# Seed Programs

# I. National Programs

A. Introduction

National seed programs are necessary to support national reforestation and afforestation efforts by ensuring an adequate supply of high-quality seeds of suitable species and sources. Countries of the Association of Southeast Asian Nations are losing over 1.2 million hectares of forest lands annually to other uses. Deforestation of "officially" designated forest lands in India has not been excessive since the 1950's (about 3 percent of the lands under the Forest Department), but more than 10 times this area of wastelands, small groves, etc., has been denuded. Reforestation efforts on a national scale are needed. Within the framework of national programs, State or Provincial seed programs may also be needed. A national forest-seed program can serve many functions.

B. Objectives

1. Learn the general functions of a national forest-seed program.
2. Examine possible administrative structures of a national program.
3. Examine an existing national program as a case study.

C. Key Points

The following points are important in national seed programs:

1. The primary function of a national forest-seed program is to ensure an adequate supply of suitable tree seeds.
2. National programs can serve many other important functions.
3. National programs should serve the needs of all tree planting: industrial wood plantations, watershed protection, social forestry plantings, agroforestry, etc.

D. Tree-Planting Activities

Many purposes are served by a national forest-seed program.

1. **Industrial wood products,** such as lumber, pulp, veneer, and speciality products, are made from softwoods or fast-growing hardwoods.
2. **Fuelwood and charcoal** are made from short-rotation hardwoods (e.g., *Acacia, Eucalyptus,* and *Prosopis).* These are good, multipurpose species for:
   a. Village forests
   b. Individual landowners
   c. Commercial production in small-scale plantations on nonarable land
3. **Watershed protection,** especially around reservoirs, mine spoils, and dune stabilization areas, is essential.
4. **Windbreaks or shelterbelts**
5. **Urban planting** can be primarily ornamental, but can include planting for climat€ modification.
6. **Wildlife habitat and food plantings** occur in parks and game preserves.
7. **Agroforestry planting** is done for fodder production, nitrogen fixation, and fuel wood.
8. **Social forestry** includes planting on road sides, canal banks, and other common pub lic areas.
9. **Conservation of genetic resources** car be achieved by ex situ planting in don( banks or "gene archives."

E. Scope Of The Program

1. The population distribution must be known
2. Physiographic characteristics of the coun try or State must be identified.
3. Available land area and ownership an important.
4. Annual goals must be realistic; the first year's may be modest to allow controlled growth and expansion into a comprehensive program.
5. Seed storage goals may include 2-, 3-, a 5-year supplies. Regional seed banks mad be needed. There may be sales to other countries.
6. Distribution of indigenous species and their potential seed collection zones must b■ mapped.

F. Species Choices

Choice of species to be included in the progran is a critical step.

1. Indigenous species and land races may be best and are usually favored.
2. Exotics are often discouraged, and cautior should be used with them; however, there a definite place for good exotics.
3. Seed source choices are extremely important. If possible, these decisions should be based on results of provenance tests.
4. Plantings should follow the natural plant succession where possible. Pioneer species should be planted first, with mycorrhizae or nitrogen-fixing bacteria innoculation, site preparation, fire control, and protection from livestock. These plants will form nurse trees for the second group of shade tolerant species. The type of planting will dictate the approach.

G. Administrative Structure

Many government agencies or ministries may be involved because the same seeds may be used for several purposes (agroforestry, watershed protection, etc.). In the United States, the U.S

Department of Agriculture, Forest Service and Soil Conservation Service; the U.S. Department of the Interior, National Park Service and Bureau of Land Management; and State and local counterparts are involved.

1. **Forestry ministry levels—** The administrative structure can be:
   a. National
   b. Provincial or State
   c. Village or other local structures
2. **Comprehensive natural resource agencies** may combine forestry and wildlife.
3. **Agricultural agencies —** Indian Council of Agricultural Research (ICAR) in India is an example for agroforestry.
4. **Military departments—in** the United States, military bases manage their own forests.
5. **Division of responsibilities** can be made for the various functions that are required:
   a. Overall planning must consider total production, seed collection zones, potential seed crops, collection vs. purchase, source of funds, etc.
   b. Seed acquisition and distribution can be concentrated at one central location or dispersed to regional centers. One strong national seed center for research, testing, and long-term storage is strongly recommended. Dispersed secondary centers are usually needed to collect and clean seeds. In large countries, such as India or Brazil, regional centers as well as subregional centers are necessary. Important elements of this function are:
      (1) Collecting and cleaning of seeds. Seed production areas and seed orchards may influence the location of this work.
      (2) Testing should be required on all lots.
      (3) Storage characteristics must be recognized. Workers must know which species can or cannot be stored and thus plan accordingly.
      (4) Certification is usually not feasible early in a program, but it may come later if needed. It should be well planned in advance.
      (5) Record keeping is an important function that should be centralized.
      (6) If there will be sales to other countries, national needs must be satisfied first.
      (7) If sales are within countries, sales policies must be established. Villages or individuals may or may not be charged for seeds and seedlings; seeds could be supplied at cost.
   c. Seedling production can be a part of national seed programs. It usually is not, but much depends on the government organization and the size of the country. There are several options:
      (1) National or State nurseries
      (2) Village nurseries
      (3) Private nurseries owned by individuals. (In some countries, farmers can grow tree seedlings as a cash crop.)
      (4) Commercial nurseries. (Government nurseries must not conflict with free enterprise.)
   d. Plantation care is not usually a function of the seed program unless seed stands are involved.
      (1) Protection, primarily from animals, fire, and people is usually needed.
      (2) Survival and early growth should be documented because early plantations can be used for seed source evaluation and then be turned into seedling seed orchards.
   e. Research may or may not be within the structure of the national program, but the program must help set research priorities.
      (1) Some common seed problems include maturity indices, pretreatment, storage, and testing. One ultimate goal is a seed manual for each country, either a comprehensive book like the USDA manual (Schopmeyer 1974) or a smaller manual that gives only basic seed handling and treatment information (tables 29 and 30) !no equivalent tables in Student Outline I.
      (2) Species, site, and seed source evaluations are critical, but they usually fall under the tree improvement program.

**H.** Critical Steps and Decisions

1. Planting goals must establish what, where, and how much to plant.
2. Availability of seed supply
   a. Is the crop potential for indigenous species sufficient?
   b. Are there suitable commercial sources? Many commercial operations deal pri-

Table 29. – *Cone and seed production characteristics of conifers in British Columbia (adapted from Dobbs and others 1976) [no equivalent table in Student Outline]*

| Species | Cone bearing age begins | Cone length | Period between collectible crops Avg. | Range | Cone yield per mature tree | Cones per hectoliter | Minimum filled seed count for collection 0.5 sect. | per cone | Collection period |
|---|---|---|---|---|---|---|---|---|---|
| | *Years* | *cm* | --- *Years* | | *hL.* | | *Number* ------ | | |
| *Abies amabilis* | 20 | 9-13 | 2-3 | | | 700 | | | Late Aug. to mid-Sept. |
| *A. grandis* | 20 | 5-12 | 5-6 | 3-8 | | 700 | | | Late Aug. to mid-Sept. |
| *A. lasiocarpa* | 20 | 6-12 | 3 | 2-5 | | 850 | | | Mid-Sept. to mid-Oct. |
| *Chamaecyparis nootkatensis* | 15 | 0.5-1.5 | 2-4 | | | 130,000 | | 2 | Aug. to Oct. |
| *Larix laricina* | 40 | 1.0-1.5 | 5-6 | | | | | | Aug. to Sept. |
| *L. lyalli* | 30 | 4-5 | ... | | | ... | ... | | Aug. to Sept. |
| *L. occidentalis* | 25 | 3-4 | 5-6 | ... | | 11,000 | 6-8 | 40 | Aug. to Sept. |
| *Picea engelmanni* | 15 | 3-8 | 5 | 2-10 | | 8,300 | 7-10 | | Mid-Aug. to Sept. |
| *P. glauca* | 20 | 3-6 | 6 | 2-12 | | 11,000 | 7-10 | | Mid-Aug. to Sept. |
| *P mariana* | 10 | 1-4 | 4-5 | 2-6 | | ... | | | Sept. |
| *P. sitchensis* | 20 | 6-10 | 3-4 | 2-5 | 0.5-1.0 | 4,700 | 7-10 | | Sept. |
| *Pinus albicaulis* | 20 | 4-8 | ... | 3-5 | | | | | Aug. to Sept. |
| *P contorta* | 10 | 3-5 | 3 | 2-4 | 0.5-1.0 | 8,300 | | 20 | Oct. to Mar. |
| *P. flexilis* | 20 | 8-20 | 3 | 2-4 | | | | | Late July, Aug. to Sept. |
| *P monticola* | 10 | 10-25 | 4 | 3-7 | 0.2-0.5 | 280 | | 90 | Late Aug. to early Sept. |
| *P ponderosa* | 15 | 8-15 | 3 | 2-5 | 1.0-1.5 | 700 | | 75 | Late Aug. to early Sept. |
| *Pseudotsuga menziesii* | 15 | 5-10 | 5 | 2-10 | 0.5-1.0 | 2,800 | 5-7 | | Mid-Aug. to early Sept. |
| *Thuja plicata* | 15 | 1-2 | 2-3 | 1-4 | | 110,000 | | | Aug. to Sept. |
| *Tsuga heterophylla* | 20 | 2-3 | 3-4 | 2-8 | | 83,000 | 3-4 | | Sept. to Oct. |
| *T. mertensiana* | 20 | 2-8 | | 1-5 | | | | | Sept. to Oct. |

No data given

Table 30. – *Selected data on seed quality of some Colombian tree species (adapted from 71-ujillo 1986) [no equivalent table in Student Outline]*

| Species | Average purity | Pure seeds/kg | Average viable seeds/kg | Average germination | Range of germination Start | End |
|---|---|---|---|---|---|---|
| | *Percent* | | --- *Number* ----------- | | --- *Days* | |
| *Cordia allidora* | 92.1 | 35.0 | 27,098 | 63.3 | 9 | 22 |
| *C. gerascanthus* | 89.2 | 64.0 | 32,459 | 65.5 | 6 | 16 |
| *Cupressus lusitanica* | 97.7 | 143.0 | 24,778 | 13.8 | 10 | 23 |
| *Delonix regia* | 98.9 | 2.3 | 1,394 | 58.1 | 5 | 16 |
| *Didimopanax monototonii* | 95.9 | 2.9 | 11,305 | 35.3 | 69 | 86 |
| *Erythina glauca* | 100.0 | 2.2 | 1,374 | 63.5 | 5 | 21 |
| *Hymenaea courbaril* | 99.5 | 2.6 | 142 | 54.5 | 22 | 32 |
| *Jacaranda copaia* | 84.5 | 65.5 | 12,097 | 20.0 | 11 | 25 |
| *Ochroma lagopus* | 98.7 | 137.0 | 61,423 | 69.0 | 10 | 40 |
| *Samanea saman* | 96.0 | 5.3 | 4,485 | 94.5 | 4 | 14 |
| *Tecoma spectabilis* | 95.8 | 120.0 | 97,239 | 77.6 | 5 | 12 |

marily with exotics (See table 31 for a list of commercial seed dealers) [no equivalent table in Student Outline].

3. **Collection crews**
   a. Equipment and transportation must be on hand.
   b. Training of all crews will be required.
   c. Legal assistance, such as permission from landowners, government agencies, or tribal administrators will be needed.

4. **Nursery administration** requires:
   a. A suitable site
   b. Trained personnel
   c. Adequate equipment for all operations

5. **Collection goals** are related to planting goals, potential seed crops, and storage potential of the seeds. (Will more than 1 year's supply be collected?)

6. **Seed centers** - A national seed center and/or State or regional seed centers should be established.

Table 31. —*International seed dealers [no equivalent table in Student Outline*

Aggarwal Nursery and Seed Stores
Panditwari
P.O. Prem Nagar
Dahra Dun 248007, U.P.
India

Roger Anderson, Ltd.
P.O. Box 51-325 Pakuranga
Auckland
New Zealand
Telex: NZ 21721 (Roger A.)

Asmer Seeds
Asmer House
Ash Street
Leicester
United Kingdom
Telephone: (0533) 26733

Barilli and Biagi
1-40.100
Bologna
Italy

EFG (Nurseries), Ltd.
Maelor Nursery, Conery Lane
Bronington nr Whitchurch
Shropshire
United Kingdom
Telephone: 094873 301

Florsilva Ansaloni
C.P. 2100
40100 Bologna
Italy
Telephone: 51-625-5218
FAX: 51-6525-6857

The Forest Research Centre
P.O. Box HG595
Highlands
Harare
Zimbabwe

A.J. Frost
7080 Borkop
Denmark

The Inland and Foreign Trading Co. (PTE) Ltd.
P.O. Box No. 2098
Maxwell Road Post Office
Singapore 9040
Telephones: 27222711, 2721801, 2782193
Telex: RS25254 IFTCO

International Forest Seed Co.
P.O. Box 290
Odenville, AL 35120
U.S.A.
Telephone: 205/629-5749

International Paper Co.
Seed Center
Nacogodches, TX 75962
U.S.A.
Telephone: 409/569-1069

Lawyer Nursery, Inc.
950 Hwy 200 West
Plains, Montana 59859
U.S.A.
Telephone: 406/826-3881
Telex: 31-9547

Soren Levinsen
Post Box 86
Kollerod
Denmark

Louisiana Forest Seed Co., Inc.
Rt. 2, Box 123
Lecompte, LA 71346
U.S.A.
Telephone: 318/443-5026

Nova Tree Seed Co., Inc.
Rt. 2, Middle Musquodoboit
Nova Scotia BON 1X0
Canada

The Old Farm Nurseries
H.den Ouden and Son b.v.
P.O. Box 1
2770 AA Boskoop
Netherlands
Telex: 39810

D. Oriell-Seed Exporters, Unit 11
10 Golfview St.
Mt. Yokine
6060 W. Australia

Pal Seed Traders
7-Araghar
Dehra Dun, U.P.
India

Reid, Collins, & Assoc.
Vancouver, BC
Canada

Renz Nachf GmbH and Co.
D-7270 Nagold-Emmingen
Germany

F.W. Schumacher Co.
36 Spring Hill Road
Sandwich, MA 02563
U.S.A.
Telephone: 617/888-0659

Table 31. —*International seed dealers [no equivalent table in Student Outline] (Continued)*

| | |
|---|---|
| Seed Branch<br>Forestry Commission Research Station<br>Alice Holt Lodge<br>Wrecclesham<br>Farnham, Surrey<br>United Kingdom<br>Telephone: 0420 22255 | G.J. Steingaesser and Company<br>Postf. 1765<br>8760 Miltenburg<br>Germany |
| Seed Export Company<br>7 Bellata St.<br>The Gap<br>Queensland 4061<br>Australia<br>Telex: AA 42027 | Timmers and Leyer<br>P.O. Box 17<br>2100AA Heemstede<br>Netherlands<br>Telex: 41754 flori n1 |
| Setropa Ltd.<br>P.O. Box 203<br>1400 AE Bussum<br>Netherlands | Tree Seeds<br>The Boat House, Potters Lane<br>Samlesbury, Preston<br>Lancashire<br>United Kingdom<br>Telephone: 077477 213 |
| Sheffield's Seed Co., Inc.<br>273-Auburn Rd., Rt. 34<br>Locke, NY 13092<br>U.S.A.<br>Telephone: 315/497-1058 | University of Hawaii at Manoa<br>Dept. of Agronomy & Soil Science<br>190 East-West Rd.<br>Honolulu, HI 96822<br>U.S.A.<br>Telephone: 808/948-7530 |
| Silvaseed Company<br>P.O. Box 118<br>Roy, WA 98580<br>U.S.A. | Van Dijk and Company<br>Einhuizen<br>Netherlands |
| Southern Seed Company, Inc.<br>Baldwin, GA 30511<br>U.S.A.<br>Telephone: 404/778-4852<br>Telex: 4611041 | Versepuy<br>43000 Le Puy<br>France |
| Southpine, Inc.<br>P.O. Box 7404<br>Birmingham, AL 35253<br>U.S.A.<br>Telephone: 205 /8 79-1099<br>Telex: 703040 | Vilmorin-Andrieux<br>La Menitre<br>49250 Beaufort-en-Vallee<br>France |
| | Yamato-Ya, Ltd.<br>16-6, 1-Chome<br>Ginza, Chuo-ku<br>Tokyo<br>Japan |

I. Other Considerations

1. **Continuity of operations — Well-trained** people should be kept at the same jobs for 3 to 5 years, preferably longer.
2. **Training** of all personnel is a key to success.
3. **Multiple functions** sometimes occur.
   a. In Morocco, government foresters also grow and distribute fruit trees to the farmers.
   b. Some countries have only one seed laboratory so the same people must test agricultural and tree seeds in the same laboratory.
4. **International organizations—The** following organizations can help seed programs.
   a. ISTA — ISTA Secretariat<br>Reckenholz, **P.** 0. Box 412<br>CH-8046 Zurich<br>Switzerland
   b. IUFRO—IUFRO Secretariat<br>Schonbrunn<br>A-1131 Vienna<br>Austria
   c. FAO—Forest Resources Development Branch<br>Forest Resources Division<br>Forestry Dept., FAO<br>Via delle Terme di Caracalla<br>I-00100 Rome, Italy

**d.** ICRAF—International Council for Research in Agroforestry
P.O. Box 30677
Nairobi, Kenya

5. **Agricultural seeds—The** relationship of agricultural seeds to tree seeds must be kept in perspective. Except for conifer seed extraction, dewinging, and x rays, all the tree seed technology is borrowed from agriculture: cleaning, storing, testing, etc. Seed maturation and general biochemistry are similar, and much can be learned from agricultural seed technologists.

J. Case Study

See Robbins and Shrestha (in press) for an example from Nepal.

K. Summary

The functions of a national seed center are to:

1. Further develop taxonomy and aids to species identification.
2. Collect and disseminate data on the ecology of individual species, thus enhancing understanding of the performance of species.
3. Promote measures, as necessary, to conserve the genetic resources of important species.
4. Develop optimum seed collection strategies based on knowledge of breeding systems.
5. Maintain existing seed collections and ensure their future development as programs evolve to use promising species and provenances.
6. Assist collectors from other countries within the framework of national policy; some countries (e.g., Brazil and Indonesia) restrict collections by foreign nationals.
7. Provide information on the physical and physiological characteristics of seeds, and any diseases that might be borne by seeds.
8. Encourage quarantine practices that minimize the chances of domestic insects becoming established in other countries.
9. Disseminate information by providing appropriate training, symposia, and publications.
10. Disseminate seed samples for research or species trials to other institutions or countries on a cost or exchange basis.

L. Sources

For additional information see Gregg 1983, Helium (in press), Robbins and Shrestha (in press), Rudolf 1974.

## II. Seed Centers

A. Introduction

National forest-seed programs require some sort of national tree-seed center, institute, or laboratory. Dedicated facilities and some centralized authority are suggested for tree-seed centers. Their level of technology may vary with the country's needs, but these centers should serve as the focal point or hub of seed activities.

B. Objectives

1. Learn the general functions of national tree-seed centers and how they support national seed programs.
2. Examine several options for center design.

C. Key Points

The following points are essential to designing and operating successful seed centers:

1. The primary function of a seed center is to support the national forest-seed program.
2. Seed centers provide seed services, research on seed problems, training of seed workers, and extension activities for seed users.
3. Many countries will require regional or subcenters for efficient operation.

D. Functions

The functions of seed centers include seed services, seed research, and training and extension programs.

1. **Services—A** seed center:
   a. Coordinates seed collection by establishing seed zones, setting collection quotas, and training crews.
   b. Conditions seed collections by extracting, cleaning, and upgrading.
      (1) All operations may be centrally located.
      (2) Drying and extracting can be at regional centers, and seeds shipped to a national center for final cleaning and storage.
   c. Stores the seeds for the following purposes:
      (1) Operational storage for nearby users
      (2) Long-term storage of surplus stocks
      (3) Very long-term storage for germplasm conservation
   d. Tests the seeds of:
      (1) National seed program collections
      (2) Other in-country users (e.g., universities) that could generate income
      (3) Third parties (to settle legal disputes) that could also generate income
   e. Assists in certification—If a program is established, seed center staff must be involved, although primary responsibility rests with the "designated certification authority," not usually the seed center staff.

2. **Seed research**
   a. Applied research on problems that hinder efficient and economical seedling production is vital; e.g., scarification techniques, maturity indices, and treatment of seed pathogens.
   b. Basic research is better done in cooperation with universities, but a basic research group in the seed center would have advantages; e.g., studying critical drying rates for recalcitrant seeds, models of storage potential, and fatty acid metabolism during storage.
3. **Training and extension programs**
   a. Centers should train seed collectors, analysts, and other personnel for specific programs.
   b. Extension programs for nursery workers and farmers to teach efficient seed utilization are vital to national seed programs and should be staffed by trained extension workers. The training of such people is beyond the scope of this course.

E. National or Regional Centers

The decision to establish a national vs. a regional center depends on the following considerations:

1. **National centers** can be more responsive to political realities and capitalize on national pride.
2. **Regional centers** can expand scope and function by pooling resources, an attractive feature to donors. Regional centers may be necessary because of the high cost of transporting large collections or because of the use of short-lived recalcitrant seeds that would not survive long trips in stressful environments.
3. **Compromise — National** centers can be used for storage, testing, and research; regional centers can be used for collecting and cleaning.

**F.** Location Concerns

1. **Proximity to seeds —** The centers should be located near major seed production zones.
2. **Transportation —** Good transportation links (roads, rail, and water) are necessary.
3. **Isolation—Complete** isolation from population centers makes it hard to recruit and retain good people.
4. **Technical help — Because** university affiliation helps in many ways, location near a campus is desirable.
5. **Disaster potential —** Flood or earthquake zones should be avoided for the safety of the facility and the workers.

G. Center Design

Seed center designs depend on the following factors.

1. **Activity zones** include the following areas:
   a. Loading dock
   b. Drying area
   c. Extraction equipment (There may be problems with dust and trash.)
   d. Cleaning equipment
   e. Conditioning equipment
   f. Seed storage
   g. Testing laboratory
   h. Offices for records and supervision
   i. Supply storeroom
2. **Building design—See** figures 54 and 55 [no equivalent figures in Student Outline] for the floor plans of Seedlabs 2000 and 5000 by ISTA.
3. **Equipment**
   a. Commercial sources are best, but much can be made locally.
   b. Spare part sources are crucial for commercial equipment.
   c. Maintenance must be available, either from equipment suppliers or from local people. If local people are used, then they must be trained.
   d. Electrical supply must be dependable.
   e. Seed centers should get the best equipment because the size of the operation will demand it. Subcenters and village operations can get by with simple equipment because of their small size.
4. **Staffing—** Supervisors should have defined areas of work; see figure 56 [no equivalent figure in Student Outline]. The staff should be made up of the following:
   a. The director coordinates seed supply needs and distribution.
   b. The collection supervisor directs collection teams and coordinates State/Province collections.
   c. An extraction/cleaning supervisor and two to five technicians.
   d. A testing supervisor and two analysts (one for purity and one for germination). Seasonal workers will also be needed.
   e. A storage/shipping supervisor, one technician, and one clerk.
5. **Training—All** staff members should be trained in their specialties by university staff, special short courses, or on-the-job training at an established center. If personnel change jobs, the new people must be trained immediately. The skills of long-time staff should be updated as new methods are developed.

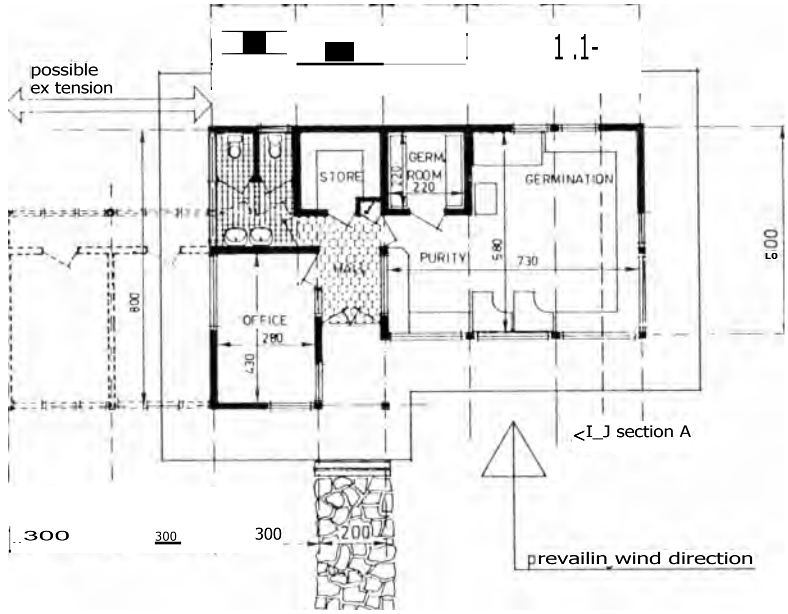


Figure 54. —*Suggested floor plan for a small testing laboratory (adapted from van der Burg and others 1983). Dimensions are in centimeters [no equivalent figure in Student Outline].*

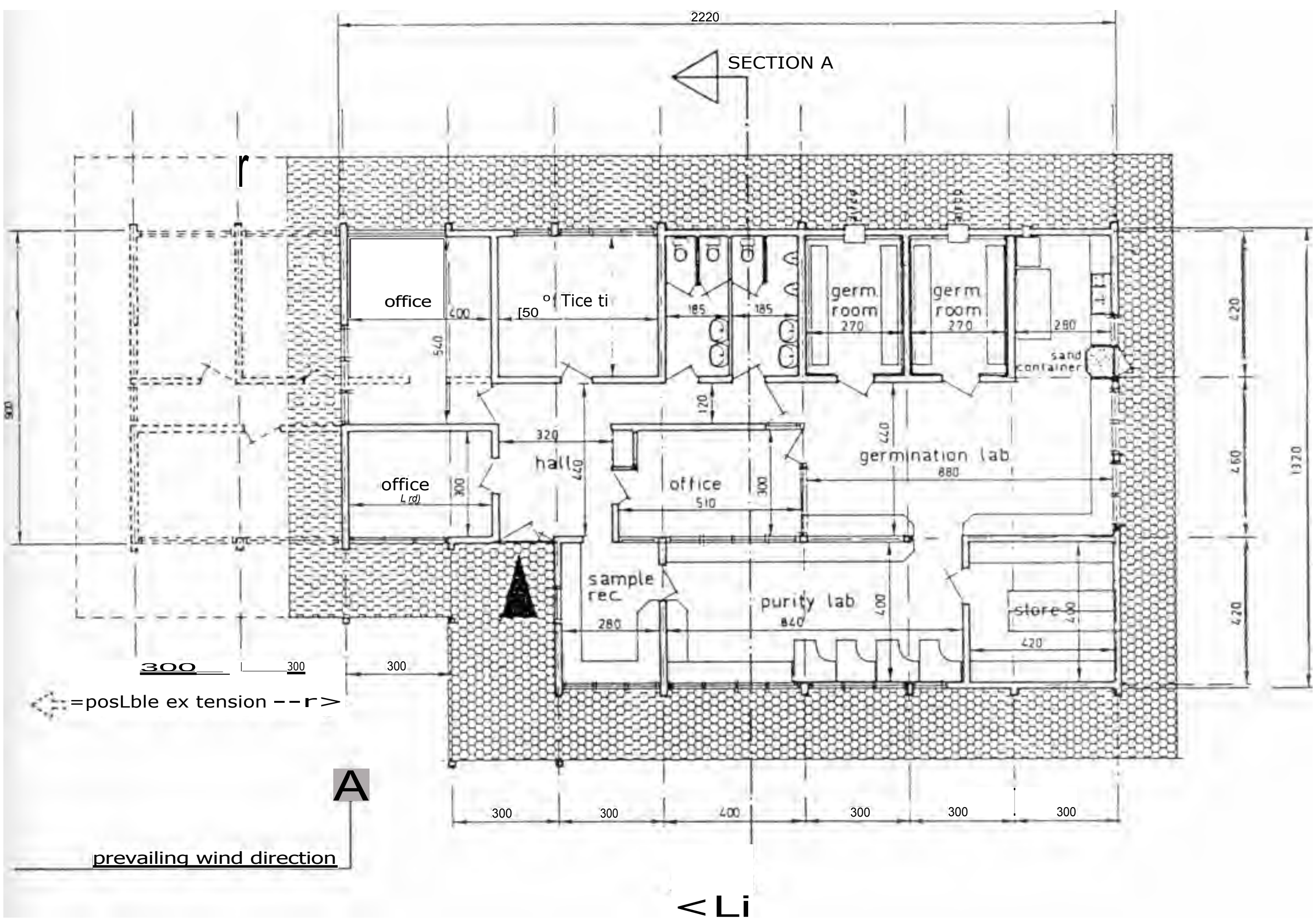


Figure 55.— *Suggested floor plan for a large testing laboratory (adapted from van der Burg and others 1983). Dimensions are in centimeters [no equivalent figure in Student Outline].*

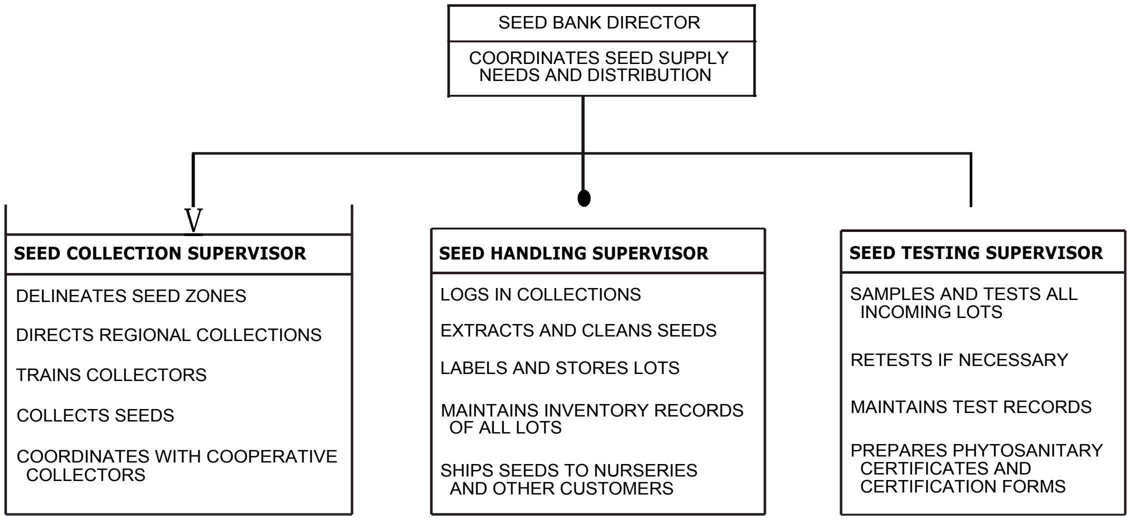


Figure 56.—A *suggested staff organization for a small seed bank [no equivalent figure in Student Outline].*

**H.** Sources
For additional information, see van der Burg and others 1983.

## III. Labeling and Certification

A. Introduction
When forest reproductive materials (seeds, seedlings, and vegetative propagules) are not collected or grown by the user, that user should have reasonable assurance of the identity and quality of the material he is buying. Many seed-labeling laws require detailed labeling to assure the buyer of the seeds' identity, purity, viability, and freedom from pests; i.e., the physiological quality of the seedlot. Certification is more than labeling required by seed laws; it is a statement about the genetic quality and identity of the seedlot.

B. Objectives
1. Understand the purpose of certification.
2. Identify the general elements of a certification program.
3. Describe the four certification categories used in the Organization for Economic Cooperation and Development (OECD) standards for international trade.

C. Key Points
The following points are essential to understanding labeling and certification of forest reproductive materials:
1. Certification is the guarantee by an officially recognized organization that forest reproductive materials of identified varieties have been grown, collected, processed, and distributed in a manner to maintain high quality and genetic identity.
2. A certification program requires a certification agency, a producer who wishes to sell certified material, records of the breeding program, certification standards, independent inspections, and certification labels.
3. The four certification categories used by OECD are:
   a. source-identified (yellow tag)
   b. selected (green tag)
   c. untested seed orchards (pink tag)
   d. tested reproduction material (blue tag)
4. Certification usually requires inspections of the production unit prior to pollination, a crop inspection before harvest, inspections during the collection-to-storage phases, and inspections at the time of packaging materials for sale.

D. Certification
1. **Definition—** the guarantee of character and quality of reproductive materials by an officially recognized organization, usually evidenced by a color-coded tag and a certificate containing such information as certification category, genuineness of species and variety, year of collection, origin, purity, soundness, and germinative capacity.
2. **Purpose —** Certification is more than just labeling. The purpose of certification is to maintain and make available to the public high-quality seeds and propagating materials of superior crop plant varieties. For agricultural and woody plant material, the word "certified" implies genetic improvement.

3. **International aspect — An** international scheme for certifying forest reproductive material was developed by the Organization of Economic Cooperation and Development (OECD). Its features are now being incorporated into forestry certification schemes in North America.

E. Definition of Terms

The following definitions are for terms used in the OECD Scheme (Organization for Economic Cooperation and Development 1974):

1. **Forest reproductive material**
   a. Seeds: cones, fruits, and seeds intended for the production of plants
   b. **Parts of plants:** stem, leaf, and root cuttings, scions and layers intended for the reproduction of plants
   c. **Plants:** plants raised by means of seeds or parts of plants; also includes natural regeneration
2. **Clone—a** genetically uniform assemblage of individuals derived originally from a single individual by vegetative propagation, such as by cuttings, divisions, grafts, layers, or apomixis
3. **Cultivar** — an assemblage of cultivated individuals, which is distinguished by any characters (morphological, physiological, cytological, chemical, or others) significant for the purposes of agriculture, forestry, or horticulture and which, when reproduced (sexually or asexually), retains its distinguishing features
4. **Provenance** — the place in which any stand of trees is growing; the stand may be indigenous or nonindigenous. (This is the location of the seed source.)
5. **Origin —** for indigenous stands of trees, the origin is the place in which trees are growing; for nonindigenous stands, the origin is the place from which the seeds or plants were originally introduced
6. **Designated authority—** an organization or institution designated by and responsible to the government of a country participating in the OECD scheme for the purpose of implementing the rules of the scheme on its behalf

F. General Elements of a Certification Program

1. The designated authority sets standards for certification and provides inspectors and certification tags and must have legal standing.
2. A producer wishing to sell certified material applies to the designated authority for qualification.
3. The history of the material (provenance, seed source, and breeding program) must be supplied to the designated authority who determines if the material meets certification standards for genetic quality and identity.
4. If the reproductive material is eligible for certification, production of the material for sale is supervised by the designated authority through independent inspections at intervals during the growing, collecting, and processing of the material.
5. The material to be sold must meet certification standards for viability, purity, and, in some programs, freedom from pests.
6. Certification labels are placed on each container of reproductive material at the time of packaging, and certificates of variety identity are given to the buyer.
7. The producer or seller is justified in charging more for certified material because certification ensures known genetic quality, provenance identity, viability, purity, and freedom from pests.
8. In summary, certification requires supervision, independent inspection, labeling, and record keeping while allowing the seller to sell at a higher price or at a competitive advantage.

G. Standards for Certification

1. **Certification classes** for forest reproductive material differ from classes for agricultural seeds. Forestry programs typically use the following OECD standards for forest reproductive material that includes "tested reproductive material," which is the equivalent of the "certified" category for agricultural seeds, and three additional classes of less rigid genetic control. The four classes and their requirements are:
   a. Source-identified reproductive material (yellow tag) comes from stands within an identified seed collection zone. It is required that:
      (1) Seed source and/or provenance must be defined and registered with the designated authority. (See "seed collection zones" below.)
      (2) Seeds must be collected, processed, and stored under inspection by the designated authority.
   b. Selected reproductive material (green tag) comes from phenotypically selected stands and cultivars. These stands and cultivars have not been tested for genetic quality, but they must:
      (1) Be isolated by distance from poor stands.

(2) Show normal variation among trees within a stand.
(3) Be large enough for adequate cross-pollination.
(4) Be old enough and developed enough to allow evaluation of phenotypes.
(5) Exhibit phenotypic superiority in some desirable quality, such as volume, wood quality, form or growth habit, resistance to disease, fodder production, or fruit production.

c. Reproductive material from untested seed orchards (pink tag) comes from phenotypically selected parent trees in a seed orchard or from the progenies of such trees.

d. Tested reproductive material (blue tag) must come from seed orchards, stands, or cultivars whose genetic superiority in at least one desirable quality has been proven in tests approved by the designated authority. Superiority can only be certified in terms of the environment and the age of the test.

e. Forestry certification classes can be applied to parts of plants (cuttings) as well as seeds.

f. Agricultural seed classes are different: breeder seeds and foundation seeds have white tags; registered seeds have purple tags; and certified seeds have blue tags.

2. **Seed collection zones**

a. Seed collection zones, or regions of provenance, should be delimited by administrative and geographic boundaries and, where applicable, by elevation and other appropriate boundaries.

b. Maps showing boundaries and reference numbers of seed collection zones should be established and published by the designated authority.

c. Seed collection zones are necessary for "source-identified reproductive material." The specific location and site characteristics of seed sources should be used for the other three subclasses.

3. **Other requirements of certification**

a. Basic information — The originator, developer, owner, agent, or producer must request certification and must provide the following information:
(1) Name of the variety
(2) Statement of the variety's origin and the breeding procedure used in its development
(3) Detailed description of any morphological, physiological, and other important characteristics that distinguish the variety
(4) Evidence of performance, including comparative yield data, insect and disease resistance, and other factors supporting the identity of the variety (not necessary for source-identified reproductive material)
(5) Statement on the suggested area of adaptation and the purpose for which the variety will be used, including a description of the regions where the variety has been tested and is recommended to be grown

b. Inspections may include:
(1) Initial field inspections when certification is first requested are conducted before pollination to check pollen-dilution zone and to remove phenotypically or genetically poor parent material.
(2) Crop inspections come just before harvest to estimate the amount of material that will be certified.
(3) Inspections during collection, conditioning, and storage of material determine that the genetic identities and viability are being maintained.
(4) Inspection at the time of packaging for sale to check for "off-types," disease, insects, viability, purity, and germinative capacity are conducted before tags are attached.

c. Fees — In the United States, certification is financed by fees producers pay to the designated authority.

**H.** Other Documentation

1. **Labels — Some** countries or other political entities require labels for commercial sales with identity (species), purity, germination, etc., on the labels. No certification is implied.
2. **Phytosanitary certificate —** Phytosanitary certification is required by most countries to stop the spread of insects and pathogens. It certifies that the seeds have been inspected and/or treated (fig. 57) [no equivalent figure in Student Outline].

I. Sources

For additional information, see Bonner 1981a, Organization for Economic Cooperation and Development 1974, Rudolf 1974.

THIS IS A SAMPLE

No phylosenitary certificate can be issued until an application is completed (7 OH 353) See reverse lor additional OMH information ORM APPROULO OMIt NO 0579-0057

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE

# PHYTOSANITARY CERTIFICATE

FOR OFFICIAL USE ONLY

PLACE OF ISSUE

NEW ORLEANS, LOUISIANA

NO.: FPC 134236

DATE INSPECTED

.06RT)447, eArAtiCt0 '.., a" 10 " sue`

TO THE PLANT PROTECTION ORGANIZATION(S) OF

CERTIFICATION

This is to certify that the plants or plant products described below have been inspected according to appropriate procedures and are considered to be free from quarantine pests, and practically free from other injurious pests; and that they are considered to conform with the current phytosanitary regulations of the importing country.

DISINFESTATION AND/OR DISINFECTION TREATMENT

| | |
|---|---|
| 1. DATE | 2. TREATMENT |
| 3. CHEMICAL *(active ingredloi,t)* | 4. DURATION AND TEMPERATURE |
| 5. CONCENTRATION | 6. ADDITIONAL INFORMATION |

DESCRIPTION OF THE CONSIGNMENT

| | |
|---|---|
| 7. NAME AND ADDRESS OF THE EXPORTER | 8. DECLARED NAME AND ADDRESS OF THE CONSIGNEE |

9. NAME OF PRODUCE AND QUANTITY DECLARED

| | | |
|---|---|---|
| 10. BOTANICAL NAME OF PLANTS | 11. NUMBER AND DESCRIPTION OF PACKAGES | 12. DISTINGUISHING MARKS |
| 13. PLACE OF ORIGIN | 14. DECLARED MEANS OF CONVEYANCE | 15. DECLARED POINT OF ENTRY |

Any intentional false statement in this phytosanitary certificate or misrepresentation relative to this phytosanitary certificate is a violation of law, punishable by a fine of not more than $10,000, or imprisonment of not more than 5 years, or both. (18 U.S.C. s1001)

ADDITIONAL DECLARATION

| | | |
|---|---|---|
| **16 DATE ISSUED** | **17. NAME OP AUTHORIZED OFFICER (type** ... Print) | 18_ SIGNATURE OF AUTHORIZED OFFICER |

No liability shall attach to the United States Department of Agriculture or to any officer or representative of the Department with respect to this certificate.

PPG) FORM 577 (SEP 92) *Previous editions may be used* PART 1 - SHIPPER'S OR?

Figure 57. _A *phytosanitary certificate used in the United States 1 no equivalent figure in Student Outline].*

## IV. Germplasm Conservation

A. Introduction

Loss of forests around the world is widely deplored for many reasons, some valid and some not so valid. One consequence of deforestation is the loss of valuable germplasm that could be used in artificial regeneration and future breeding programs. The Food and Agriculture Organization of the United Nations (FAO) lists more than 300 tree species or provenances as endangered. Fortunately, there are steps that can be taken to conserve this germplasm.

B. Objectives

1. Recognize the consequences of excessive loss of germplasm of forest trees.
2. Learn the strategies available to conserve germplasm.

C. Key Points

The following points are essential to understanding germplasm conservation:

1. The ideal practice would be extensive in situ preservation.
2. Ex situ conservation is widely practiced already, but "passport data" on planted material need to be maintained.
3. Seed storage can play a critical role in germplasm conservation.
4. National programs of conservation should be carefully planned and established.

D. Importance of the Problem

1. The deforestation to replanting ratio is about 30:1 worldwide, although some of the deforested areas regenerate naturally.
2. Insects and diseases can eliminate certain gene pools or sometimes entire species. For example, *Castanea dentata, Ulmus americana,* and *Abies fraseri* are almost gone in North America.
3. Global climate changes could eventually change distribution of species through changing selection pressures. Some gene pools could be lost, or at least, gene frequencies would change.
4. According to FAO statistics, more than 300 species or special provenances are endangered. Complete species loss is rare, but some provenances could be easily lost.

E. Available Technologies for Conservation

The following strategies are options for germplasm conservation:

1. **In situ conservation** is good for tropical hardwoods; 100 species can be found in 0.4 ha. Land use pressures and economics make this option increasingly difficult, however.
2. **Ex situ conservation** is widely used for fast-growing plantation species. It is well suited to international cooperative efforts because seeds can be shipped to available sites. Blocks of 10 ha on several sites are recommended. Current recommendations are to save 50 to 400 individuals per geographic race or provenance.
3. **Conventional seed storage** plays a supporting role for tree germplasm because regeneration of seed supplies requires long periods of time. Storage is becoming more popular because of its low cost. Genetic damage during storage is possible, but this is largely unproven in tree seeds.
   a. True orthodox seeds can be stored for long periods (longer than one rotation) at subfreezing temperatures.
   b. Suborthodox seeds can be stored the same as true orthodox seeds but for shorter periods because of high lipid content (e.g., *Carya)* or thin seedcoats (e.g., *Populus).*
   c. Temperate recalcitrant seeds can be stored up to 3 years at a high moisture content and temperatures just above freezing.
   d. Tropical recalcitrant seeds can be stored the same as temperate recalcitrant seeds, but chilling damage occurs below 15 to 20 °C, and seeds live for only a few months.
4. **Cryogenic storage** is storage in liquid nitrogen at — 196 °C. This method is potentially very useful, but more research is needed. Limits for true orthodox seeds are unknown. Cost is about the same as for conventional storage for small seeds (e.g., *Eucalyptus* and some *Pinus* spp.), but too high for larger seeds.
5. **Storage of pollen** has little potential, except as micropropagation tissues. Haploid tissue, which may be useful in breeding, could be stored this way. Storage life is shorter than for seeds.
6. **Micropropagation tissues** have potential for long-term storage of suspension cultures. This concept is intriguing, but research is in the early stages. It could help most with endangered, tropical, recalcitrant species. Technology will soon be available, but cost may be high.

F. Current Efforts

1. The FAO, Forest Resources Division, through the Panel of Experts on Forest Gene Resources, promotes national and international efforts.

2. Supported by FAO, the International Board for Plant Genetic Resources (IBPGR) is an autonomous scientific organization of 13 countries. The board has recently added forest trees to its agenda.
3. The Central America and Mexico Coniferous Resource Cooperative (CAMCORE) is directed from North Carolina State University in Raleigh. Members include forest industries and governments; the Cooperative includes hardwoods in its efforts.
4. The Oxford Forestry Institute (OFI) (formerly, the Commonwealth Forestry Institute) in the United Kingdom is active in seed source and tree improvement for tropical species.
5. Danish International Development Agency (DANIDA) operates the Forest Seed Centre in Humblaek, Denmark. This agency is active in Asia.
6. The Centre Technique Forestier Tropical (CTFT) is a French organization that is very active in Africa but less so in Asia.
7. Commonwealth Scientific and Industrial Research Organization (CSIRO), Division of Forest Research, an Australian organization, is active in Asia and eastern Africa.
8. Numerous countries' seed banks concentrate on indigenous species. Current efforts at forest tree germplasm conservation include seed storage at several international and national centers (table 32) [table 17 in Student Outline]. In addition, many countries have national seed storage facilities that serve their domestic needs. It is questionable how much of this seed storage is for long-term preservation of germplasm; most of it is designed for short-term storage to establish provenance trials and ex situ conservation stands.

G. Recommendations for Action

1. In situ conservation efforts should increase, especially in tropical forests, both moist and dry. The extent of genetic variation in natural stands must be determined.
2. Assistance in international efforts for more ex situ conservation planting, similar to that provided by FAO and OFI, is needed.
3. Research should continue on modeling conventional seed storage of true orthodox and

Table 32. —*Some major international seed storage centers* [table 17 in Student Outline]*

| Center | Country | Approximate size of collection: Species | Sources | Reference |
|---|---|---|---|---|
| | | --- *Number* --- | | |
| United States Forest Tree Seed Center | United States | 67 | 197 | Karrfalt (1985)t |
| National Seed Storage Laboratory | United States | 18 | 41 | Bass (1985)t |
| Petawawa National Forestry Institute | Canada | 118 | 2,130 | Janas (1984) |
| DANIDA Forest Seed Centre | Denmark | 46 | 187 | Anonymous (1985) |
| CSIRO Tree Seed Centre | Australia | 900 | 4,000 | Turnbull and Doran (in press) |
| OFI Oxford, UK | United Kingdom | | | |
| Banco Latinoamericano de Semillas Forestales | Costa Rica | 153 | 308 | Anon. (1983) |
| Banco de Semillas COHDEFOR | Honduras | 4 | 46 | Gustavo (1985)t |

*Bonner, F.T. 1986. Unpublished report. On file with: USAID Science and Technology Office, Washington, DC. [Number of pages unknown].
tpersonal communication from center directors.
▶Data not available.

suborthodox seeds to predict just how long they can be stored. Increased efforts with these species in cryogenic storage is also needed.

4. More research effort to conserve species with recalcitrant seeds is crucial. High-priority areas are reproductive biology, conventional seed storage, and micropropagation techniques.
5. More seed banks must be established now for forest species. Rangewide collections can be stored as seed reserves for ex situ plantings and as cellular reserves for micropropagation. These will also provide data on conventional seed storage.

## V. Applied Research

A. Introduction

Many seed problems can be solved locally without sophisticated research equipment that is costly to acquire and operate. Some investigations furnish answers without statistical treatment; others need statistical work to demonstrate their reliability. Simple designs are usually satisfactory in seed work, including completely randomized treatments and factorials. The main requirements are curiosity and dedication.

B. Objectives

1. Learn a few principles of simple research studies.
2. Review case study examples of applied seed research.

C. Key Points

The following points are essential to applied seed research:

1. Problems can often, but not always, be solved with simple tests and experiments.
2. Standard procedures are always used when they are available; e.g., ISTA (1985) rules for germination testing.
3. Treatments are always replicated with several seed sources or in different seed years.
4. The limitations of the procedures in use must be recognized; e.g., electric seed moisture meters cannot be accurate to 0.1 percent.

D. General Considerations

1. **Replication—** The "standard" for seed work is usually 4 replicates of 100 seeds each (4 x 100), although in research, 50 (or even 25) are acceptable. If seeds are limited, the number in each replicate is decreased, but not the number of replicates. If the material is variable, five or six replicates would be satisfactory. If possible, more than one seed source should be used or more than one seed year from the same trees. Half-sib collections are also good for certain tests, such as determining maturity indices.
2. **Documentation—Complete** records are essential. Entries should be in ink in bound notebooks, if possible. Carbon or photocopies stored in a different place are also desirable. Computer files are extremely useful, but not essential. The key is to make a complete record of all treatment details and results.
3. **Statistics—Because** this is not a statistics course, experimental design will not be taught. However, it is important to:
   a. Design studies to allow statistical analysis.
   b. Use simple designs whenever possible, but be sure that they are valid.
   c. Temper statistics with common sense because statistical significance may not always equate with practical significance.
4. **Publication — Publication** of results is usually desirable because it disseminates knowledge to others who may face the same problems. However, it should never be the primary goal of research.

E. Case Studies

1. **Maturity indices of fruits or seeds** – The steps for this research are:
   a. Use a minimum of five trees.
   b. Sample over a reasonable period.
   c. Collect 10 to 15 fruits per tree.
   d. Take color photographs if possible.
   e. Take the following measurements:
      (1) Size (length and diameter)
      (2) Weight (wet and dry; dried at 103 °C for 15 to 24 hours)
      (3) Moisture content
      (4) Germination
      (5) Chemical analyses (optional)
      (6) Histochemistry (an alternative)
   f. Plot means on a time scale. (See the example in the "Seed Maturity" section.)
   g. Repeat at least twice to cover three seed crops.
2. **Extracting and cleaning methods** – The steps for this research are:
   a. Make pertinent comparisons
      (1) Sun drying vs. shade drying
      (2) Hand extraction vs. machine extraction
      (3) Any mechanical action vs. hand cleaning

(4) Seed size (size into three groups and test germination)
(5) Dewinging vs. sowing winged seeds
b. Replicate each treatment 5 times; test each replicate with 4 samples of 50 seeds each.
c. Retests unusual results.
d. Use the "t" tests for two treatments and complete randomization for more than two treatments.

3. **Pretreatment for germination—The** steps in pretreatment are:
a. Make pertinent comparisons (tests)
(1) Hand scarification vs. mechanical scarification
(2) Hot vs. cold water soak
(3) Stratification (time and temperature parameters)
(4) Chemical stimulation
b. Use the same general directions as for extracting and cleaning. Factorial designs will be more common for treatment combinations (e.g., time vs. temperature and soak time vs. chemical level).

4. **Storage conditions—The** steps for storage tests are:
a. Make pertinent comparisons (tests).
(1) Room temperature vs. refrigerated conditions
(2) Different refrigeration temperatures
(3) Seed moisture levels
(4) Type of storage containers
b. Use large enough replicates to allow sampling over time.
c. Test orthodox seeds at 0.5, 1.0, 2.0, 3.0, 4.0, and 5.0 years, and test recalcitrant seeds at **1,** 2, 4, 8, 12, 18, and 24 months, then every 6 months thereafter.
d. Use at least four replicates.

5. **Testing for recalcitrance—The** steps to test for recalcitrance are:
a. Bring the seedlot to full imbibition.
b. Start drying with at least two rates (slow and fast), either indoors or outdoors, shade or sun.
c. Take periodic samples for moisture content and germination. Collect samples every 2 to 4 hours for the first 24 hours, then double that time in the next 24 hours, and double again in the next 48 hours.
d. Maintain the drying range from full imbibition to 10-percent moisture or until death of the seeds.
e. Designate seeds that cannot be dried below 20 percent as recalcitrant.
f. Repeat this test to confirm recalcitrance; never trust just one measurement cycle. Tests of additional seedlots are desirable.
g. Check chilling injury at 0 to 5 °C by exposing fully imbibed seeds to this temperature for 24 hours.
h. Keep statistics in perspective. Realize that they are not as important as common sense in interpretation of results.