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FINAL REPORT

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WORKSHOP ON TREE SEED TECHNOLOGY
Under Agroforestry Subproject
Contract No. 297-89-3
MAY 22 to JUNE 3, 1989

TAMIL NADU AGRICULTURAL UNIVERSITY
COIMBATORE

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EXECUTIVE SUMMARY

An Indo-US workshop on Tree Seed Technology was conducted at Tamil Nadu Agricultrual University from May 22 to June 3, 1989. Dr. S. Chinnamani of ICAR was in charge of the workshop. U.S. scientists Dr. W.W. Elam, Dr. F.T. Bonner, and Dr. S.B. Land, Jr. gave tree seed technology lectures, while local Indian scientists conducted lab practicals and field tours. Dr. O.P. Toky from Haryana Agricultural University provided lectures and led discussions on (1) tree seed physiology and (2) multipurpose Indian tree species for agroforestry. Twenty scientists representing 11 states from throughout India participated in the workshop. These scientists were charged by Dr. Chinnamani at the end of the workshop to use the newly-acquired information in (1) extension activities in their states (farmer training sessions and seed technology leaflets), (2) research, and (3) teaching university courses.

Recommendations are separated into (1) those for future Indo-US workshops sponsored by USAID and (2) those for subsequent Indian tree seed workshops conducted by Indian scientists. The recommendations for USAID-sponsored workshops center on greater need for adequate, advanced planning and coordination between U.S. scientists and their counterparts in India. For subsequent Indian workshops on Tree Seed Technology, the U.S. team recommends that Dr. Toky be the coordinator and that he utilize lectures/suggestions from this first workshop to conduct those later workshops. Twelve specific recommendations for improving those workshops are included.

HISTORY

Origination:

The Tree Seed Technology Workshop was one of the four types of workshops proposed in the report "Two-year work plan for the ARF subproject on agroforestry" by C.R. Hatch and D.P. Richards dated May 6, 1988. The document was submitted to ICAR-USAID/INDIA and describes a detailed plan for major agroforestry subproject activities during the succeeding two-year period.

Mississippi State University was subsequently selected to develop a two-week workshop on tree seed technology to be presented in India at a site selected by ICAR. The course was developed in conjunction with a 5-month specialized training program of an Indian scientist in tree seed technology at MSU, Dr. O.P. Toky. (The scope of services for the workshop is given in Appendix Attachment A).

Development

The course was developed by Drs. Bonner, Elam and Land (MSU) and Dr. Toky of Haryana Agricultural University, Hisar, India. It is based on successful tree seed technology shortcourses which have been presented in the Philippines, Kenya and several times at MSU. An abbreviated tree seed shortcourse was presented to visiting Indian scientists at MSU in 1988 and their comments were considered in the development of this course.

EXECUTION OF WORKSHOP

Circumstances

This was the first in a series of shortcourses to be sponsored under the ICAR/USAID-India agroforestry program, and thus it served as a pilot program. The circumstances under which it was presented and recommendations resulting from it should be of value to following Indo-US shortcourses. None of the US scientists had prior experience in India. They were not familiar with Indian methods of operation, even though all had experience working with Indian scientists in the US.

Execution

The course was held at Tamil Nadu Agricultural University in the Department of Seed Technology. The prinicipal liasion person was Dr. T.V. Karivaratharaju, Head of the Department of Seed Technology, who had to carry on his normal duties in addition to shortcourse responsibilities. He and his staff were well prepared for the shortcourse and in fact had prepared lectures and made plans to put on the shortcourse themselves. This problem was due to a lack of communication at an early stage of planning for the course, and it caused some last minute changes. Duplication in course content resulted in some cases. Overall, however, the Indian preparations strengthened the course. The course design and training schedule were modified to incorporate some of their prepared materials and speakers, especially on species examples. Additionally, they prepared poster sessions, which were presented during tea breaks and were an asset to the program (Appendix Attachment H). The cooperation of the staff and Dr. Karivaratharaju was exemplary. Dr. Chinnamani was present during the entire shortcourse and attended practically all the lectures. His presence and efforts to facilitate matters no doubt allowed the course to proceed as smoothly as it did.

Some of the participants were late in arriving at Coimbatore, possibly due to train delays. Usually there was some delay at the beginning of the morning session due to late arrivals. This may have resulted from local transportation problems.

Lectures and some laboratory exercises were held in a lecture room that had been recently refinished and air-conditioned for presentation of the shortcourse. Normal power outages occurred. However, a back-up generator was available.

The site was well selected for the presentation of the course. The Agricultural Seed Technology Department at TNAU had prime responsibilitiy for support of the course. Other units immediately adjacent to the Seed Technology Department that gave excellent cooperation were the Tamil Nadu Conservator of Forests Genetics Unit and the National Institute of Forest Genetics at Coimbatore. Nearby sites allowed for short field trips to enhance the program by providing field examples of lecture discussions. Extended field trips were used to emphasize other aspects of the course. In short, the choice of location was very advantageous to presenting the course.

Content of Course and Responsible Scientists

The lecture and lab topics for the shortcourse were known by both the U.S. and Indian teams of scientists before the U.S. team arrived. However, coordination of the two teams' plans and the scheduling of the actual program occurred after arrival of the U.S. scientists. All of the originally planned topics were covered, with U.S. scientists responsible for most lectures and Indian scientists serving as lab instructors and assisting with most lab practicals. Lab practicals did not take as much time as expected, which was fortunate in that time was required for inauguration and validictory ceremonies. Time was also made available for some short field trips to local installations to illustrate nursery, seed handling, storage and forest genetics activities. The final course schedule and responsible scientists for each activity are given in Table 1.

Table 1. Training schedule and responsible scientists for Indo-US Forest Tree Seed Technology shortcourse.

Date	Time	Topic	Scientists
May 22	8:00-9:30 a.m.	Registration	Dr. S. Chinnamani
	9:30-10:45	Inauguration ceremonies	Dr. S. Jayaraj, VC for TNAU
			Mr. R. Sundararaju
			Dr. S. Sankaran
			Dr. W.W. Elam
	10:45-11:30	Pre-Test	Dr. Elam
	1:30-2:45 p.m.	Seed Biology	Dr. S.B. Land
	2:45-5:00	Seed Structure Practical	Dr. J.A. Selvaraj, Dr. F.T. Bonner
May 23	8:00-11:30a.m.	Seed Prod. & Tree Improv.	Dr. Land
	1:30-5:00 p.m.	Sampling Practical	Dr. C. Dharmalingam, Dr. Elam
May 24	8:00-9:15 a.m.	Planning Collection	Dr. Elam
	9:15-10:30	Maturity Indices	Dr. Bonner
	10:45-11:45	Purity and Weight	Dr. Bonner
	1:30-3:30 p.m.	Purity and Wt. Practical	Dr. Thiyagarajan, Dr. Bonner
	3:45-5:00	Germination Practical	Dr. Thiyagarajan, Dr. Bonner
May 25	8:00-9:15 a.m.	Collection Methods	Dr. Elam
	9:15-10:30	Post Harvest Care	Dr. Bonner
	10:45-11:45	Maturity-Post Harvest Care	Dr.T.V.Karivaratharaju
	1:30-3:30	Seed Moisture & Practical	Dr. Bonner, Dr. A.S. Ponnusamy
	3:45-5.00	Field Trip--National Institute of Forest Genetics at Coimbatore	Dr. Chinnamani

Table 1. (continued)

Date	Time	Topic	Scientists
May 26	8:00-9:15 a.m.	Drying & Extraction	Dr. Bonner
	9:15-10:30	Cleaning & Upgrading	Dr. Bonner
	10:45-11:30	Weigh samples from Moisture Practical	Dr. A.S. Ponnusamy, Dr. Bonner
	1:30-3:30 p.m.	Excised Embruo Practical	Dr. V. Krishnasamy, Dr. Bonner
	3:45-5:00	Field Trip--Tree Seedling Nursery	Dr. Chinnamani
May 27	8:00am-8:00pm.	One-day field trip: (i) Kapok agroforestry planting (2) Eucalyptus tereticornis seed stand and plus tree selection (3) Moist deciduous forest (4) Teak seed production area	Dr. Jambulingam, Dr. Laird
May 28	8:00am-8:30pm.	One-day field trip: (1) Mettupalayam Forestry Research Station--agroforestry and genetics research	Dr. Jambulingam
		(2) Central soil & water Conservation Research and Training Institute (Ooty)	Dr. Chinnamani
May 29	8:15-10:30a.m.	Seed Storage	Dr. Pilam
	10:45-11:45	Tetrazolium Test Practical	Dr. T.K. Vadivelu, Dr. Bonner
	3:30-5:00p.m.	Field trip to Conservator of Forests Genetics Unit (seed extraction and storage)	Dr. Karivaratharaju

Table 1 (continued)

Date	Time	Topic	Scientists
May 30	8:15-10:30a.m.	Germination Testing	Dr. Bonner
	10:45-11:45	Vigor Testing	Dr. Karivaratharaju, Dr. Elam
	1:30-2.30 p.m.	Eucalyptus Seed Technology	Dr. Chinnamani
	2:30-3:25	Acacia Seed Technology	Dr. Chinnamani
	3:25-4:15	Kapok Seed Technology and Poster Session	Dr. Karivaratharaju
May 31	8:15-10:30a.m.	Seed Physiology	Dr. O.P. Toky
	10:45-12:00pm.	Multipurpose Species	Dr. Toky
	1:30-3:30 p.m.	Rapid Tests & X-ray Tests	Dr. Bonner
	3:45-5:00	Leachate Conductivity Tests	Dr. T. Jayaraj, Dr. Bonner
June 1	8:00-9:00 a.m.	Panel Discussion on Seed Entomology and Pathology	Dr. S. Jayaraj, Dr. R. Jeyarajan
	9:30-11:45	Seed Insects and Diseases	Dr. Elam, Dr Ayyavoo
	1:30-3.00 p.m.	Certification	Dr. Land
	3:00-3:30	Germplasm Conservation	Dr. Bonner
	3:45-5:00	TNAU Forest Scientists Meeting	Dr. S. Jayaraj
June 2	8:15-8:45 a.m.	Seeds for Agroforestry	Dr. Chinnamani
	8:45-9:30	Guest Speakers on Agro-forestry	Dr. S. Kondas, Dr. R. DebRoy
	9:30-11:15	Discussion & Answer session	Drs. Bonner, Land, Elam, & Toky
	11:15-11:45	Vice Chancellor & Guest	Dr. Jayaraj, Mr. S. Johnjoseph
	1:30-2:10 p.m.	Discussion & Answer session (continued)	Drs. Bonner, Land, Elam, & Toky
	2:10-3:00 p.m.	Post-Workshop Test	Drs. Land, Bonner, & Elam
	3:45-5:00 p.m.	Validictory Function	Drs. Chinnamani, Elam, Johnjoseph, Jayaraj
June 3	8:15-11:00a.m.	Course Evaluation & Critique	Drs. Elam, Toky, Chinnamani, Jayaraj, Yadav, DebRoy, Bonner, and Land

Participants

Twenty participants attended the shortcourse (Table 2 and Appendix Attachment I). Biographical data were provided by the participants (Appendix Attachment B). These participants came from 11 states scattered throughout India, but eight of the 20 were from the local state of Tamil Nadu (Table 3). Only three of the 20 did not have a graduate degree (M.S. or Ph.D.), with six having a Ph.D.. Three-fourths of the participants were trained in Agriculture - Agronomy - Horticulture, with one-fourth having undergraduate or graduate forestry training. Thus, there was a wide range of experience and knowledge represented among the participants, and this benefitted discussions. Most of these participants will be expected to go back to their home states and conduct an extension meeting for farmers about the importance of tree seed technology in agroforestry, as originally envisioned in the Two-Year Work Plan for the ARP Subproject on Agroforestry (Hatch and Richards, Consultancy Report, May 6, 1988, New Delhi, India). They will also utilize the training in their agroforestry research and classroom teaching. All participants received a copy of the training lectures to assist them in accomplishing these objectives.

Table 2. List of participants attending Indo-US Forest Tree Seed Technology Shortcourse on 22 May - 3 June, 1989.

Name	Designation	(Degree)	Home Location
1. Dr.M.G.Dasthagir	Assoc.Prof.	(Forestry--Ph.D.)	Mettupalayam, Tamil Nadu
2. K. Ganesamurthy	Asst.Prof.	(Ag.Plant Breed-M.S.)	Coimbatore, Tamil Nadu
3. Dr.M.S. Hoada	Asst.Prof.	(Forestry--Ph.D)	Hisar, Haryana
4. Edwin Jeyaraj	Asst.Conserv.of Forests	(Forestry--B.A.)	Coimbatore, Tamil Nadu
5. Dr. Amar Nath Jha	Asst. Prof.	(Agronomy-Ph.D)	Samastipur, Bihar
6. Ajay Kumar Khare	Tech.Asst.	(Agric.--M.S.)	Jabalpur, Madhya Pradesh
7. Dr. S.K. Majhi	Lecturer	(Agronomy--Ph.D.)	Kalyani, West Bengal
8. Thomas Mathew	Asst. Prof.	(Agronomy--M.S.)	Palghat, Kerala
9. S. Nayar	Regional Mgr.	(Agric.--M.S.)	Madras, Tamil Nadu
10.B.N. Patil	Assoc. Prof.	(Soc.Forestry-M.S.)	Nagpur, Maharashtra

Table 2. (continued)

Name	Designation	(Degree)	Home Location
11.S.C. Patil	Research Asst.	(Ag.Plant Breed.-M.S.)	Rahuri, Maharashtra
12.A.S. Ponnuswamy	Asst. Prof.	(Ag.-Seed Tech.--M.S.)	Mettupalayam, Tamil Nadu
13.Pradhan I.P.	Sci. SI	(Agro For.--B.S.&AIFC)	Gangtok, Sikkim
14.S.S. Rathore	Sci.-1	(Agronomy--M.S.)	Jodhpur, Rajasthan
15.S. Selvaraj	Asst Seed Officer	(Ag.Seed Tech.-M.S.)	Coimbatore Tamil Nadu
16.S.K. Sharma	Asst Sci.	(Agronomy M.S.)	Nauni Solan, Himachal Pradesh
17.Dr. R.C. Singh	Scientist	(Agronomy Ph.D.)	Jhansi, Uttar Pradesh
18.Dr. R.R. Singh	Assoc. Prof.	(Horticulture + 1 yr. Oregon State U.--Ph.D.)	Hisar, Haryana
19.S. Srinivasan	Dep.Dir. Agric.	(Agric.--B.S.)	Kudumiamalai, Tamil Nadu
20.K.K. Suresh	Asst. Prof.	(Agronomy - M.S.)	Mettupalayam, Tamil Nadu

Table 3. Summary statistics on home state, highest degree, and degree specialization of participants

	State	No. of Participants
1.	Tamil Nadu	8
2.	Haryana	2
3.	Madhya Pradesh	1
4.	Bihar	1
5.	West Bengal	1
6	Kerala	1
7.	Sikkim	1
8.	Rajasthan	1
9.	Himachal Pradesh	1
10.	Uttar Pradesh	1
11.	Maharashtra	2
	Total	20

Highest degree	#Attendees	Training	#Attendees
B.S.	2	Forestry	5
M.S.	11	Agriculture	3
Ph.D.	6	Agric.Plant Breed	2
Other	1	Agric. Seed Tech.	2
		Agronomy	7
		Horticulture	1

ANALYSIS OF EFFECTIVENESS

Effectiveness of the workshop was evaluated by (1) comparison of participant performance on a post-test at the end of the workshop with a pre-test at the start (Appendix Attachments C and D) and (2) examining responses to a post-workshop questionaire given to the participants (Appendix Attachment E).

A comparison of 12 participants' pre-test scores with post-workshop scores for 10 identical True-False questions indicated an improvement from 57% correct answers (pre workshop) to 70% correct answers (post workshop) (Table 4). This suggests that between one-fourth and one-third of the information presented in lectures and labs was assimilated by the participants. Part of the reason why dissimination of information was not more effective is probably related to English communication problems. It was difficult for the instructors to understand the English of some of the participants, so that it is reasonable to expect that some of the verbal lecture content was lost to the participants. A goal of getting one-half of the information effectively assimilated by participants should be sought, and use of (1) more writing on the blackboard, (2) more large-print overheads, and (3) more typed handouts of summarized lecture notes should help in obtaining this goal.

Other observations from the pre-test and post-workshop tests are: (1) at the start of the workshop the average participant had little knowledge of seea technology and (2) the 55% correct answers on multiple choice questions (Table 4) was quite good, since the odds of guessing the right answer was only about 25% as versus 50% for True-False questions.

Table 4. Average performance of participants on pre-test and post-test for tree seed workshop.

Student Group	Pre Test (40 True-False)	Post Test (Same 10 T-F)	Post Test (30 Mult.Choice)	Post Test (Total)
	% Correct Answers			
12 Students present on 1st day (22 May)	57%	70%	54%	63%
8 Students arriving after 1st day	-	70%	57%	64%
Total all 20 students	-	70%	55%	64%

Responses received on the post-workshop evaluation questionaire indicated unanimous agreement among the participants (1) that the workshop would improve their ability to do their job and (2) that they would recommend the workshop to others (Table 5). The length of the workshop was about right. There were many discrepencies and contradictions among the participants' comments on items that they most liked and least liked about the shortcourse. This suggests that there were no major factors reducing the effectiveness of the course for all participants. The comments are summarized in Table 5 to illustrate minor points that might be considered in future shortcourses. The low ratings given by a few participants to "tours" (field trips) and "workshop facilities" are probably associated with (1) the two consecutive day-long field tours on May 27-28 that did not allow the participants a day of rest and (2) the air-conditioner noise and cramped seating in the meeting room.

Final determination of effectiveness of the workshop, as indicated by Dr. S. Chinnamani in his lecture to the participants on June 2, will be provided by the subsequent use of the shortcourse material by the participants to (1) start new tree seed research, (2) teach tree seed technology in the classroom, (3) conduct 1-2 day training meetings for local farmers, and (4) develop instruction leaflets in the local language for tree seed technology. The numbers of participants proposing to accomplish these activities, as summarized from question 7 on the evaluation form, are given in Table 6. A survey questionaire could be sent to the participants by ICAR in six months, if USAID so desires, to determine if these activities are being accomplished.

Table 5. Summary of EVALUATION form comments by participants at end of workshop.

	Question	Response	
1.	Did the workshop improve your ability to do your job?	Yes=	20
		No =	0
2.	Would you recommend this workshop to other?	Yes=	20
		No =	0
3.	Was the length of the workshop	Too long=	4
		Too short=	5
		About right=	11

4. What did you like most about this workshop?

a.	Conduct of workshop, method of teaching, & visual aides	6
b.	Field Trips	4
c.	Labs (practicals)	4
d.	Lectures	2
e.	Poster session during breaks	2
f.	Handouts, textbook, workshop facilities	1
g.	Specific topics:	
	(1) Tree improvement	5
	(2) Collection and storage	4
	(3) Seed treatment, scarification, & dormancy	3
	(4) New treatments for seed upgrading (IDS)	1
	(5) Certification	1
h.	All of it	1

Table 5. (continued)

Question	Response
5. What did you like least about the workshop?	
a. Lab practicals not conducted well (sampling, moisture, germination, excised embryo	4
b. Seed physiology and biology lectures	2
c. Not enough field trips	1
d. Not enough on tropical tree seed	1
e. Noisy room	1
f. Unable to understand English of U.S. scientists	1
g. No one in charge -- not sure who would teach	1
h. Not able to see some of equipment discussed	1

6. Ratings (1= Poor to 5= Excellent):	Range	Average
Instruction Methods	3-5	4.4
Text book (FAO 20/2)	3-5	1.5
Handout materials	3-5	4.2
Tours	1-5	3.7
Workshop facilities	2-5	4.2

Table 6. Summary of planned use of shortcourse information by participants.

	Planned Use (General)	No. Participants
1.	Training meetings for farmers and agricultural officers.....	13
2.	Seed technology leaflets in local languages.....	2
3.	Teaching in university courses.....	10
4.	New research and application.....	17

RECOMMENDATIONS

I. For future Indo-US shortcourses sponsored by USAID:

1. Complete the required approvals and paperwork from all agencies at least two months prior to the shortcourse.

2. Budget for a pre-visit to the shortcourse site by one member of the visiting US team at least six weeks prior to the shortcourse. That member and the host organization will mutually plan the shortcourse schedule, assign specific responsibilities, and arrange for needed physical facilities and laboratory supplies.

3. Use local field trips to supplement lectures and labs.

4. Insist on a "rest" day (Sunday) midway through a two-week shortcourse.

5. Keep some open times in the shortcourse schedule to allow for flexibility and guest speakers.

6. Provide general principles and the latest worldwide technologies (US team), supplemented with local expertise (Indian team) with indigenous Indian species.

7. Make copies of all handouts in U.S. and ship to the meeting site, rather than relying on copying facilities at the site.

II. <u>For subsequent Indian shortcourses on forest seed technology</u>:

1. Conduct follow-up workshops at other locations in India, under the coordination of Dr. O.P. Toky, utilyzing the course materials that have been provided by Mississippi State University scientists at this first workshop (Appendix Attachment J). Practicals should utilize local multipurpose species from the list developed at Coimbatore (Appendix Attachment F), and equipment/materials as specified in Appendix Attachment G.

2. Provide participants at the start of those workshops with a packet of materials that include a complete course outline, workshop schedule, and name tag.

3. Accommodate participants and instructors in one housing facility to improve off-session interactions.

4. If required, conduct a pre-test and a post-workshop test to assess effectiveness of the workshop.

5. Provide participants with an abstract of each lecture before the lecture (to increase comprehension and listening time).

6. Use effective visual aides, such as slides, overheads (large print), and movies (when available), to supplement lectures.

7. Put seed testing lectures and practicals near the start of the workshop, so that at least some germination will take place for evaluation by the end of the workshop.

8. Provide adequate quantities of forest tree seeds and laboratory facilities so that each participant can conduct sequential, coordinated practicals with "hands-on" activities, rather than having to observe small, segmented demonstrations.

9. Increase emphasis on indigenous, multipurpose species.

10. Use poster sessions during tea breaks to illustrate ongoing research and seed technology for specific tree species in the region (see Appendix Attachment H).

11. Use short (1-2 hour) field trips to local facilities to supplement lectures and practicals.

12. At the end of the workshop, summarize differences and similarities between forest seed technology and agricultural seed technology.

13. Conduct follow-up surveys of participants six months after the workshop to assess use of information provided in the workshop.

APPENDICES

Attachment A

SCOPE OF SERVICES

Workshop on Tree Seed Technology
under Agroforestry Subproject
to be offered May 22 to June 3, 1989
at Tamil Nadu Agricultural University, Coimbatore

The three staff members will:

1. Outline a two-week course to be accomplished in 12 working days that conveys knowledge on tree seed technology with particular regard to basic principals to sub-tropical and tropical species and locations. These should include practical laboratory and field exercises to be done by the participants.

2. Prepare daily teaching plans and develop appropriate teaching materials and reference lists for the implementation of the course. These plans and materials should become a part of the permanent record as annexes to the staff members' written report.

3. Draw on local expertise within India as appropriate and with particular regard to requirements of species found within India. This may lead to some modification in the work plan and training materials if the course is offered subsequently. Such possible changes should be mentioned in the final written report.

4. Prepare a list of equipment and supplies needed for the course.

5. Report to the site where the workshop is to be held about three days before the course is to be offered in order to assure that plans and materials for study are properly available and synchronized.

6. Take responsibility for conducting the workshop in collaboration with local counterparts in the forestry program and the staff of the seed technology unit at TNAU, Coimbatore.

7. Prepare an evaluation of the results of course, making use of appropriate training course evaluation questionnaires and other materials. Data from the questionnaires should be evaluated as a part of the final report, which should have a section on suggested modification for the improvement of the course if it is offered again.

8. Prepare and deliver to Winrock before leaving India a written report that describes the workshop in its context, its development, its content, its circumstances, its execution, the participants, an analysis of evidence of the workshop's effectiveness, and recommendations to improve the workshop if it is held again.

9. Give an oral debriefing to ICAR/USAID/Winrock, preferably at ICAR headquarters.

BIOGRAPHICAL DATA

Name:

Designation:

Address:

Affiliation:

Academic Qualifications:

Job Assignment/Responsibilities:

Experience related to tree seed technology/testing/seed use:

Attachment C

Name _____

Forest Seed Short Course
(Indicate "T" for True or "F" for False)

_____ 1. All tree species are seed-producing plants and belong to either the class Gymnospermae or Angiospermae.

_____ 2. A tree's life cycle is the development from zygote to seed production.

_____ 3. The angiosperm life cycle differs from the gymnosperm life cycle in having naked seeds rather than seeds enclosed in fruit.

_____ 4. Double fertilization occurs during the angiosperm life cycle, meaning that each seed has two zygotes.

_____ 5. The fruit develops from the ovary, so that it has half the number of chromosomes per cell as the mother tree.

_____ 6. The developing embryo is nourished by the haploid female gametophyte in gymnosperms, but it is nourished from either diploid cotyledons, triploid endosperm, or diploid nucellar material in angiosperms.

_____ 7. Fertilization is required before physical growth of the cone or fruit begins.

_____ 8. Three types of mature fruits are (a) dry fruits that release seed at maturity, (b) dry fruits that separate from the tree without releasing their seeds, and (c) fleshy fruits that drop with their seed enclosed.

_____ 9. Secondary seed dormancy refers to conditions that develop during the seed maturation process before seed collection.

_____ 10. Hypogeal germination refers to species where cotyledons remain below ground, with a rapid upward elongation of the plumule during the germination process.

_____ 11. The genoptype of a tree is a result of the tree's phenotype, the environment in which that tree has grown, and the interaction between the tree's phenotype and environment.

_____ 12. Genetic improvement is accomplished by selection of the best genotypes and crossing among these selected trees to produce seed for reforestation.

_____ 13. Exotics are tree species from other countries.

_____ 14. The provenance of a seed lot is more important information than the seed source, if the two are different.

_____ 15. Somaclonal variation is genetic variation among germ cells (pollen and egg cells) from the same clone.

_____ 16. A seed production area (seed stand) is a collection of selected trees established and grown together under intensive management for production of genetically improved seeds.

_____ 17. The most important practice for maximizing seed production from seed orchards is selection of the site where the orchard will be established.

_____ 18. Certification is a guarantee of seed quality and genetic identity, and the word "certified" implies genetic improvement.

_____ 19. Yellow tag certificates in the O.E.C.D. scheme for international forest certification indicates that the material comes from untested seed orchards.

_____ 20. O.E.C.D. certification standards cover forest seeds, parts of plants, and plants.

_____ 21. The only requirement for development of a comprehensive seed program is the technical training of personnel.

_____ 22. The seed certification program and the seed regulatory programs are segments of the quality control program of a seed industry.

_____ 23. A crop can be no better than the seed which are planted.

_____ 24. The ISTA establishes rules and regulations governing determination of seed quality at the international level of seed trade.

_____ 25. The primary objective of taking a sample is to determine the mechanical purity and viability of a seed lot.

_____ 26. The moisture content of each seed is a major factor in determining how long the seed will live.

_____ 27. The statement "Seed are hygroscopic" means that seed will absorb water vapor from the air regardless of the seed's moisture content.

_____ 28. An abnormal seedling is one that possesses all the essential parts that indicate the ability of the seedling to produce a plant under favorable, but not unfavorable, conditions.

_____ 29. All seed of a single lot will germinate at the same time.

_____ 30. The primary purpose of seed certification is to guarantee to the person planting the seed that the seed in the bag are varietally pure and of good quality.

_____ 31. After seed are dried to a level of moisture safe for storage, approximately 10-12%, they will remain at that moisture content until placed in the soil.

_____ 32. When air temperature decreases the relative humidity increases.

_____ 33. the screens available for air-screen cleaners will permit the removal of all contaminates from a lot when properly selected.

_____ 34. There must be a measurable difference in at least one of the physical characteristics of two seed before mechanical separation is possible.

_____ 35. Seed stored under cool humid conditions will retain their viability longer than the same seed stored at 30° C and 40°% R.H.

_____ 36. The embryo develops from the fusion of one sperm cell with the egg cell.

_____ 37. A seed is a completely developed ovule.

_____ 38. Seed are physiologically mature when they reach the point of maximum dry weight.

_____ 39. The weight of the "working sample" of a purity analysis may be more but never less than that specified in the seed testing rules.

_____ 40. The tetrazolium test is used to indicate seed viability by staining the living tissue of seed.

_____ 41. The first count of the standard germination test is used to evaluate and eliminate the abnormal and diseased seedlings.

_____ 42. Recalcitrant seeds are seeds that are difficult to remove from their fruits.

_____ 43. Air-screen cleaners are used only for special cleaning of a few species.

_____ 44. The best maturity index for Pinus cones is their moisture content.

_____ 45. The most common index of fruit maturity for all species is color change.

_____ 46. Indigo carmine stains live tissue red.

_____ 47. The hot wire and the Boerner divider perform the same function.

_____ 48. X-rays have longer wavelengths than visible light.

_____ 49. The ASAC-1000 is a new model of sports car.

_____ 50. Water should never be applied to pine cones being stored for seed extraction.

_____ 51. Same as above for a wing from chir pine?

_____ 52. One week is a sufficient period for Quercus seeds to reach equilibrium with their storage atmosphere.

_____ 53. Large seeds always germinate more rapidly than small seeds.

_____ 54. Kimpak is a popular seed disinfectant.

_____ 55. The most viable seed are the first disseminated in a season by a tree.

_____ 56. The greatest quantity of tree seed is collected from standing trees.

_____ 57. Longevity of seed is a species characteristic.

_____ 58. The vigor of seed can be increased by proper storage.

_____ 59. Seed vigor is measured by the standard germination test.

_____ 60. Internal fungi most often occur as mycelium.

_____ 61. In general, moths are more specific than beetles when selecting host seed species.

_____ 62. An empty pine seed shows more or less leachate conductivity than a dead seed?

_____ 63. Name the cheapest of all rapid tests.

_____ 64. Name the most expensive of all rapid tests.

65. In seed radiography, contrast can be lowered by increasing

_____.

66. Silver nitrate, chloroform, and water are all what?

_____

67. Which test should be performed first at the testing lab, purity, or moisture content?

68. Is legume fragment of Robinia pseudoacacia considered trash or pure seed in a purity test?

69. Hydrogen peroxide has two important potential uses in a seed laboratory; name one of them.

70. What is the usual desired seedling density in a germination bed where seedlings will be pricked out for transplanting? (Circle your answer.) 240; 860; 1,800; or 2,400 per square meter.

Name.....

Forest Seed Technology Workshop

Post-Workshop Test

I True-False (Indicate "T" for True or "F" for False)

_____1. All tree species are seed-producing plants and belong to either the class Gymnospermae or Angiospermae.

_____2. A tree's life cycle is the development from zygote to seed production.

_____3. The angiosperm life cycle differs from the gymnosperm life cycle in having naked seeds rather than seeds enclosed in fruit.

_____4. Double fertilization occurs during the angiosperm life cycle, meaning that each seed has two zygotes.

_____5. The fruit develops from the ovary, so that it has half the number of chromosomes per cell as the mother tree.

_____6. The developing embryo is nourished by the haploid female gametophyte in gymnosperms but it is nourished from either diploid cotyledons, triploid endosperm, or diploid nucellar material in angiosperms.

_____7. The genotype of a tree is a result of the tree's phenotype, the environment in which that tree has grown, and the interaction between the tree's phenotype and environment.

_____8. Genetic improvement is accomplished by selection of the best genotype and crossing among these selected trees to produce seed for reforestation.

_____9. Exotics are tree species from other countries only.

_____10. The provenance of a seed lot may be different than its seed source.

_____11. Somaclonal variation is genetic variation among germ cells (pollen and egg cells) from the same clone.

_____12. A seed production area (seed stand) is a collection of selected tree that are established together and grown under intensive management for production of genetically improved seeds.

_____13. The most important practice for maximizing seed production from seed orchards is selection of the site where the orchard will be established.

_____14 Certification is a guarantee of seed quality and genetic indentity, and the word "certified" in forest reproductive material implies genetic improvement.

_____15. Yellow tag certificates in the O.E.C.D scheme for international forest certification indicates that the material comes from untested seed orchards.

_____16. O.E.C.D. certification standards cover forest seeds, parts of plants, and plants.

_____17. The ISTA establishes rules and regulations governing determination of seed quality at the international level of seed trade.

_____18. The primary objective of taking a sample is to determine the mechanical purity and viability of a seed lot.

_____19. The moisture content of each seed is a major factor in determining how long the seed will live.

_____20. The statement "seed are hygroscopic" means that seed will absorb water vapour from the air regardless of the seed's moisture content.

_____21 All seed of a single lot will germinate at the same time.

_____22. After seed are dried to a level of moisture safe for storage, approximately 10-12%, they will remain at that moisture content until placed in the soil.

_____23. When air temperature decreases the relative humidity increases.

_____24. There must be a measurable difference in at least one of the physical characteristics of two seed before mechanical seperation is possible.

_____25. The embryo develops from the fusion of one sperm cell with the egg cell.

_____26. A seed is a completely developed ovule.

_____27. Seed are physiologically mature when they reach the point of maximum dry weight.

_____28. The weight of the "working sample" ~~of~~ for a purity analysis may be more, but never less, than that specified in the seed testing rules.

_____29. The tetrazolium test is used to indicate seed viability by staining the living tissue of seed.

_____30. The first count of the standard germination test is used to evaluate and eliminate the abnormal and diseased seedlings.

_____31. Recalcitrant seeds are seeds that are difficult to remove from their fruits.

_____32. The best maturity index for *Pinus* cones is their moisture content.

_____33. The most common index of fruit maturity for all species is colour change.

_____34. Indigo carmine stains live tissue red.

_____35. X-rays have longer wavelengths than visible light.

_____36. Water should never be applied to pine cones being stored for seed extraction.

_____37. Large seeds always germinate more rapidly than small seeds.

_____38. The most viable seeds are the first disseminated in a season by a tree.

_____39. Longevity of seed is a species characteristic.

_____40. The vigour of seed can be increased by proper storage.

II <u>Multiple choice (Choose the one answer which is most correct, and circle the letter)</u>

1. Both Angiosperm and Gymnosperm seeds contain:

   a. Fruit.

   b. Endosperm.

c.Seed coat.

d.Female gametophytic tissue.

2. Cell division in which the chromosome number is halved is called:

a.Fertilization.

b.Meiosis.

c.Mitosis.

d.Hybridization.

3. The Angiosperm and Gymnosperm life cycles differ for all of the following except:

a.Presence of fruit.

b.True flowers.

c.Double fertilization.

d.Union of egg and sperm to form a zygote.

4. The most important factors to consider when initiating a tree improvement program include:

a.Flowering characteristics, seed orchard management, size of country.

b.Provenance, export potential, amount of information already available.

c.Sites to be planted,adaptability of a genetic material, products desired.

d.Labour supply, nursery management, heritability.

5. The amount of genetic gain from a tree breeding program is not dependent upon:

a.Heritability of the trait.

b.Selection intensity.

c.Value of trait

d.Amount of phenotypic variation.

6. New biotechnology methods for genetic improvement of trees include:

a.Selection, supplemental mass pollination, vegetative propagation.

b.Species introduction, chloroplast fusion, controlled pollination.

c.Gene transfer, somatic cell selection, somaclonal variation.

7. Which of the following differences between seed orchards (SO) and seed production areas (SPA) is not true?

a.SO is planned and managed from time of establishment, while SPA is an existing stand that is chosen and then managed for seed production.

b.SO requires more time from initial planning to actual seed production than does a SPA

c.SO is temporary, whereas a SPA is permanent.

d.SO gives greater genetic gain than SPA.

8. Seed orchard (SO) management practices for maximising seed production do not include:

a.Establishment of the SO on a site where soil and climatic conditions are most favourable for seed production.

b.Mechanical injury of the stem to stimulate following.

c.Irrigation and fertilization.

d.Seed insect control with insecticides.

9. The four certification classes for forest reproductive material are:

a.Source identified, breeder, foundation, and certified.

b.Source identified, selected, untested orchard, and tested material.

c.Breeder, untested orchard, foundation, and seed production area.

10. O.E.C.D certification labels for forest reproductive material do not contain:

a.Category of reproductive material.

b.Common and Latin name of species.

c.Provenance.

d.Year of ripening of seed.

e.Name of certifying agency.

f.Purity, soundness and germinative capacity of the seed.

11. The principles of air seperation and screening are combined in what piece of seed equipment?

a.Gamet divider.

b.Net retrieval system.

c.Air-screen cleaner.

d.Gravity table.

12. What seed testing method originated with tree seed testing instead of agricultural seed testing?

a.X-ray.

b.Excised embryo.

c.Cutting test.

d.Leachate conductivity.

13. Specific gravity of the fruit is calculated by:

a.Fresh weight + dry weight.

b.Volume divided by weight.

c.Weight divided by volume.

d.

Weight multiplied by volume.

14. The preferred method of dewinging most pine seeds is:

a.Dry dewinging.

b.Gravity separation.

c.Dipping in boiling water.

d.Wet dewinging.

15. High conductivity of seed leachates could indicate which of the following?

a.Seeds with high oil content.

b.Empty seeds.

c.Damaged seeds.

16. Among the following genera, which one would be most suited to the excised embryo test?
a.Eucalyptus.
b.Juglans.
c.Pinus.
d.Populus.

17. Which of the following is the best indicator of seed vigour?
a.Germination rate.
b.Fruit specific gravity.
c.Percentage of abnormal seeds.
d.Percent purity.

18. As a general rule, ISTA recommends rapid tests for a species if a standard germination test takes longer than:
a.15 days.
b.60 days.
c.3 months.
d.28 days.

19. The newest method for scarification of hard seeds is:
a.Sulfuric acid.
b.Hot water soak.
c.Nicking.
d.Hot-wire.

20. When eucalyptus capsules are collected in the field, they should be transported in:
a.Polyethylene bags.
b.Cloth bags.
c.Glass jars.

21. Which type of seed is the most difficult to store?
a.Orthodox.
b.Tropical recalcitrant.
c.Temperate recalcitrant.

22. Which of the following is the <u>most important</u> in seed storage?
    a. Seed moisture content.
    b. Storage temperature.
    c. Storage atmosphere.
23. Which of the following types of seed would establish the highest equilibrium moisture content under identical conditions?
    a. Seeds that have a high protein content.
    b. Seeds that have a high carbohydrate content.
    c. Seeds that have a high oil content.
    d. Seeds that have high vigour.
24. What is the name of the sub-sample (taken from the sample received by the Testing Laboratory) on which one of the quality tests is made?
    a. Primary sample.
    b. Submitted sample.
    c. Composite sample.
    d. Working sample.
25. According to ISTA rules how many primary samples must be taken if a seed lot consists of 24 containers?
    a. Four.
    b. Six.
    c. Eight.
    d. Ten.
26. Which one of the following is <u>incorrect</u> for large-scale collection of tree seeds?
    a. Collect seeds only from healthy, vigourous trees of reasonably good form that are making better than average growth.
    b. When possible, collect from mature and over-mature trees.
    c. Avoid isolated trees of naturally cross-pollinating species.
    d. Avoid collecting in stands containing numerous poorly-formed, off-colour, diseased trees.
27. Which of the following is <u>incorrect</u> concerning the x-ray test?

a.Use of radiopaque agents increase image intensity and make the test more sensitive.

b.It is possible to determine the physiological status of the seeds.

c.It is not applicable for testing all seeds.

d.It is possible to detect insect and fungus damage in large seeds.

28. The leachate conductivity test is based on:

a.Changes in the seed coat as the seed ages.

b.An increasing respiration rate in aging seed.

c.Changes in the permeability of cell membranes as seed age.

d.Changes in the enzyme activity of cells of the seed embryo.

29. What are the suggested best storage conditions of Group I (Orthodox) seeds?

a.0-5° C temperature and 5-10° moisture content (MC).

b.0-5° C and 25% MC.

c.20° C and 5-10% MC.

d.20° C and above 25% MC.

30. The best storage container for recalcitrant seeds is:

a.Impermeable to water vapour and air.

b.Permeable to water vapour and impermeable to air.

c.impermeable to water vapour and permeable to air.

d.Permeable to water vapour and air.

Attachment E

WORKSHOP ON TREE SEED TECHNOLOGY
UNDER AGROFORESTRY SUBPROJECT
MAY 22 to JUNE 3, 1989
TAMIL NADU AGRICULTURAL UNIVERSITY, COIMBATORE

EVALUATION

1. Did this workshop improve your ability to do your job?

   Yes..... No.....

2. Would you recommend this workshop to others?

   Yes..... No.....

3. Was the length of the workshop

   (Please check one)

   Too long.....
   Too short.....
   About right.....

4. What did you like most about the workshop?

5. What did you like least about the workshop?

6. Please rate the following by circling a number.

Item	Poor				Excellent
	1	2	3	4	5
Instruction methods	1	2	3	4	5
Text book (FAO 20/2)	1	2	3	4	5
Handout materials	1	2	3	4	5
Tours	1	2	3	4	5
Workshop facilities	1	2	3	4	5

7. List 2 or 3 ways you plan to use this information.

8. Suggest ways that the workshop can be improved.

Attachment F

List of Multipurpose Indian Trees

A. Himalayan Region:

1. Grewia optiva
2. Celtis australis
3. Toona ciliata
4. Wild apricot
5. Wild pomgranate
6. Bauhinia variegata

B. Gangetic plains

(a) Arid zone

1. Prosopis cineraria
2. Zizyphus mauritiana
3. Teccomela undulata

(b) Semi-arid zone

1. Syzygium cuminii
2. Azadirachta indica
3. Acacia catechu
4. A. nilotica
5. Capparis decidua
6. Phyllanthus emblica
7. Butea monosperma
8. Tamarindus indica

D. 9. Hardwickia binata

(c) Mesic condition

1. Madhuca latifolia
2. Aegle marmelos
3. Moringa olefera
4. Artocarpus integrifolia
5. Derris indica
6. Ailanthus excelsa
7. Terminalia spp

C. North-eastern India

1. Alnus nepalensis
2. Schima wallichii
3. Duabanga sonnerasoides
4. Ficus spp

D. Mangrove areas

1. Rhizphora mukernata
2. Avicinia officinalis
3. Brugrera conjugata

E. High rainfall tropical areas

1. Ailanthus malabarica
2. Artocorpus hirsuta
3. Erythrina indica
4. Grevillea ro usta
5. Sesbania grandiflora
6. Gercinia combosa
7. Pterocorpus marsupium

F. Coastal plains

1. Borossus flabellifer
2. Casuarina equisitifolia
3. Calophyllum inophyllum
4. Acacia planifrons
5. Bamboos
6. Thespesia populnea

Attachment G

Equipment/Materials Needed for
Two-Week Tree Technology Short Course

1. 35 mm projector.

2. Overhead projector.

3. Photocopier.

4. Hand pruning shears, 8 $^1/_2$" long.

5. Electric moisture tester; operated by battery; portable.

6. Germinator; electronic control of temperatures at $\pm$ 1 $^1/_2$ F.

7. Germination paper or towels.

8. Stereo microscope; dual illuminatig system; 1 X objective and 10 XWF ocular.

9. Laboratory oven, 1.5 cu. ft.; forced air.

10. Top-loading electronic balance; 100 g capacity; 0.01 g sensitivity.

11. Seed triers; $^1/_2$" outside diameter/ 18" and 30" lengths.

12. Plastic desiccating cabinet.

13. Sample cans for sample drying.

14. Forceps.

15. Scalpels.

16. Petri dishes; 100 x 15 mm.

17. Lab marking pens, permanent ink.

18. Tree seed; local multipurpose species; 1-3 kg of each.

19. Tetrazolium powder. 2, 3, 5 Triphenyl tetrazolium chloride.

20. Aluminum foil--as used in home kitchens.

21. Paper--notebook paper for students

22. Pencils--=2 for student use.

23. Dissecting needles.

24 Hand Lens--5 and 10X.

25. Sandpaper--medium grit, 8"x10" sheet.

26. "Saran" wrap--plastic, transparent wrap as used in home kitchens.

27. Chlorox--sodium hypochlorite solution as used in home.

28. Filter paper--9 cm.

29. Spatula.

30. Plastic bags.

31. Spoons--as purchased for home use.

32. Weighing dishes.

33. Graph paper--8"x10", 5 mm ruled or similar.

34. Ethyl alcohol--minimum 80% alcohol for sterilization.

Attachment G. (con't.)

35. Conductivity meter and probe.

36. Distilled or deionized water.

37. Absorbent paper towels as used in kitchen, home use.

38. Photocopier paper.

39. Texbook--A guide to forest seed handling-with special reference to the tropics. Compiled by R.L. Willan. FAO FORESTRY PAPER 20/2. ISBN 92.5.102291-7. Available from: UNIPUB, 1611 F Assembly Drive, Lahan, Maryland 20706. Price, ca. $30 each.

Attachment H

INDO-US FOREST TREE SEED TECHNOLOGY WORKSHOP CUM SHORT COURSE

22nd MAY - 3rd JUNE, 1989

POSTER CUM DISCUSSION SESSIONS.

22.05.89	: General pattern of seed Research - Disciplinewise, centres of activity
23.05.89	: CASHEWNUT - Seed Physiological maturity, harvest date, seed nut grading, pre-soak treatments, positional features, seed nut storage.
24.05.89	: **Delonix regia** - **Hardwickia binata** **samanea saman** Seed production technology encompassing harvest date, seed processing and storage
25.05.89	: *Casuarina - Seed production technology * Papaya - physiological maturity, Date of collection, Ripening retardants, Lancings and seed quality ultrasonic waves for sex expression - seed storage mid storage correction.
26.05.89	: * Eucalyptus * Acacias * Kapaok } Seed production technology encompassing harvest date, seed processing and seed stora
27.05.89	: Field trip to Top Slip, seed collection source, etc.
28.05.89	: Field trip to Forestry Research station and Ooty.
29.05.89	: *Ailanthus *Leucaena } Seed production technology
30.05.89	: Vigour tests AND FOREST PRODUCTS ON SEED QUALITY
31.05.89	: Neem seed production technology
01.06.89	: *Seed entomology *Seed pathology
02.06.89	: *Seed inoculation - microbilogy - Forest species *Forest, its location in Tamil Nadu
03.06.89	: Seed identification and seedling evaluation

Attachment I

List of Participants

1. Dr. M.G. Dasthagir,
   Associate Professor,
   Forest Research Station
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2. Mr. K. Ganesamurthy
   Assistant Professor (Soybean)
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3. Dr. M.S. Hooda
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   Haryana Agricultural University
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4. Mr. A. Edwin Jeyaraj
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   Faculty of Horticulture
   Tamil Nadu Agricultural University
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5. Dr. A.N. Jha
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9. Mr. B.N. Patil
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10. S.C. Patil, SRA (PL)
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11. Mr. A.S. Ponnuswamy
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13. S.S. Rathore
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14. Mr. S. Selvaraj
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15. Dr. S.K. Sharma
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16. Mr. B. Gurudev Singh
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17. Dr. R.C. Singh
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18. Dr. R.R. Singh
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19. Mr. S. Srinivasan, D.F.A.
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20. Mr. K.K. Suresh
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