and silver. The bark yields the gum Cambogia used as pigment, medicine and varnish. Seed is a source of edible fat.

Seed maturity : Mature fruits generally available from January to March.

Collection : Either directly from the trees by using long pole or from the ground by spreading a plastic sheet below the mother tree .

Transportation	: Fruits collected in plastic/ gunny bags are packed and transported immediately. Adequate air circulation should be ensured.
Processing	: The pulpy, fleshy rind is removed by hand or by a knife; thoroughly washed in water for several times to remove the white succulent aril. Seeds are dried for 4-5 days in shade.
Seed description	: Fruit a green, ovoid berry, 5 cm in diameter, yellow or red when ripe, with 6-8 grooves. Seed 6-8, smooth, large, about 5 cm long and 2 cm wide surrounded by succulent aril.
Seed dimension	: 21.5 mm length X 7.6 mm breadth
Seed weight	: 1500 – 1800/kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	:Seeds remain viable for six months under ambient condition.
Germination type	: Hypogeal
Germination	: 70%
Germination period	: 25 - 90 days
Storage	: Seeds can be stored in cold condition in plastic containers or polythene bag for more than one year
Viability testing	: Cutting test and germination test.
Pre-sowing treatment	: Seed coat removal increases germination percentage.
Seedling production	:Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they establish.

3.2.1.11 *Garcinia indica* (Thouars)Choisy

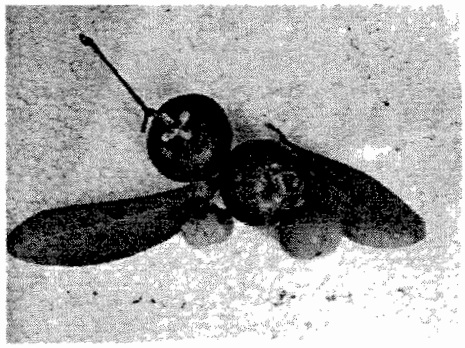

Fig. 28 Mature fruits

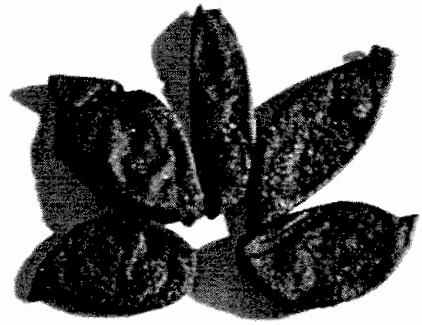

Fig.29 Extracted seeds

Synonyms : *Garcinia purpurea*(G.Don) Roxb
Brindonia indica Thouars

Family : Clusiaceae

Trade names : Kokum,

Local names : Wild mangosteen

Malayalam : Punampuli, Kudam Puli

Hindi : Kokam

Tamil : Murgal

Habit : A slender evergreen tree with drooping branches. Flowers during November – February. Flowers are fleshy, dark pink, solitary or in spreading cluster.

Distribution : These plants prefer evergreen forests, but some also thrive in relatively low- rainfall areas. It is indigenous to the Western Ghats region of India, along the western coast. Heavy concentration is found in the coastal Ratnagiri district. Scattered plantations have also come up in Belgaum,North Karnataka and Kerala. It exists in Khasi and Jantia hills of North Eastern Hill region, West Bengal and Assam, up to an altitude of 6000 ft.on slopes down to coastal areas. It is quite predominant in East Indies.

Uses	: The fruit is anthelmintic and cardiotonic. Kokum butter is considered nutritive, demulcent and astringent used for suppositories and other pharmaceutical preparations. The dried purplish rinds, known as kokum, are used for imparting flavor and taste to curries, much in the same way as tamarind
Seed maturity	:April-May.
Collection	: Fruits are collected from the tree by loping the branches or by cutting the small branches without causing harm to the plant.
Transportation	: Fruits collected in plastic/ gunny bags are packed and transported immediately. Adequate air circulation should be ensured.
Processing	: The fruits are beaten with sticks to separate the rind from seeds.
Seed description	: An average tree yields 60 to 80 kg fruits, The lemon sized dark purple ripe fruits contain five to eight large seeds. The seeds account for 20 to 23 per cent of the fruit weight.
Seed dimension	: 24.5 mm length X 7.9 mm breadth
Seed weight	: 1500 -1800/kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for six months under ambient condition.
Germination type	: Hypogeal
Germination	: Up to 90%
Germination period	: 7-60 days

Storage	: Seeds can be stored in cold condition in plastic containers or polythene bag for more than one year
Viability testing	: Cutting test and germination test.
Pre-sowing treatment	: Decoating of seeds give better germination percent.
Seedling production:	Pre- treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out into polythene bags of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they establish.

3.2.1.12. Indigofera tinctoria L.

Fig. 30. Fruits.

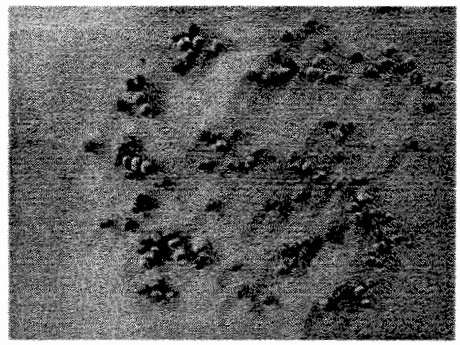

Fig.31. Extracted seeds

Synonyms : *Indigofera sumathrana* Gaertn.

Family : Fabaceae

Trade names : True indigo.

Local names :

Malayalam : Nilamari

Hindi : Nil

Tamil : Avari

Habit : Branching shrub up to 2 m hight..

Distribution : It is usually found in dry deciduous forests of Indio- Malaysian region. It is widely cultivated in India.

Uses : Whole plant is medicinally important. The plant is one of the original sources of indigo dye.

Seed maturity : October - January

Collection : Pods are collected from the plant by hand before they dehisce. Care should be taken while collecting as they will burst open and release seeds.

Transportation : Fruits collected in plastic/ gunny bag are packed and transported immediately. Adequate air circulation should be ensured.

Processing	: keep the fruits in cotton bags or a big plastic tray for about one month till they dehisce and release the seeds.
Seed description	: Fruits are cylindric pods, 1.5-3 cm long, greenish when young and dark brown on ripening and contains 4-5 seeds / fruit.
Seed dimension	:1.5 x 2 mm
Seed weight	: 200,000-250,000 /Kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for six months under ambient condition.
Germination type	: Hypogeal
Germination	: Up to35%
Germination period	: 3-50 days
Storage	: Seed can be stored in cold condition in plastic containers, polythene bag for more than one year
Viability testing	: Germination test.
Pre-sawing treatment	: Not necessary. Cold water soaking for 12 hours increases germination percentage.
Seedling production	: Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.13 *Leucaena leucocephala*(L) de Wit.

Fig. 32. Fruits

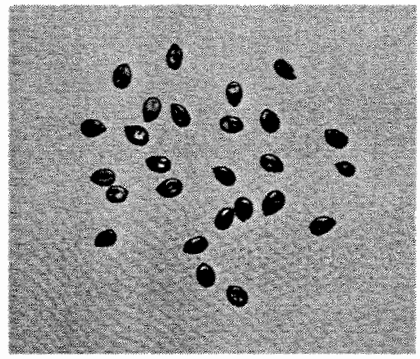

Fig.33. Seeds

Synonyms : *Leucaena latisiliqua(L.) Gillis*
Leucaena glauca Benth.
Mimosa latisiliqua L.

Family : Fabaceae

Trade names : White Leadtree, White Popinac

Local names :

Malayalam : Subabul/ Ippilippili
Hindi : Subabul
Tamil : Tagarai

Habit : *Leucaena leucocephala* is a thorn less long-lived evergreen tree which may grow to a height of 7-20 m.

Distribution : Grows very well in arid tropical climates. It is grown for fodder, but unless severely grazed or controlled, it spreads rampantly throughout adjacent areas

Uses : It is grown for a variety of uses; for green manure, a charcoal source, and livestock fodder and soil conservation. Used as a shade tree. Seeds have antidiabetic property.

Seed maturity : Mature fruits are generally available during dry season (December to August)

Collection : Legumes may be collected from branches when ripe, before dehiscence.

Transportation : Fruits collected in plastic/ gunny bags are packed and transported immediately. Adequate air circulation should be ensured.

Processing	: The fruits should be sun-dried and then threshed to release seeds. Threshing is commonly done by beating the dried legumes in cloth bags.
Seed description	: The fruits are flat, thin, legumes that are dark brown when ripe. A legume contains 15 to 20 seeds (Parrotta, 1992). The seeds are small, flat, shiny teardrop- shaped, and dark brown with a thin but fairly durable seed coat
Seed dimension	: 8.23mm length x 5.5 mm breadth
Seed weight	: 22,000 -23,000 /kg
Seed emptiness	: Medium
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	:Seeds remain viable for more than one year under ambient condition.
Germination type	: Hypogeal
Germination	: Up to 30%
Germination period	: 7-60 days
Storage	: Seed can be stored in cold condition in plastic containers or polythene bag up to 3 years.
Viability testing	: Cutting test and germination test.
Pre-sowing treatment	: Hot water treatment for 10 minutes in 80^0 C followed by cold water soaking for 12 hours is better germination percentage than acid scarification and control.
Seedling production:	Pre -treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, having 5 - 8 cm in height they are pricked out into polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.14 *Oroxylum indicum(L)Benth.*

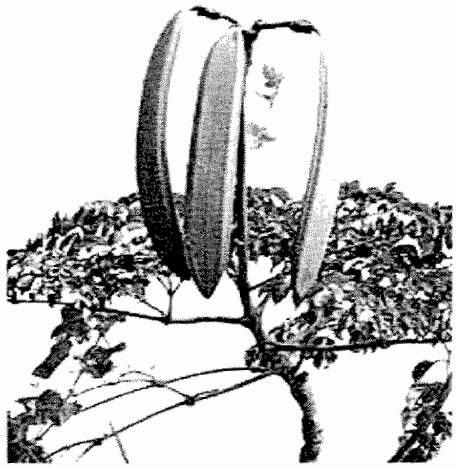

Fig. 34. Branch with capsule

Fig.35 Dehisced fruit

Synonyms :*Bignonia indica L*
Calosanthes indica(L) Blume.

Family :Bignoniaceae

Trade names : Tree of Damocles,

Local names :

Malayalam : Palakappayyani
Hindi : Bhut-vriksha
Tamil : cori-konnai

Habit : It is a medium sized, soft wooded deciduous tree which can reach a height of 12 m (40 ft).

Distribution : *Oroxylum indicum* is native to the Indian subcontinent, in the Himalayan foothills with a part extending to Bhutan and Southern China. Sporadically distributed in India.

Uses : The tree is often grown as an ornamental for its strange appearance. Materials used include wood, tannins and dyestuffs. Its root is one of the ten ingredients (roots) of the well known ayurvedic formulation Dasamoola.

Seed maturity : Mature fruits are generally available during January to March.

Collection : Fruits are collected from the tree by using a long pole just before they dehisce. Care should be

	taken while collecting the seeds as the pod may burst open and release the seeds.
Transportation	: Capsules collected in plastic/ gunny bag are packed and transported. Adequate air circulation is to be ensured.
Processing	: Capsules are sun dried before storage. While processing, the follicle should be covered as the seeds may be blown away by wind.
Seed description	: Capsules 45 x 8 cm, brown, flat and woody. Seeds many, thin, whitish, transparent and winged.
Seed dimension	: 64.13 mm length x 38.13 mm breadth including wings
Seed weight	: 8100 -10600 /kg
Seed emptiness	: Moderate
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for one year under ambient condition.
Germination type	: Hypogeal
Germination	: Up to 95%
Germination period	: 7- 30 days
Storage	: Seeds can be stored in dry place in plastic containers or polythene bag for more than one year
Viability testing	: Germination test.
Pre-sowing treatment	: Not required
Seedling production	: Pre treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish

3.2.1.15. *Pterocarpus santalinus* L.f.

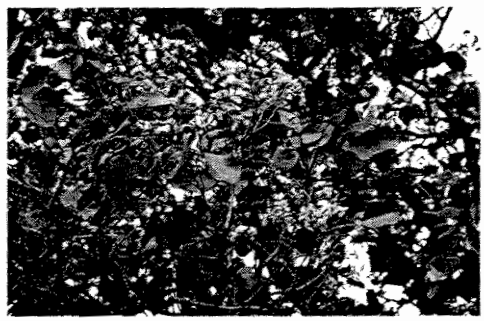

Fig.36. Branch with flowers

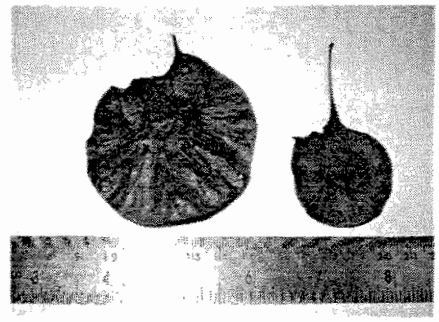

Fig.37. Dried fruit

Synonyms	:*Lingoum santalinum* (L.f.) Kuntze
Family	: Fabaceae
Sub family	: Papilionaceae
Trade names	: Red Sandalwood
Local names	:
Malayalam	: Rakthachandanam
Hindi	: Lalchandan
Tamil	: Sandana vengai
Habit	: It is a light-demanding small tree growing to 8 m tall with a trunk 50–150 cm diameter. It is fast-growing when young, reaching 5 m tall in three years even on degraded soils.
Distribution	: It is widely distributed in the drier, hilly zones of deciduous forests. Found in South India in Kadappa and Chittoor on the Tamil Nadu and Andhra Pradesh border.
Uses	:The heartwood and fruits of Rakta chandana have great medicinal value.
Seed maturity	:Mature fruits are generally available during September to november
Collection	: Fruits are collected from the ground.
Transportation	: Fruits collected in plastic/ gunny bag are packed and transported immediately. Adequate air circulation should be ensured.

Processing	: The fruits are dried properly.
Seed description	:Fruit is samara single seeded rarely two seeds can be seen.
Seed dimension	: 76.6 mm length x 69 mm breadth including wings.
Seed weight	: 100-1500 /Kg
Seed emptiness	: Low
Insect infestation	: Low
Fungal infection	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for one year under ambient condition.
Germination type	: Hypogeal
Germination	: Up to15%
Germination period	: 8-45 days
Storage	: Seeds can be stored in cold condition in plastic containers, polythene bag for more than one year
Viability testing	: Cutting test and germination test.
Pre-sawing treatment	: Soaking in cow dung slurry for 3 days gave better germination percent.
Seedling production:	Pre treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.16. Radermachera xylocarpa (Roxb.)K.Schum.

Fig. 38.Plant with fruit.

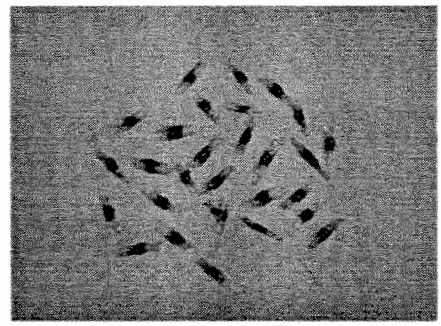

Fig. 39.Extracted seeds

Synonyms :Bignonia xylocarpa Roxb.
Stereospermum xylocarpum (Roxb) Benth.

Family :Bignoniaceae

Local names :

Malayalam : Vedamgorana

Hindi : Paral, Jaimangal

Tamil : Vedamgorana

Habit : Tree is large deciduous type growing up to 5-10 m tall.

Distribution : It is usually found in dry deciduous forests of Central India. It is a rare species in the Central Indian region with very thin and scattered population. It is widely cultivated as ornamental, for the showy flowers.

Uses : Wood is used for furniture, house building and agricultural implements. Seeds are effective cure against snake bite, when applied externally at the point of snake bite. (G. Ganapati)

Seed maturity : Mature fruits are generally available during January to March

Collection : Capsules are collected from the tree by loping branches just before they dehisce. Care should be taken while collecting as they will burst open and release seeds.

Transportation	: Fruits collected in plastic/ gunny bag are packed and transported immediately. Adequate air circulation should be ensured.
Processing	: Keep the fruits in cotton bags for a few days till they dehisce and release the seeds.
Seed description	: Capsules are long up to 1 m, 5 cm wide, curved and woody, Seeds many, winged on their either side and compressed.
Seed dimension	:17-21mm length
Seed weight	: 45,000-55,000 /Kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for six months under ambient condition.
Germination type	: Hypogeal
Germination	: Up to21%
Germination period	: 7-30days
Storage	: Seed can be stored in cold condition in plastic containers, polythene bag for more than one year
Viability testing	: Germination test.
Pre-sawing treatment	: Cold water soaking for 12 hours increases germination percentage.
Seedling production	: Pre treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil based potting mixture and kept under shade till they establish.

3.2.1.17. *Samanea saman (Jacquin) Merr*

Fig. 40. Mature pods

Fig. 41. Extracted seeds

Synonyms : *Enterolobium Saman* (Jacq.)Prain ex king
Mimosa samanea Jacq.

Family : Fabaceae

Trade names : Rain Tree

Local names :

Malayalam : Chakkarakkay maram

Hindi : Vilaiti siris

Tamil : Thoongu moonji maram

Habit : Rain tree generally attains a height of 15–25 m. In rare cases it can reach a height of 50 m. The crown typically reaches 30 m (100 ft) in diameter. It is planted for shade along avenues and is identified by rose coloured heads of flowers.

Distribution : Native to Northern South America, and now naturalized throughout the tropics. Naturally occurs on grasslands, deciduous forests and riparian corridors.

Uses : Rain tree has long been a source of timber and livestock feed (green forage and pods) for local consumption.

Seed maturity : Mature pods fully ripen in March to April

Collection : Fruits are collected from the ground.

Transportation	: Fruits collected in plastic/ gunny bags are packed and transported immediately.
Processing	: Fruits are dried in the sun and beaten to get the seeds.
Seed description	: Seeds are oblong – ellipsoid, flattened, with smooth brown surface and a yellowish pleurogram
Seed dimension	: 8-12 mm long, 5-8 mm wide and 4-5 mm thick
Seed weight	: 4000 to 6000/kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: The viability remains up to 2 years.
Germination type	: Hypogeal
Germination	: Up to 68 %
Germination period	: 20-40 days
Storage	: Seeds can be stored in cold condition in plastic containers polythene bag for more than 2 years
Viability testing	: Cutting test and germination test.
Pre-sowing treatment	: Overnight soaking in cold water. Acid scarification enhances the germination percentage.
Seedling production:	Pre- treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out in to polythene bags of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they establish

3.2.1.18 *Sapindus emarginatus* Vahl.

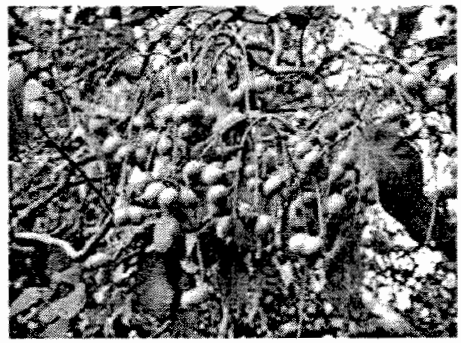

Fig.42. Branch with mature fruit

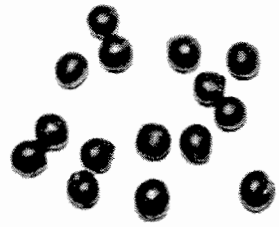

Fig.43. Extracted seeds

Synonyms : *Sapindus trifoliata* sensu

Family : Sapindaceae

Trade names : Ritha

Local names :

Malayalam : uruangi

Hindi : ritha,

Tamil : bunthikottai, kottan,

Habit : A medium sized tree. Leaves 12-17 cm long; leaflets 2-3 pairs, opposite, 6-11 cm long, 4.5-9 cm broad.

Distribution : This species is native to South India, globally distributed in India, Sri Lanka and Myanmar. Within India, it is common in peninsular India. It is also cultivated on avenues or for ornamental purposes.

Uses : The fruit is used for washing purpose. Fruits made into a paste which is applied externally in case of burning sensation of body parts and headache; Fruit juice is used as a Nasal drop in headache /hemicrania.

Seed maturity :Fruits are generally available during October-January.

Collection	:Fruits are collected from the ground under the tree.
Transportation	: Fruits collected in plastic/ gunny bags are packed and transported immediately.
Processing	: Depulped by squeezing in water and drying under shade
Seed description	: Fruit is fleshy, 3 lobed, 1.3 to 2.0 cm in diameter, consisting of 2 to 3 indehiscent carpels which are partially joined; yellowish brown and wrinkled when ripe. Each carpel contains one hard, smooth, black seed.
Seed dimension	: 6-7 mm
Seed weight	: 2,000 to 25,00/kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds can withstand ambient storage conditions upto 6 months.
Germination type	: Hypogeal
Germination	: Up to 60%
Germination period	: 15-56 days
Storage	: *S. emarginatus* seeds can be safely stored in sealed polybags at room temperature or in a refrigerator up to 1 year.
Viability testing	: Germination test.
Pre-sawing treatment	: Seeds germinate readily without pretreatment.
Seedling production	: Seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out into polythene bags of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they establish.

3.2.1.19. *Stereospermum colais* (Buch.-Ham.ex Dillw.) Mabb.

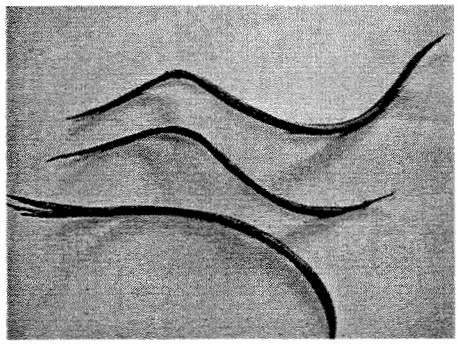

Fig. 44. Mature capsules

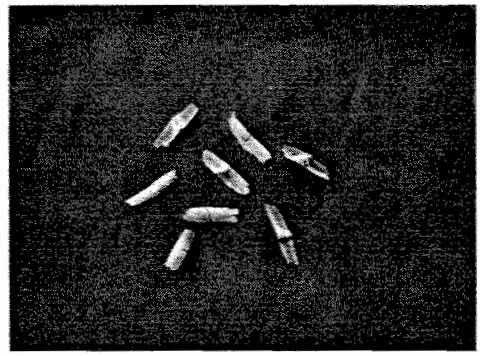

Fig. 45. Extracted seeds

Synonyms :*Bignonia colais* Buch.-Ham.ex Dillw.
Stereospermum personatum (Hassk)Chatter.

Family :Bignoniaceae

Trade names : Yellow Snake Tree

Local names :

Malayalam : Pathiri

Hindi : Paroli.

Tamil : Ampu

Habit : It is a medium-sized, deciduous tree up to 18m height with the trunk 15-25 cm in diameter.

Distribution :Globally the species is distributed In Indo-Malasia to Indo-China. It is found throughout India.

Uses : The whole parts of the plant have medicinal value. Root constitutes one of the ten ingredients in the well known ayurvedic formulation Dasamoola.

Seed maturity : Mature fruits are generally available during January - March

Collection : Capsules are collected from the tree by lopping branches just before they dehisce. Care should be taken while collecting the capsules as they will burst open and release seeds.

Transportation	: Fruits collected in plastic/ gunny bags are packed and transported immediately. Adequate air circulation should be ensured.
Processing	: Fruits are kept in cotton bags for a few days till they dehisce and release the seeds.
Seed description	: Capsules are smooth and four angled, slender, twisted 40cm long and1cm broad covered with raised white specks. Seeds numerous, wedge shaped and winged at each end.
Seed dimension	: 13.8 mm X 5.3mm including wings
Seed weight	: 45,000-55,000 /kg
Seed emptiness	: Medium
Insect infestation	: Low
Fungal infection	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for six months under ambient condition.
Germination type	: Hypogeal
Germination	: Up to 25%
Germination period	: 8- 45 days
Storage	: Seeds can be stored in cold condition in plastic containers, polythene bag for more than one year
Viability testing	: Germination test.
Pre-sawing treatment	: Cold water soaking for 12 hours increases germination percentage.
Seedling production	:Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out into polythene bags of size 20 x 10 cm filled with soil-based potting mixture and kept under shade till they establish.

3.2.1.20. *Thyrsostachys siamensis* Gamble.

Fig. 46. A clump

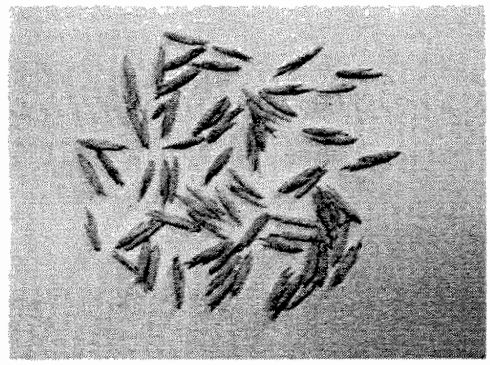

Fig. 47. Dried seeds

Synonyms : *Thyrsostachys regia* (Munro) Bennet

Family : Graminae

Trade names : Monastry bamboo, Thailand Bamboo.

Habit : Culm size: max. 13 m height, max. 6 cm diameter. Rhizomes pachy morph, short- necked, forming a very tight clump. Shoots dull dark green, glabrous, emerging from early or mid June.

Distribution : A graceful bamboo used extensively around monasteries in Thailand. Introduced and cultivated in many countries of tropical and subtropical Asia.

Uses : Shoots for diet, culms for construction, plants for hedges and wind- break. One of the most useful species.

Seed maturity : Monocarpic species.

Collection :Seeds can be collected from the ground by spreading a tarpaulin sheet under the clump.

Transportation :Seeds collected in plastic/ gunny bags are packed and transported immediately. Adequate air circulation should be ensured.

Processing	: Collected seeds are dried under shade for two days. All impurities are removed.
Seed description	: Seeds are protected with palea and lemma.
Seed dimension	: 16.7 mm length x 7.7 mm breadth including palea and lemma
Seed weight	: 80,000 /kg
Seed emptiness	: Low
Insect infection	: Low
Fungal infestation	: Low
Storage physiology	: Orthodox
Viability period	: Seeds remain viable for 3 years in cold storage condition.
Germination type	: Hypogeal
Germination	: Up to 90%
Germination period	: 7-30 days
Storage	: Seeds can be stored in cold condition in plastic containers or polythene bag for more than one year
Viability testing	: Cutting test and germination test.
Pre-sawing treatment	: Cold water soaking for 12 hours increases germination percentage.
Seedling production:	Pre-treated seeds are sown in germination trays filled with vermiculite and watered regularly. When the seedlings emerge, they are pricked out into polythene bags of size 20 x 10 cm filled with soil- based potting mixture and kept under shade till they establish. Easy growing, thrives well in heavy (loamy, clay) moisture-retentive soil with good drainage, but can grow even in poor and dry soil.

3.3. Training Programmes

Two training programs were conducted during the reporting period. Details are as follows

3.3.1 The first training was a one day workshop on "Oushadha sasyangalude paripalanavum parambaryajnanavum" conducted at KFSC on 25. Aug 2008.

The major objectives of the Training Programme were:

1. Detailed discussion on informations of selected medicinal plants.
2. Give basic information on cultivation to farmers interested in propagation of medicinal plants.
3. Production and supply of species required by the farmers.

The training programme was attended by about 50 farmers from Thrissur, Palakkad and Malappuram Districts of Kerala. The programme started with the welcome address by Dr. K. C. Chacko, Director-in-Charge, KFRI. Mr. Lakhwinder Singh, IFS, Chief Conservator of Forests, Working Plan and Research, Kerala Forest Department gave a briefing about the Training Programme. Dr. N. Sasidharan explained about the importance, uses and propagation techniques of selected medicinal plants that can be successfully grown in homesteds in Kerala. After the lecture session in the morning, group discussion followed. The delegates were requested to give the number of plants they needed. In the group discussion a list of medicinal plants were prepared and the number of seedlings requested by each of the farmers were recorded, so as to commence the planting stock production in the Central nursery of Kerala Forest Research Institute, Peechi.

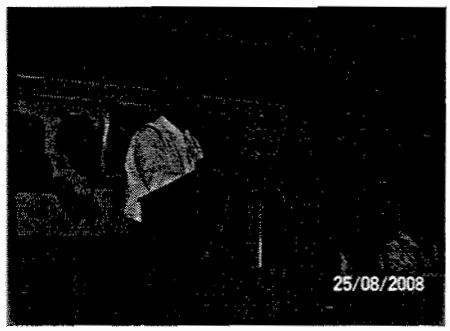

Fig. 48 .

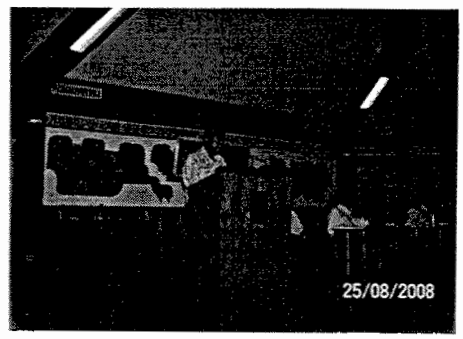

Fig. 49.

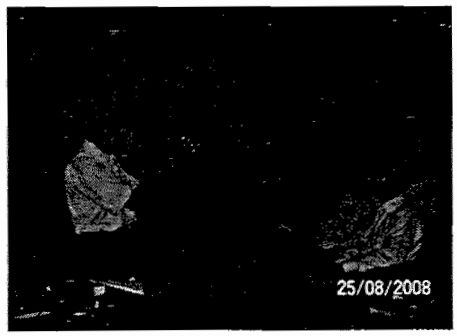

Fig.50.

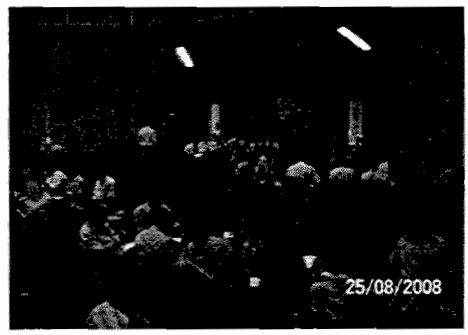

Fig.51.

Fig. 42-45. Different sessions of training programme

3.3.2 The second training programme, another one day workshop on "**Collection and processing of seeds and nursery techniques of selected forestry and medicinal plants**" was held on 30th March 2010.

The major objectives of the Training Programme were the following

1. To showcase the activities of the Kerala Forest Seed Center (KFSC)
2. To provide awareness on "Importance of scientific seed collection from forests"for the benefit of the field staff of KFD and members of Vana Samrakshana Samithy (VSS) of the Central Circle.
3. To discuss the genetic implications in scientific seed collection.
4. To introduce and familiarize data to be collected during seed collection and methods of documenting them.

The Training Programme was attended by 19 delegates (Assistant Conservator of Forests (ACF) from Research Unit Palakkad, the Deputy Conservator of Forests, from Research (North), 2 Research Forest Range Officers, (Research Unit, Mananthavadi & Nilambur), Research Range Officer, KFSC, Foresters and Forest Guards, and 5 VSS members).

The first lecture was on "Importance and methods of seed collection". The lecture dealt with fundamental aspects on seed development, seed maturation and indications of seed maturity. Aspects on the genetic and physical qualities of seed were also discussed. The importance of seed collection from natural geographical areas- *Provenance* was explained in detail. It was stressed that seed collection should be made from an area having at least a minimum of 20 or 30 trees in order to get maximum genetic diversity. Soon after collection, the seeds are to be properly labeled

and packed in appropriate containers like gunny bags/ polythene covers etc. Labels are to be kept both inside and outside the container. While labeling, one should write the species name, (if known) local name, place of collection, date of collection, seed collectors name & number etc. The importance of seed handling and seed transportation was elaborated and it was mentioned that good and healthy seeds should be collected from natural stands, seed production areas, and seed orchards. The flowering season and the time when the fruit matures are all information a seed collector should essentially have prior to going for the tour. The maturity indices and its importance in identifying the correct ripeness of the seed, types of seeds, orthodox seeds and recalcitrant seeds was also topics of discussion.

The second lecture was "Genetic implications of Seed Collection". The genetic constitution / inheritance probabilities in forest trees and the importance of progeny trials were the main aspects covered. Genetic qualities can only be proven by progeny trials. To retain diversity, the seeds are to be collected from cross pollinated plants and the seed collector should avoid the inbred populations. The seed collector should give more preference to seeds from stands with heavily fruiting trees standing in groups rather than from isolated trees. In natural seed stands, seed collection should be from middle aged trees and only such seeds will be healthy and with high vigor. The mixing up of seeds of different provenances will not be a healthy trend as it may always result in mixing up of favorable and non favorable characters of different provenances.

The activities of Kerala Forest Seed Center were showcased and different *performas* to be filled in by the seed collector while collecting seeds from forest areas.

The delegates were taken to KFSC, to provide hands on information on different equipments, instruments being used at KFSC. Some of the common laboratory tests like viability test, pre-treatments, and storage methods were also demonstrated to the delegates.

Fig.52

Fig.53

Fig.54

Fig.55

Fig.52 –55. Different sessions in progress

4. Summary

- Fourty five tonnes of processed and graded seeds were supplied to Kerala Forest Department during the reporting period (2006-2010).
- Seeds of seventy different miscellaneous forest tree species were also processed and supplied to KFD and other user agencies.
- Best period for teak seed collection from TSPA's in Kerala is March- May. The seeds are to be processed, graded and kept in ambient condition for about 3 months in order to get optimum germination percentage. This is because it has been understood that teak seeds undergo post harvest maturation during this period.
- Seven days alternate wetting and drying (wetting during nights and drying during day time) was confirmed as the best pre-treatment for teak seeds collected from different TSPA's of Kerala in order to obtain maximum germination percentage of 35 – 40%.

- Seed biological aspects of 20 species were studied and are included in the report. This is being made into brochures for free distribution to user agencies/farmers.
- Training programmes on "Seed biological aspects of forest trees including teak" conducted in collaboration with Kerala Forest Department and other user agencies like Foundation for Revitalization of Local Health Traditions (FRLHT) gave an opportunity for taking the laboratory results to the forest officials and other user agencies.
- Training programmes on "Collection, handling and transportation of seeds of Teak and other miscellaneous tree species", conducted mainly for the benefit of VSS members and field staff of Kerala Forest Department at the four central nurseries viz., Kulathupuzha, Chettikulam, Nilambur and Cheruvanchery of the Department was of immense help to convince the seed collectors the true value of scientific and economic seed collection procedures.

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