

PW-ABW-243

95294

**SEED TECHNOLOGY WORKSHOP**

**19-31 October, 1991**

**Pakistan Forestry Institute**

**Conducted by:**

**Winrock International  
Forestry Planning & Development Project**

**and**

**Department of Forestry  
Mississippi State University**

**SEED TECHNOLOGY WORKSHOP**

19-31 October, 1991

Pakistan Forestry Institute

Conducted by:

Winrock International  
Forestry Planning & Development Project

and

Department of Forestry  
Mississippi State University

Report prepared by:

Frank Bonner  
27 November, 1991

## Table of Contents

<u>Section</u>	<u>page</u>
Executive Summary.....	1
I. Background.....	2
II. Objectives.....	2
III. Results.....	3
A. Workshop.....	3
B. Manual.....	4
C. National Tree Seed Manual.....	4
D. Symposium.....	7
IV. Recommendations.....	8
Appendices	
1. Biographic Sketch of Instructors.....	11
2. List of Participants.....	12
3. Workshop Course Schedule.....	13
4. Pre-Workshop Questionnaire.....	15
5. Post-Workshop Questionnaire.....	18
6. Comments from Participants.....	20
7. Equipment for Extraction, Cleaning, & Testing....	21

## EXECUTIVE SUMMARY

The Tree Seed Workshop was successfully carried out in Peshawar on 19-31 October, 1991. There were 20 participants, all of whom appeared to gain significant technical training in tree seed management.

The material used in teaching the course was delivered to Dr. George Blake of Winrock International. This material will stay in Pakistan and serve as the information base for additional training of Pakistani foresters.

Specific recommendations on the Workshop and elements of a national tree seed program for Pakistan are as follows:

- A. The training material in the Instructor's Manual should be made available to all provincial forestry departments upon request in order to train their people in tree seed technology.
- B. This same material, supported by U.S. Agriculture Handbook 450 and FAO Publication 20/2, should be used to teach a course in tree seed management at PFI. It should be a required course in the forestry curriculum.
- C. Both PFI and PFRI should expand their tree seed research programs. One Research Officer should be assigned to this topic alone at each Institute.
- D. A tree seed manual for Pakistan should be written.
- E. Plans should begin immediately for an international scientific symposium on tree seed technology in Pakistan. Proceedings of the symposium should be published.
- F. Tree seed procurement and management must be improved through implementation of a National Tree Seed Plan. This plan should be incorporated into the National Forestry Plan currently under development and carefully coordinated with national planning in forest genetics and tree improvement (hopefully coming in 1992). Elements of a National Tree Seed Plan are outlined in the main body of the Report.

## I. Background

The Workshop on Seed Technology was an activity of the Forestry Planning and Development Project, a joint effort of the Government of Pakistan and the US Agency for International Development. The Project is administered by the Winrock International Institute for Agricultural Development and the Office of the Inspector General of Forests for Pakistan. The Workshop took place at the Pakistan Forest Institute, Peshawar, Pakistan, on October 10-31, 1991. Instructors were Dr. Frank Bonner and Dr. J. A. Vozzo. Brief biographical sketches are found in Appendix 1.

## II. Objectives

The objectives of the Workshop were to:

- A. Carry out two weeks (12 days) of instruction in tree seed technology for forest officers and research officers from various provinces of Pakistan.
- B. Deliver at the conclusion of the Workshop a manual that can guide seed collection and conditioning activities, direct testing activities of a seed laboratory, and assist in development of a national program in tree seed procurement and management.
- C. Explore the need for and the feasibility of developing a national tree seed manual for Pakistan based on the format of U.S. Agriculture Handbook 450.
- D. Develop a plan for an international symposium on collection and utilization of tree seeds in arid and

semi-arid forest conditions in 1993.

### III. Results

#### A. Workshop

There were 20 participants in the Workshop. Their names and institutions are listed in Appendix 2. The schedule of the Workshop is found in Appendix 3. The instructors feel that the Workshop was successful, and that all participants appeared to be genuinely interested in the material, as they completed all class problems and exercises without complaint.

A pre-workshop questionnaire (Appendix 4) was given to the participants at the beginning of the course. The results were:

Mean score: 34%

Range of scores: 12 to 60%

Frequency distribution: <u>Score</u>	<u>Number</u>
0-10	0
11-20	2
21-30	6
31-40	3
41-50	5
51-60	2

A post-workshop questionnaire (Appendix 5) produced the following results:

Mean score: 58%

Range of scores: 42 to 73%

Frequency distribution: <u>Score</u>	<u>Number</u>
0-40	0
41-50	8
51-60	3
61-70	5
71-80	3

The mean score was almost doubled, but more important was the fact that there were no extremely low scores on the post-test. Most of the wrong answers were on the questions that dealt with laboratory seed testing; some adjustments of instructional materials may be needed here. On the other hand, most of the Workshop participants will not perform laboratory seed tests in the course of their normal duties, and this topic may not have held their interest. An exception to this was the practical on tetrazolium staining, which was very well received.

Participants were also asked to make written comments at the end of the Workshop on the following points:

1. What did you like best about the Workshop?
2. What did you like least?
3. How could the Workshop be improved?
4. Will it help you in your job?
5. Any additional comments?

These comments were, in general, very favorable, and the most common ones are listed in Appendix 6.

B. Manual

The Manual called for in objective B is composed of three large ringbinders that served as the teaching guide during the Workshop. They include all lecture notes, overheads and color slides used during the Workshop. Selected technical reprints were also included. All of this material was turned over to Dr. George M. Blake, Training and Research Advisor for the Winrock International Technical Assistance Team.

C. National Tree Seed Manual

We believe that development of a National Tree Seed Manual is an important and necessary step to be taken for the effective reversal of deforestation in Pakistan. Considerable information on seed technology of the woody plants of Pakistan already exists in various technical publications, both in Pakistan and abroad; the best species of Pakistan are widely grown and utilized in many countries.

Few countries have a national tree seed manual, but for those that do, it is normally a source of national pride. To be the first country on the subcontinent to produce such a manual would provide a significant boost to the self-esteem of Pakistani foresters. It would also strengthen the forest research institutions of the country.

Development of the Manual should proceed as follows:

1. Two scientists from Pakistan should spend 4 to 5 months in the United States early in 1992 to

perform an exhaustive search of seed literature on the top 100 tree species of Pakistan. Electronic search and retrieval services would be employed. The scientists should have a good working knowledge of seed and seed technology, and they should have demonstrated good writing ability in English. This work should be done at a university in the United States where American collaborators can give technical advice.

2. The product of the work described above will be an outline/format for the manual, rough drafts for 5 to 10 key genera or species, and a large amount of summarized published material on seed technology of all 100 species.
3. Upon return to Pakistan, the two scientists should complete writing on at least the 5 to 10 key genera or species and begin drafts for the others. Help from other Pakistani scientists could then be solicited to complete the first draft of the manual.
4. The completed manuscripts on the key genera or species should be published as sections of a loose-leaf binder in time to be displayed at the international tree seed symposium (see D below). The U.S. scientists who have collaborated on the job should arrive 10 to 14 days in advance of the symposium and review the draft material that has been prepared in Pakistan. A final technical review of the entire manual will have to be done at a later date, hopefully no longer than 6 months after the symposium.

#### D. Symposium

An international scientific symposium on tree seeds should be organized for Pakistan in 1993. The theme of the symposium should be "Forest Seeds for Arid and Semi-arid Zones." Since there will be a IUFRO-sponsored meeting on a similar subject and theme in November, 1992, in Burkina Faso, the Pakistan symposium should be held in late summer or early fall of 1993.

To attract top people to this symposium, FPDP should invite up to four well-known experts in arid-zone forestry or tree seed technology and pay their travel and living expenses. These people would present keynote papers during the 2-day symposium. All other contributions would be volunteer papers. A call for papers must be distributed early in 1992. The symposium would serve three purposes:

1. Pakistani forest scientists would be exposed to the top people in this field, and they might be inspired to increase the quantity and quality of their seed research.
2. The first finished sections of the tree seed manual would be displayed, which should increase enthusiasm for the project.
3. The event could establish the claim of GOP and PFI that they can become a genuine regional center for tree seed technology. They could be for the sub-continent what the ASEAN/Canada center in Thailand has become for the moist tropical forests of Southeast Asia.

#### IV. Recommendations

The following recommendations are made in relation to the results in the preceding section and topics discussed during the Workshop:

- A. The training material in the Instructor's Manual should be made available to all provincial forestry departments upon request in order to train their people in tree seed technology.
- B. This same material, supported by U.S. Agriculture Handbook 450 and FAO Publication 20/2, should be used to teach a course in tree seed management at PFI. It should be a required course in the forestry curriculum.
- C. Both PFI and PFRI should expand their tree seed research programs. One Research Officer should be assigned to this topic alone at each Institute.
- D. A tree seed manual for Pakistan should be written as outlined in III C.
- E. Plans should begin immediately for an international scientific symposium on tree seed technology in Pakistan as outlined in III D. Islamabad should be the site of this symposium, and PFI could be visited in a day-long field trip. Proceedings of the symposium should be published.
- F. Tree seed procurement and management must be improved through implementation of a National Tree Seed Plan. This plan should be incorporated into the National Forestry Plan currently under development and carefully

coordinated with national planning in forest genetics and tree improvement (hopefully coming in 1992). Elements of a National Tree Seed Plan are recommended as follows:

1. Seed collection, cleaning, short-term (1- to 3-year) storage, and distribution should be carried out by Provincial Forestry Departments. Their seed collection efforts should be increased (at least doubled) with careful planning for anticipated seed needs.
2. Each province should have a center for extraction, cleaning, and storage. Some extraction and cleaning equipment is now on hand in every province, and storage facilities are present at the center in Kashmir. The cold store at PFI is also large enough to serve the needs of NWFP.
3. District Forest Officers should collect an assigned quota each year and send them to their respective centers for extraction, cleaning, and storage. Cleaned seeds would then be returned to DFO's as required.
4. Surplus seeds should be stored at the provincial centers, and seed exchange between provinces could help meet seed requirements of all parties. Computerized seed inventories should be maintained and coordinated through PFI at Peshawar.
5. Additional cleaning and storage facilities might be available at the provincial level through cooperation with the Provincial Seed Corporations. It is even possible that tree seed divisions could be formed within the Corporations.

6. In cooperation with an expanding program in genetics and tree improvement, a small program of germplasm conservation for tree species should be initiated. PFI should coordinate this effort and furnish all seed storage needs of the program.
  
7. Existing equipment for extraction, cleaning, and testing should be augmented and upgraded if funds are available. A list of suggested equipment is attached in Appendix 7.

Biographic Sketch of Instructors

Franklin Thomson Bonner, DF

Dr. Bonner is a citizen of the United States of America. He was born in 1936, and after doing his BS in forestry, he joined the US Forest Service in 1959 as Research Forester. Dr. Bonner got his Doctorate in Forestry in Tree Physiology in 1965, and he is currently working as Plant Physiologist and Project Leader, USFS Southern Forest Experiment Station, Starkville, Mississippi.

Dr. Bonner is a member of numerous professional societies, and is past Chairman of the IUFRO Group on Seed Problems. He has been on several special assignments related to seeds and allied subjects, not only in the US, but in Poland, Yugoslavia, China, Morocco, Mexico, Thailand, Indonesia, Philippines, Costa Rica, Kenya, India, Uganda, Botswana, Zimbabwe, Zambia, Brazil, and Pakistan.

He has over 100 publications to his credit, 90 on tree seeds, and has presented over 75 talks and papers locally in the USA and internationally. He has previously taught seed technology courses in Kenya, India, Brazil, and Puerto Rico.

John Anthony Vozzo, Ph.D.

Dr. Vozzo, a citizen of the United States of America, was born in 1937. He did his MS in Botany in 1963 and was awarded a Ph. D. in Plant Physiology in 1967. During 1965-66 Dr. Vozzo worked as an instructor of Botany at the Montgomery Junior College.

Dr. Vozzo is Research Plant Physiologist, USDA Forest Service, assigned to the Forestry Sciences Laboratory, Starkville, Mississippi. He was appointed Adjunct Associate Professor of Forestry at Mississippi State University in 1967.

Dr. Vozzo has the honor of being one of the 40 scientists who were involved in the biological pathogenic analysis of lunar samples brought back by the Apollo space craft from the moon from April, 1969, to September, 1970.

Dr. Vozzo has a vast experience of seed technology work in the USA and abroad, both as a researcher and as a teacher. He has consulted with governments, NGO's, universities, and private organizations on mycorrhizal synthesis and seed development. He has over 45 technical publications to his credit. He has previously taught seed technology courses in USA and Kenya, and he is currently Co-Chairman of the IUFRO Group on Seed Problems.

Workshop on Seed Technology under Forestry  
Planning and Development Project from  
October 19 to 31, 1991

---

List of participants

- |  |  |
|--|--|
| 1. Mr. Mohammad Fiaz Joyia,<br>S.O.(AF), National Agricultural<br>Research Centre, Islamabad, Ph: 82005177<br>House No.275, Sec: I-10/4, Islamabad<br>Ph: 417426. (Res.) | 12. Mr. Muhammad Latif,<br>Range Forest Officer,<br>Quetta, H.No.7-64/6,<br>Alamdard Road, Nauabad,<br>Quetta. Ph.No.74013. (Office) |
| 2. Mr. Shakeel Ahmad,<br>Range Forest Officer, C/O<br>D.F.O. Demarcation,<br>Peshawar.   | 13. Mr. Mohammad Kabir Khan,<br>Range Forest Officer,<br>Hill Farming Bagh, (A.K.)<br>Tele.Ph.407(Office).                           |
| 3. Mr. Abdur Rauf Khan,<br>Range Forest Officer,<br>Coordination Cell,<br>Shami Road, Peshawar.  | 14. Mr. Gul Hussain Shah,<br>R/O, Chelra bandi Ward<br>No.18, Neelem Valley Road,<br>Muzaffarabad, (A.K.) Ph.3125.PP                 |
| 4. Mr. M. Farooq,<br>Range Forest Officer,<br>Reforestation, Ph.No.2530,<br>Range Kotli, (A.K.).   | 15. Mr. Hafiz Muhammad Jan<br>Jamali, Range Forest<br>Officer, Sibi, Baluchistan.<br>Ph.No.602.                                      |
| 5. Mr. Ali Haider,<br>Range Forest Officer, C/O<br>Divisional Forest Officer,<br>Demarcation, Peshawar.<br>Ph.No.79559. (Office)   | 16. Mr. Muhammad Asif Majeed,<br>C/O Abdu Majeed,<br>Admn: Officer, Pakistan Forest<br>Institute, Peshawar.<br>Off.Ph.No.40360.      |
| 6. Mr. Fazal Din Khan,<br>Horticulture Officer, CDA,<br>H.No.742, I-10/2,<br>Islamabad.  | 17. Mr. Muhammad Muslim,<br>(M.P.B.), Pakistan Forest<br>Institute, Peshawar.<br>Ph.No.42081.  |
| 7. Mr. Muhammad Shabbir Mughal,<br>Assistant Forest Ecologist,<br>P.F.I. Peshawar,<br>Ph.No.42054(Office).   | 18. Dr. Zahid Javid,<br>Divisional Forest Officer,<br>SRO(E&T), PFRI, P.O.1513,<br>Nishatabad, Faisalabad.<br>Ph.No.53406, 53405.    |
| 8. Mr. Muhammad Afzal,<br>Research Officer, PFRI,<br>Faisalabad.   | 19. Mr. Muhammad Arif Chaudhary,<br>Plant Physiologist,<br>P.F.I. Peshawar.<br>Tele.Ph.42054 (Biological Div)                        |
| 9. Mr. Abdul Habib,<br>Research Officer,<br>P.F.I. Peshawar.<br>Tele.Ph.No.40360.  | 20. Mr. Zaheer Ahmad,<br>Research Officer,<br>P.F.I. Peshawar.<br>Tele.Ph.No.40360.  |
| 10. Mr. Muhammad Hafeezullah,<br>Research Officer,<br>PFRI, Faisalabad.<br>Ph.No.53406.  | 21. Mr. Muhammad Jalil, Env. St<br>CDA, H.No.708,<br>G-10/4, Islamabad.<br>Off.Tele.Ph.859703.<br>Res.858492.                        |
| 11. Dr. Franklin T. Bonner,<br>USDA, Forest Service,<br>P.O.Box 906,<br>Starkville, Miss.39759,<br>U.S.A.  | 22. Dr. J.A. Vozzo,<br>USDA Forest Service,<br>P.O.Box 906,<br>Starkville, Miss.39759,<br>U.S.A.                                     |

**SEED TECHNOLOGY WORKSHOP**

19 - 31 October 1991

**Course Schedule**

October 19, 1991	<p>Opening session Introduction to the course Pre-Workshop Questionnaire</p> <p>Flowering, Pollination, seed maturation, practical (Seed structure)</p>
October 20, 1991	<p>Seed dormancy Germination Genetics and seed source Practical (Germination test)</p>
October 21, 1991	<p>Seed production Planning collections Recognizing seed maturity Practical (Seed crop estimation)</p>
October 22, 1991	<p>Post harvest care Drying and extraction Equipment demonstration</p>
October 23, 1991	<p>Cleaning and upgrading Equipment demonstration</p>
October 24, 1991	<p>Storage principles Storage applications Sampling Practical (sampling)</p>
October 25, 1991	<p>No class - Friday</p>
October 26, 1991	<p>Moisture content Purity and weight Practical (moisture) Equipment demonstration</p>
October 27, 1991	<p>Germination tests Rapid tests - I Rapid tests - II Practical (rapid tests)</p>
October 28, 1991	<p>Vigor tests Seed insects Seed pathogens Practical (evaluate tests)</p>

<b>October 29, 1991</b>	<b>Seed basics for nurseries National programs Seed centers</b>
<b>October 30, 1991</b>	<b>Labeling and certification Germplasm conservation Practical (germination test; class problems)</b>
<b>October 31, 1991</b>	<b>Applied seed research Review session Post workshop Questionnaire Closing session</b>

TWM:ha

## SEED TECHNOLOGY WORKSHOP

### Pre-Workshop Questionnaire

1. How many months are there from flower bud formation to seed dispersal in Pinus?
2. Name two types of dormancy in tree seeds?
3. What is the most favorable temperature for seed germination in Pakistan?
4. What is a "land race"?
5. Name two ways to stimulate seed production in a seed stand?
6. Should water ever be applied to Pinus cones after collection?
7. What is a Boerner divider used for?
8. What is equilibrium moisture content?
9. Name the best range of seed moisture content for storage of Dalbergia Sissoo?
10. What is the first measurement taken when a seed testing laboratory receives a sample?

11. **How many replications and how many seeds per replicate are required for a standard germination test?**
12. **In a tetrazolium staining test, live tissue stains what color?**
13. **What is a seed vigor test?**
14. **Name the most important insect pest group in Acacia seeds.**
15. **Name the international organization that prescribes standard germination test procedures?**
16. **What does the term "Pricking out" refer to?**
17. **In a seed certification program for trees, name three biological characteristics that may be certified?**
18. **Name three ways that tree germplasm may be saved in a germplasm conservation program?**
19. **What is a tolerance table in seed testing?**
20. **Which rapid estimate of viability is the least expensive to perform?**

21. T or F The best index of seed maturity is a change of color in the fruit or seed.
22. T or F Cones of Chir pine should be heated at 55°C to open them for seed extraction.
23. T or F A purity test determines only the presence of insects in a seed sample.
24. T or F X-ray testing can distinguish between dormant and non-dormant seeds.
25. T or F A seed health test is a test for the present of seed pathogens.

TWM:ha

## SEED TECHNOLOGY WORKSHOP

### Post-Workshop Questionnaire

1. Who establishes rules and regulations governing determination of seed quality at the international level of seed trade?
2. Which is more important to seed longevity in storage, temperature or moisture content?
3. Which are more difficult to store, oily seeds or starchy seeds?
4. How many days into a germination test is the first count taken?
5. What do the following terms apply to: peak value, E-10, Weibull b parameter?
6. An empty pine seed shows more or less leachate conductivity than a dead seed?
7. Name the cheapest of all rapid tests.
8. Name the most expensive of all rapid tests.
9. In seed radiography, contrast can be lowered by increasing?
10. Silver nitrate, chloroform, and water are all what?

11. Which test should be performed first at the testing lab, purity or moisture content?
  
12. Is a legume fragment of Robinia pseudoacacia considered trash or pure seed in a purity test?
  
13. Hydrogen peroxide has two important potential uses in a seed laboratory; name one of them.
  
14. 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.
  
15. T or F Recalcitrant seeds are seeds that are difficult to remove from their fruits.
  
16. T or F Air-screen cleaners are used only for special cleaning of a few species.
  
17. T or F The best maturity index for Pinus cones is their moisture content.
  
18. T or F Indigo carmine stains live tissue red.
  
19. T or F The hot wire and the Boerner divider perform the same function.
  
20. T or F X-rays have longer wavelengths than visible light.
  
21. T or F Water should never be applied to pine cones being stored for seed extraction.
  
22. T or F One week is a sufficient period for Quercus seeds to reach equilibrium with their storage atmosphere.
  
23. T or F Large seeds always germinate more rapidly than small seeds.
  
24. T or F Kimpak is a popular seed disinfectant.

TWM:ha

Comments from Participants

1. What did you like best?
  - "Focus on Pakistani tree species."
  - "Suggestions for seed management."
  - "Practical work on how to extract, clean, and store tree seeds."
  - "Use of audiovisual aids."
  - Up-to-date knowledge was achieved."
  
2. What did you like least?
  - "Language problems." (with instructors)
  - "Limited time for practicals."
  - "Picked up only 10% from the lectures." (Language again)
  - "Length of workshop was too short."
  - "Confined to American methodology."
  
3. How could the Workshop be improved?
  - "There should be field tours."
  - "Such courses should be held in Islamabad."
  - "More practicals and less theory."
  - "Length of the course should be increased."
  - "More on seed storage."
  
4. Will it help you in your job?
  - All responses were positive.
  
5. Any additional comments?
  - "Workshops like this must be held every year."
  - "There should be a 5-minute break after each hour."
  - "Repeat the course for every year at a different part of the country."
  - "Almost 50% of the time should be spent on practicals."

Equipment for Extraction, Cleaning, and Testing

Each Province should have at their seed center a minimum amount of equipment for mechanized extraction and cleaning. Cleaning by hand was once sufficient, but the larger amounts of seeds needed in expanded planting programs require mechanization. Suggested equipment is listed below, with the same general specifications from Bonner's 1988 report to USAID on seed equipment for Pakistan. Some of this equipment was purchased previously and is in operation. Where available, current prices are given in \$US.

- (1) Macerator/Cleaner; stainless steel hopper; flanged, revolving bottom plate; variable speed drive electric motor, 220 V, 50 Hz. Equal to Dybvig Seed Cleaner, Melvin Dybvig, Milwaukie Oregon. (2 units per location).  
\$1,500.
- (2) Cone tumbler, 3 bu. capacity; chest-type drum enclosure w/hinged top. Hot-rolled painted or galvanized steel. Size: 42" L x 26" W x 42" H (plus motor/drive outside); encloses 7 1/2 cu. ft. variable speed drum w/secured door for loading. Drum circumference covered w/ 1/2" steel mesh. Seed-cone drawer, 4 cu. ft. capacity. With cycle timer, bell and cycle-end red light. 220 V, 50 Hz 1-ph motor. Equal to Model SLT-3 , McPherson & Assoc. (Needed for conifers only, so current unit at PFI is enough.)
- (3) Air-screen cleaner, scalping capacity up to 75 bu./hr.; ball screen cleaning system; 2-screen, bottom air operation; V-belt drive with 220 V, 50 Hz motor; two screens as follows: perforated metal, round holes: 9 and 14. Equal to M2BCH/C Clipper cleaner; Seedburo Equipment Co. Catalog 91, p. 74.  
\$2,197.

- (4) Extra screens for M2-B, all perforated metal.  
11 screens: round hole 5 1/2, 8, 11, 13, 15, 16, 18, 20, 22;  
oblong 14 X 3/4 and 8 X 3/4. \$450.
- (5) Table-top air-screen cleaner; two screen, one air system  
cleaner; 34" long, 18" wide, 27" high; 1/4 hp split phase  
230 V, 50 Hz motor; with 2 screens. Equal to "Office  
Clipper", Cat. # 400/C, Seedburo Equipment Co. Catalog  
91. Screen specs: perforated metal, 8 and 9 round holes.  
\$1,228.
- (6) Extra screens (12) for above cleaner. Perforated metal,  
round holes, sizes: 1/12, 5 1/2, 11, 13, 14, 15, 16, 18, 20,  
and 22. Perforated metal, oblong holes: 8 X 3/4 and 14 X 3/4.  
\$380.
- (9) Seed aspirator; approximately 40 lbs./hr. capacity; 6 "  
air column, closed circuit system; 40 lb. O-Max variable  
speed control; variable speed fan motor, 220 V, 50 Hz, 1-  
ph; includes 20" feed hopper. Equal to Model COS 1 Forest  
Tree Seed Aspirator, SouthPine, Inc., except 3' work platform  
is not included. \$5,375.
- (8) Laboratory seed blower; air-column blower w/488 CFM  
capacity; timer switch; static pressure gauge for precision  
control; damper controls on top of vertical column and on a  
side arm; 220 V, 50 Hz electric operation. Equal to Stults  
Scientific Engineering Corp. "Purity Blower." \$2,000. (Do not  
purchase the Seedburo South Dakota blowers.)
- (9) Floor fan: mobile cooler fan, 36" blade diam., 440 RPM,  
13,800 CFM; fan guard front and back; rubber wheels; 230 V, 50  
Hz motor; 18' cord. Equal to Cat. # 2074K13, McMaster-  
Carr Supply Co. (catalog 92). \$2,000.

- (10) Hand-held air blower; 1 1/2 HP; 24,500 FPM velocity at nozzle; 220 V, 50 Hz motor. Equal to Tornado Blower Model 98801, Seedburo Equipment Co. Catalog 91, #98801 and 90010. (For cleaning extraction and cleaning equipment.) \$600.

It now appears likely that few, if any, samples of tree seeds will be sent from the provinces to PFI for standard germination testing. If germination testing is to become routine at the provincial level, then provincial seed centers must have the needed equipment. Minimum testing equipment is listed below.

- (1) Electric moisture tester; operated by 4 AA alkaline batteries; portable; range of 10 to 25% (corn); automatic sample weight determination. Equal to Dickey-John Multi-Grain moisture tester, Seedburo Equipment Co. Cat 91, p. 9. Also accessory weight. \$280.
- (2) Germinator; electronic control of temperatures from 3 to 50 C.; alternating day-night temperature and light cycles set by time clocks; stainless steel exterior; capacity: 20 trays at 2" spacing, tray size at least 19" X 20"; supported on rubber-wheeled casters; 2 fluorescent tubes on each side for light; 1/4 HP compressor; external indicator of internal temperature; overall size not to exceed 32" W and 36" D; 220 V, 50 Hz operation; 20 trays per germinator. Equal to Stults Scientific Engineering Corp. Junior Model 12 Germinator. \$12,000. (At least one unit in each center; 3 to 4 at PFI and PFRI.)
- (3) Stereo microscope; dual illuminating system; 1 X objective and 10 XWF ocular; includes transformer for 220V, 50 Hz operation. Equal to Cat. # 4E1220 and K-22 Transformer, Seedburo Equipment Co. \$750.

- (4) Refrigerator, household type, 12 cu. ft. total capacity (8 cu. ft. refrigerator, 4 cu. ft. freezer); adjustable temperature control; steel exterior with enamel finish; magnetic door closure; operate on 220 V, 50 Hz. Local purchase.
- (5) Sample scarifier, small lot; 5 3/4" diam. drum ; 1/3 HP 220 V, 50 Hz electric motor; 1725 RPM. Equal to Forsberg Sample Lot Electric Huller/Scarifier. Seedburo Catalog 91, #390/C. \$455.
- (6) Laboratory oven, 1.5 cu. ft.; forced air; 50 to 200 + 3 C. range; temperature display; 2 chrome-plated steel shelves; 220 V, 50 Hz. Equal to Isotemp Model 616 F. Fisher 91/92 Cat. # 13-245-616 F. \$915.
- (7) Top-loading electronic balance; 400 g capacity; 0.01 g sensitivity; 100 g capacity: 0.001 g sensitivity; 220 V, 50 Hz operation. Equal to Fisher Dual-Range XT-400 D Fisher 91/92 Cat. # 01-913-20. \$1,550.
- (8) Sample divider, Boerner type; brass and copper construction; 31" high; w/2 pans. Equal to Model 34, Hoffman Manuf. Co. \$795.
- (9) Seed triers; double tube brass, nickel plated; 1/2" outside diameter; 18" and 30" lengths (2 of each size). Equal to Seedburo Equipment Co. Cat. # 235 and 236. \$150.
- (10) Plastic desiccating cabinet; dimensions: 12 1/2" X 15 1/4" X 20", with 3 trays. Equal to Fisher 91/92 Cat. # 08-647-24. \$310.
- (11) Desiccant, 8-mesh, indicating (10 lb.). Equal to Fisher

91/92 Cat. # 07-578-3B. \$98.

- (12) Sample cans; 53 mm diam. X 40 mm high; with covers  
(3 doz.) Equal to Seedburo Cat. # SSC3. \$16.45
- (13) Polyethylene bags, transparent, 4-mil wall thickness. 3" X 5"  
(1M); 4" X 6" (1M). Local purchase.
- (14) Electronic sample counter. Count-a-pak 77 Seed Totalizer;  
adjustable speed control; 7" feeder bowl; LCD readout; 220 V,  
50 Hz. Hoffman Mfg. Co. Cat. # Model 77. \$2,866. (PFI and PFRI  
only.)
- (15) X-ray device. Faxitron Cabinet X-ray Model #43855A (Option  
A03); 240 V, 50 Hz. Hewlett-Packard. \$11,840. (PFI and PFRI  
only.)

Commercial Sources of Equipment Listed

Cole-Parmer Instrument Co.  
7425 North Oak Park Ave.  
Chicago, IL 60648-9930  
1-800-323-4340

Sandia Cone Cutter Co.  
2595 Cohansey Street  
Roseville, MN 55113  
(612) 483-1061

Continental Forest Industries  
Fibre Drum Division  
1902 Leland Drive, Suite 3  
Marietta, GA 30067  
(404) 952-7374

Seedburo Equipment Co.  
1022 West Jackson Blvd.  
Chicago, IL 60607  
(312) 738-3700

Melvin R. Dybvig  
1425 SE Riovista  
Milwaukie, OR 97222  
(503) 659-0718

Southpine, Inc.  
P.O. Box 7404  
Birmingham, AL 35253  
(205) 879-1099

Fisher Scientific  
50 Fadem Road  
Springfield, NJ 07081  
(201) 467-6400

Stults Scientific  
Engineering Corporation  
3313 South 6th Street Hwy  
Frontage Road West  
Springfield, IL 62703  
(217) 529-3723

Forestry Suppliers, Inc.  
205 West Rankin Street  
P.O. Box 8397  
Jackson, MS 39204  
1-800-647-5367

R. W. McPherson & Assoc.  
P. O. Box 5011  
Monroe, LA 71203  
(318) 343-5957

Fred Forsberg & Sons  
P.O. Box 510  
Thief River Falls, MN 56701  
(218) 681-1927

Hewlett-Packard  
1700 S. Baker St.  
McMinnville, OR 97128

Hoffman Manufacturing Co.  
30392 Walnut Drive, S.W.  
Albany, OR 97321  
(503) 926-2920

McMaster-Carr Supply Co.  
P.O. Box 4355  
Chicago, IL 60680-4355  
(312) 833-0300