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Proposed

A Manual on the Seeds of Selected Woody Plants in India

Consultancy Report

December 14, 1990

by

William Elam
Department of Forestry
Mississippi State University
Mississippi State, MS. 39762

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Executive Summary

This reports on discussions concerning the production of a manual on the seeds of selected woody species in India. Outputs of the project will be a manual on collection and compiling tree seed data, a workshop on same, identification of needed tree seed research, a tree seed technology manual and species data on selected trees in India and tree seed research.

A major problem exists due to the prospective termination of the Agroforestry subproject and some ideas are offered for possible solutions. None were finalized however.

It is recommended the project be initiated under the Agroforestry subproject which terminates in 18 months. During that time concerted efforts should be made by ICAR to finalize a method so the project can be carried to completion (60 months)

A complete proposal for producing the manual in collaboration with ICAR is attached.

Introduction

India uses woody plant products for construction material, pulp, fuel, fodder, oils, pharmaceuticals, traditional medicines, tannin, food and fiber. Demand for wood products greatly exceeds supply and markets exist for increased supply of agroforestry products such as fruit and speciality items. Too, depletion of woody plant resources results in environmental degradation. Too often, regeneration projects begin with seedling production paying little attention to the important preceeding step of how to produce and use the highest quality seed. The seed, not the seedling, is the basic biological unit of plant regeneration. It will continue to be until biotechnological methods for producing plantable plants are a feasible reality. Information on the seeds of woody plants is therefore extremely important and a source book on the seeds of the species that furnish such a vast array of products in India would be of great value, both nationally and internationally.

India is increasing its use of woody plant seed in agroforestry and is approaching the point in its forestry tree improvement programs where it will be producing more costly seed in seed orchards. Information on proper handling, storing and testing of these seed is of importance and economically desirable.

In 1989, following a shortcourse on tree seed technology in Coimbatore, Tamil Nadu a pre-proposal was sent to USAID/India to determine interest in compiling a manual on selected tree seed in India patterned after the highly successful USDA Handbook, Seeds of the Woody Plants in the United States. There was interest expressed which led to further discussion concerning the project. This report deals with an assignment for discussion and clarification of the modalities of the project.

Project Background

The Indo-US Subcommission on Agriculture identified agroforestry as an important area of mutual interest. Following this, the ICAR and USAID developed a subproject funded and implemented under the USAID Agricultural Research Project.

In May 1988, a two year work plan for the ARP subproject on agroforestry was submitted by C.R. Hatch and D.P. Richards. The document described a detailed plan for major agroforestry subproject activities over a two-year period. One of the proposed activities was the presentation of workshops in India by U.S. scientists, one of the workshops was on tree seed technology and management.

Accordingly, in May 1989, a shortcourse-cum-workshop on tree seed technology was presented by Drs. Bonner, Land and Elam of Mississippi State University.. It was held at Tamil Nadu Agricultural University under the auspices of the USAID Agroforestry subproject. A need for a woody plant seed manual was identified and a recommendation to that effect was made in the consultant's report to Winrock International and USAID. As a follow-up activity a proposal to determine interest in such a project was submitted to USAID/India by the MSU scientists who conducted the workshop.

Following submission of the proposal ICAR proposed a one-week visit to India to further discuss details including modalities, manual outline, cost involved, scientists to be associated, time frame and finalize a memorandum of understanding.

Objective

To discuss specifics for preparation of a woody plant seed manual for India including modalities cost, funding and participation.

Problems

The major problem is that this is a 60 month project and the agroforesty subproject terminates in 18 months, unless extended or renewed. Possible solutions would be

1. Extension/renewal of the agroforestry subproject.
2. Initiate under agroforestry, complete under an Institute such as the National Institute for Agroforestry Research at Jhansi.
3. Use of the NBPGR as a vehicle for completion. (See discussion in Addendum to Proposal).

Another problem is that USAID has no facility through which to pay proposed compiling scientists - this cannot be solved by a consultant.

Recommendations

Following discussion with representatives of Winrock (McClung, Singh, Srinivasan), ICAR (Chinnamani, Abrol), USAID (Becker, Yadav) and NBPGR (Rana) the following is proposed concerning the project.

As previously stated, the problem area is that the length of the project (60 months) exceeds the termination date (June 1992) for the Agroforestry subproject. If the Agroforestry project is extended or renewed this problem is solved, if not, alternative means for carrying the project to its conclusion must be found. Various avenues have been suggested. The most feasible may be to complete the project under the auspices of one of the ICAR institutes such as the National Institute for Agroforestry Research at Jhansi. This potential problem can and should be resolved by ICAR if the project is considered worthwhile and initiating funding provided through USAID under the Agroforestry Subproject.

A discussion was held with Dr. R.S. Rana, Director of the National Bureau of Plant Genetic Resources at the suggestion of John Becker to explore the possibility of using the NBPGR as a vehicle for completion of the woody plant seed manual. Dr. Rana

said that information from the manual would be useful to NBPGR and indeed, agroforestry species were included in the mandate of the program. He said, however, that the program was user driven and thus far agroforestry was not of high priority. He further expressed interest in information that would be contained in the manual developed for the woody plant seed manual workshop. As far as collaboration on the woody plant seed manual project was concerned there was no provision in their mandate for such. He added that a dialogue between Dr. Abrol and his counterpart Dr. Paroda, over the NBPGR project, could be initiated, however, it was Dr. Rana's opinion that Dr. Abrol should be the one to make the initial approach. He did not offer much support to the idea that the NBPGR could be a cooperating agency even though the information contained in the woody plant seed manual was of interest and would be useful.

Another means for completion of the project was suggested by John Becker and Dr. Yadav. That being the use of the Technical Assistance Support Program (TASP) to complete the project after its beginning in Agroforestry.

Time during this consultancy did not allow exploration of all options. However, <u>it is recommended that the project be initiated in 1991 under the Agroforestry subproject and means to complete it be vigorously sought by ICAR.</u>

Further that the implementation and responsibilities be as shown in the attached project proposal with particular attention paid to the Addendum to Proposal dated December 12, 1990 and the recommendations proposed there.

Appendices

A. Acknowledgements :

I wish to acknowledge with thanks the help of Mrs. Surbhi Bhatt of the Washington Office of Winrock International.

The assistance of the personnel of the Winrock Office in Delhi was invaluable particularly Dr. Colin McClung and Mr. P.S. Srinivasan. Special thanks also to the typist who had to decipher my writing.

Special recognition is due to John Becker and Dr. J.S.P. Yadav of the USAID/India office who gave freely of their time and advice.

Dr. Abrol and Dr. Chinnamani of ICAR contributed greatly to this project. Their discussions and time are appreciated.

Finally, Dr. R.S. Rana of the NBPGR is to be thanked for his time and hospitality. It is appreciated.

B. Persons and Offices Visited

Winrock International, New Delhi, India

- A. Colin McClung, India Coordinator
- P.S. Srinivasan, Administration Specialist
- Dr. Chuck Hatch, Consultant, Pakistan
- Dr. Terry Acree, Consultant, Cornell University
- Dr. D.P. Richards, Consultant, Mississippi State University

USAID/India, New Delhi, India

- John Becker, Chief, Office of Agricultural Research
- J.S.P. Yadav, Project Manager, Office of Resources Management

ICAR, New Delhi, India

- I.P. Abrol, Deputy Director-General (SAE)
- S. Chinnamani, Asst. Director-General (Agroforestry)

NBPGR, New Delhi, India

Dr. R.S. Rana, Director, National Bureau of Plant Genetic Resources

December 12, 1990

Addendum to Proposal

I. Manual on the Seeds of Selected Woody Plants in India

Following discussion with representatives of Winrock (McClung, Srinivasan), ICAR (Chinnamani, Abrol), USAID (Becker, Yadav) and NBPGR (Rana) the following is proposed concerning the project.

A major problem area is that the length of the project (60 months) exceeds the termination date (June 1992) for the Agroforestry subproject. If the Agroforestry project is extended or renewed this problem is solved, if not, alternative means for carrying the project to its conclusion must be found. Various avenues have been suggested. The most feasible may be to complete the project under the auspices of one of the ICAR institutes such as the National Institute for Agroforestry Research at Jhansi. This potential problem can and should be resolved by ICAR if the project is considered worthwhile and initiating funding provided through USAID under the Agroforestry Subproject.

A discussion was held with Dr. R.S. Rana, Director of the National Bureau of Plant Genetic Resources at the suggestion of John Becker to explore the possibility of using the NBPGR as a vehicle for completion of the woody plant seed manual. Dr. Rana said that information from the manual would be useful to NBPGR and indeed, agroforestry species were included in the mandate of the program. He said, however, that the program was user driven and thus far agroforestry was not of high priority. He further expressed interest in information that would be contained in the manual developed for the woody plant seed manual workshop. As far as collaboration on the woody plant seed manual project was concerned there was no provision in their mandate for such. He added that a dialogue between Dr. Abrol and his counterpart Dr. Paroda, over the NBPGR project, could be initiated, however, it was Dr. Rana's opinion that Dr. Abrol should be the one to make

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Another means for completion of the project was suggested by John Becker and Dr. Yadav. That being the use of the Technical Assistance Support Program (TASP) to complete the project after its beginning in Agroforestry.

Time during this consultancy did not allow exploration of all options. However, <u>it is recommended that the project be initiated in 1991 under the Agroforestry subproject and means to complete it be vigorously sought by ICAR</u>.

II. Implementation, Modalities

In response to questions and requests by Dr. Yadav, the following delineation of responsibilities are offered to make more complete the information in pages 6 thru 9 of the revised proposal.

1. Organisation (time : 2 months)
   - a. Selection of administrator to oversee project - ICAR
   - b. Selection of central compiling unit location - ICAR
     Recommendation : TNAU, Coimbatore or NIAFR, Jhansi
   - c. Selection of senior compiler such as an AICRP Agroforestry scientist and achieving his services full/ time with a technical assistant and secretarial assistance - ICAR
     Recommendation : Dr. Vanangamudi, TNAU or
     Dr. K. Sudhakara, Kerala
   - d. Selection of 20 participants to compile data - ICAR
     1. should be representative of Agro-ecological zones
     Recommendation : Scientists trained at MSU or in Tree Seed workshop, TNAU would be good cadre from which to select.
   - e. Allocation of scientist/compiler time for project - ICAR

Recommendation :Equivalent to one scientist man/day per week.

2. <u>Training workshop</u> (time : 3 months)
   a. Workshop proposal - MSU scientists (Elam, Bonner, Land)
   b. Workshop approval and contract - ICAR, USAID/WINROCK
   c. Selection of 20 workshop participants - ICAR
      1. Assignment of pre-workshop preparation - MSU/ICAR
   d. Selection of site for workshop - ICAR
   e. Logistics for participants - WINROCK - ICAR
   f. Clearance for U.S. scientists - ICAR
   g. Logistics for U.S. scientists - ICAR
   h. Workshop presentation (Elam, Bonner, Land) - MSU
      1. Determine species list (participants)- MSU, ICAR
      2. Seed Tech chapters, Co-author agreements (MSU scientists, ICAR participants) - MSU, ICAR
      3. Genera species assigned - MSU, ICAR

3. <u>Compilation of existing data</u> - 24 months (all by ICAR scientists)
   a. Collection and compilation of seed data from available sources according to workshop standards - ICAR scientists
   b. Identification of needed data through compilations.
   c. Training other data compilers.

4. <u>Collecting new data</u> - 30 months (all by ICAR scientists)
   a. Research and testing for information identified in 3.b.
   b. Field studies, phenology, maturity indices.
   c. Seed collection, handling, testing, storage methods.
   d. Collection of material for illustrations.
   e. Preparation of herbarium specimens.

5. <u>Data transfer</u> - 24 months (all by ICAR scientists)

a. Write up of collected material by workshop standards.

b. Transfer by hard copy and/or computer diskettes.

c. Transfer of material for illustrations.

d. Location as determined by ICAR in 1.b.

6. <u>Project reviews</u> (Duration of project)

a. Semi-annual review by ICAR administrator - ICAR

1. Logistics and program - ICAR

b. Annual review by U.S. scientists (Elam, Bonner, Land) - MSU

1. Clearance - ICAR

2. Logistics - WINROCK (or equivalent) - WINROCK

3. Program - based on problem areas, and collaborative research projects - MSU

7. <u>Composition</u> - first draft 44 months

a. Write seed tech chapters - Co-authors - MSU, ICAR

b. Write genera and species chapters - Assigned Indian authors

c. Photographs at site selected by ICAR - ICAR

d. Drawings, illustrations - ICAR

e. Prepare first complete draft (senior compiler) - ICAR

8. <u>Review and editing</u> - 8 months

a. Review of first draft - ICAR, MSU

b. Revision, editing (senior compiler) - ICAR

c. Final draft review - ICAR, MSU

9. <u>Printing</u> - ICAR

10. <u>Distribution</u> - ICAR

Note : Where Winrock International is noted in this proposal - <u>equivalent agency</u> should be understood.

PROPOSAL

A MANUAL ON THE SEEDS OF SELECTED WOODY PLANTS IN INDIA

A follow-up to the Tree Seed Workshop held at Tamil Nadu Agricultural University

May 22 to June 3, 1989

Prepared by:

U.S. Scientists:

Dr. W. W. Elam, Forestry Department, Mississippi State University
Dr. S. B. Land, Jr., Forestry Department, Mississippi State University
Dr. F. T. Bonner, U.S. Forest Service, Southern Forest Experiment Station
Dr. J. A. Vozzo, U.S. Forest Service, Southern Forest Experiment Station

ICAR Scientists:

Dr. S. Chinnamani, ADG (Agroforestry), New Delhi
Dr. T. V. Karivartharaju, Tamil Nadu Agricultural University

In consultancy with Visiting Indian Scientists:

Dr. M. S. Hooda, Haryana Agricultural University
Dr. D. P. Nandal, Haryana Agricultural University
Dr. J. C. Rajput, Konkan Krishi Vidyapeeth
Dr. R. V. Singh, G.B.P.U.A. Hill Campus,
Dr. K. Vanangamudi, Agricultural Research Station, TNAU
Dr. J. S. Zopé, Punjabrao Krishi Vidyapeeth

and

Indian Scientists who participated in the Tree Seed Workshop at Tamil Nadu Agricultural University May 22 to June 3, 1989

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PROPOSAL

A Manual on the
Seeds of Selected Woody Plants in India

PROPOSAL SUMMARY

This is a proposal to undertake a collaborative research program between Mississippi State University and the Indian Council on Agricultural Research to produce a major national publication on the seeds of selected trees and shrubs in India patterned after the United States Department of Agriculture Handbook No. 450, Seeds of Woody Plants in the United States. Additionally, the information will be compiled in such a format that it can be made available on computer diskettes.

Specifically, there will be a section on seed biology, genetic improvement, and the principles and general methods of producing and handling woody plant seeds. This will be followed by a section with specific seed data for selected genera of trees and shrubs found in India. The data will include flowering and fruiting dates, seed processing methods, storage conditions, seed yields and weights, methods of breaking seed dormancy, testing methods, and general nursery practices. The publication will be illustrated with photographs and drawings of seed of the genera.

Information in the proposed volume will be useful to any users of woody plant seed. It will bring together existing knowledge in a single source, identify knowledge gaps, stimulate research, and foster national and international technology transfer about woody plant seeds.

INTRODUCTION

Population increases in many countries have caused unprecedented demands on the woody plant resources of those countries. Frequently, depletion of the natural wood resource results in environmental degradation. With the global increase in environmental awareness comes the awareness that our forest resource must be regenerated. Too often, regeneration projects begin with seedling production. Typically these projects provide little information on the vital preceding step of how to produce and process seed. The seed, not the seedling, is the basic biological unit of regeneration. This will continue to be true until biotechnological methods for producing plantable plants become economically feasible. Information on the seeds of woody plants is therefore extremely important, especially when one considers the time involved to grow a desired final product.

India is now using woody plant products for construction material, pulp, fuel, fodder, oils, pharmaceuticals, traditional medicines, tannin, fruit, and fiber. A source book on the seeds of the species that furnish this vast array of products would be of great value, both nationally and internationally. India

has a great diversity of habitat; a large number of indigenous and adapted woody plant species which are grown in other countries; and a network of agricultural universities and research stations. This unique situation puts India in a position to become a leader in the compiling and dissemination of information on tree seed technology throughout Asia.

USDA Handbook 450 is a widely used reference book which has been revised from its original version and reprinted several times. It is used by horticulturists, foresters, seedsmen, and nurserymen to name but a few. A comparable handbook for India will be of even greater value with the current emphasis on agroforestry and the use of indigenous multipurpose species.

Publishing such a book would serve more than one purpose:

1. It would provide a single reference source for selected woody plant seed in India.

2. It would provide technology and data to other countries which grow the same or similar species.

3. Unpublished seed data and technical reviews would be incorporated and disseminated.

4. It would indicate gaps in knowledge where further seed research is needed and stimulate tree seed research throughout the country.

India is increasing its use of woody plant seed in agroforestry and is approaching the point in its tree improvement programs where it will be producing more costly seed in seed orchards. Information in the proposed publication will be of much importance in the proper handling, storing, and testing of these seed.

The Indo-US Subcommission on Agriculture identified agroforestry as an important area of mutual interest. Collaborative research between U.S. and Indian scientists has been suggested. This project would not only augment collaborative work, but would identify those areas in which woody plant seed research is lacking and needed.

The experience of the proposed collaborating U.S. scientists encompasses many years of work with tree seed technology, tree improvement, and importantly, hands-on work in compiling and producing USDA Handbook 450, the model for the proposed publication for India. Further, the U.S. scientists all have experience in preparing and presenting short-courses, and each has served as mentor for Indian scientists training at Mississippi State University. Additionally, all of the U.S. scientists are, or will be, involved in collaborative research projects with Indian scientists during this project.

PROJECT DESCRIPTION

It is proposed that Indian scientists and other personnel chosen by ICAR collaborate with scientists of the Mississippi State University Tree Seed Program

to produce an Indian national publication on woody plant seed limited in scope to approximately 1,000 species. This work would include the most important agroforestry and forestry species of India. Both indigenous and introduced species would be included.

The India Council for Agricultural Research will coordinate and manage the project. The American scientists will collaborate as technical consultants on data compilation, technical review, co-authoring seed technology chapters in the book, and in identifying collaborative seed research opportunities.

Based on experience with producing and using the USDA Agricultural Handbook 450, U.S. scientists at MSU will develop a detailed step-by-step work-plan for the nation-wide seed data compilations job. The work-plan will include: a descriptive list for key persons in data compilation, examples of desired reports, suggested deadlines, detailed procedures on selecting species to be included, nomenclature to be used, information sources, seed testing methods, taxonomic items to be included, photography guidelines, a basic seed glossary, and necessary worksheets for data compilation. This work-plan will be introduced and explained in detail by the U.S. scientists at a one-week workshop for Indian participants in India.

Prior to the workshop, ICAR should select the participants. The participants should represent the different states and/or ecological regions of India.

WORKSHOP

A one-week training workshop will be held for the Indian participants. It will be held in India at a time and site selected by ICAR. The location should have classroom facilities for instruction. It should also be located near library facilities which contain technical seed references.

The U.S. scientists will train the workshop participants in seed data acquisition and compilation so that they in turn can train other data compilers in carrying out their assignments.

Participants in the workshop will be expected to prepare for the workshop ahead of time by preparing a list of the most important woody plant species in their state or area. From these lists the master list of species to be included in the book will be determined, and species assignments will be made to participating scientists.

At their duty stations, participants will collect and compile in a standard format information available about their assigned species. At the same time, they should obtain information on other species which may not be available to the compiler assigned that species; i.e., special reports, unpublished departmental reports, etc. This information would be sent to the assigned individual for that species. This is advantageous since it would cause the creation of a network of corresponding tree seed scientists whose work would become better known to each other.

It should be realized that collecting and compiling data will require time, and allowances should be made for the personnel involved. The more personnel-time allocated for work on the seed manual, the faster it will be completed and the more comprehensive it will be.

U.S. Scientists' Participation

Participation of U.S. scientists in the project will be:

1. Preparation of detailed manual of procedures.

2. Presentation of training session (workshop) on procedures.

3. Annual review of project status.

4. Co-authoring, with Indian scientists, seed technology chapters included in the book.

5. Identifying, with Indian scientists, areas for collaborative tree seed research.

Organization and Plan of Work

In consultation with the six visiting Indian scientists at MSU, the following organizational scheme and plan of work was determined and is proposed for consideration.

Scientists from the Tree Seed Program of Mississippi State University will serve as technical consultants as previously detailed. The Indian Council for Agricultural Research will be responsible for selecting personnel and assignment of their responsibilities in the project.

The project will require a National Coordinator assisted by a Steering Committee to keep the project on task and on schedule. These will be supervisory positions which will require only a limited amount of time. A coordinator will also be desired in each state. Each State Coordinator will be responsible for the project in his state. They will receive progress reports from the data compilers at six-month intervals and will receive the species data for their state. The reports and data will be sent to the office of the National Coordinator. The State Coordinator positions, as envisioned, will require a limited amount of each person's time. The scientist data compilers will be assigned genera for which they will be responsible. They will author the chapter in the book dealing with that genera. The amount of time required will vary depending on several factors such as access to information sources, data available on the genera, research necessary to complete the data, etc. They will report to their state coordinator at specified intervals and forward compiled data to him.

When the flow of information to the office of the National Coordinator begins, it will require the full-time commitment of a technical editor. This is an important position and will require an assistant and/or secretary who is skilled in word-processing. The editor and his assistant will prepare the information for publication. The information will be written using a database management program for personal computers, for example the Clarion program for IBM personal computers and compatibles. This will facilitate the transfer of information on diskettes and take advantage of the capability of computers to rapidly access and manipulate data. Final products of the project will be both a printed publication and a set of computer diskettes which will contain the compiled data.

For the printed publication, it is suggested that all specimens which are to be photographed be sent to one firm or location. This will achieve consistency in the quality of the photographs.

National Coordinator. A person with a good knowledge of both agroforestry and forestry is desirable. This position should also have the authority to initiate action.

Steering Committee. This committee should be of a manageable size (5 to 6) and should include representatives of both agroforestry and forestry interests, including a member from Dehradun.

State Coordinators. Each person chosen should carry some authority in his state so that requests for information will be honored; for example, the Chief Conservator of the Forest or a Director of Research or their designees.

Participants or Data Compilers. These people should have a knowledge of tree seed technology. They will gather and compile the information, be responsible for writing chapters, collecting seed, submitting reports, and doing research. It is suggested that the cadre of Indian scientists trained in the United States in tree seed technology and the participants in the Tree Seed Short-Course at Tamil Nadu Agricultural University in 1989 would form an excellent nucleus of personnel for these tasks.

The training workshop will be held for the Steering Committee and State Coordinators following selection by ICAR of personnel who will participate in the project. The scope of the project and any necessary modifications will be determined in consultation with the National Coordinator and the Steering Committee during the first two days of the meeting. A detailed work-plan for the seed data compilation will be presented to the State Coordinators or their designates during the remainder of the meeting. The plan will include: a suggested job list for the coordinators in each state, examples of progress reports, suggested deadlines, detailed procedures on selecting species to be included, nomenclature to be used, information sources, seed testing methods, taxonomic items to be included, a worksheet for data compilation, photography guidelines, a basic seed glossary, and other details necessary for collection of necessary data.

Also to be completed at the workshop will be the determination of seed technology subjects to be included as text chapters and assignment of authors and

the assignment of genera to scientists. This may be modified as material sources become better known, i.e. assigned authors may not have access to information as readily as another participant so change would be suggested.

Following collection and compilation of data by assigned scientists, the data should be sent to the technical editor as assigned by the National Coordinator. Progress reports should be sent in every six months by data compilers to State Coordinators who will in turn report the progress to the National Coordinator or his designee.

After 12 months, the Steering Committee should meet to determine and make changes desired (if any) in the program.

Annually, MSU Tree Seed Program scientists will review the status of the project until completion which is estimated to take four to five years.

Alternative Scheme. If the preceding organizational scheme and plan of work is not feasible an alternative would be to have an ICAR administrator assume overall responsibility for the project. An existing ICAR unit would be designated as the central compiling unit. A scientist at that unit trained in tree seed technology would be selected to be the senior compiler or technical editor. ICAR scientists at the other 30 units would be assigned species or genera on which to collect and compile data which would be sent to the central unit.

Under this scheme, the participants at the workshop would be scientists from the ICAR units. They would be data compilers and genera authors and train other participants.

Essentially, the other changes would be: (1) elimination of the National Coordinator position, an ICAR scientist at the designated central compiling unit would assume a similar role; (2) change from a steering committee of 5 to 6 to one or two overall administrators who would participate in annual status reviews with U.S. scientists and make recommendations; and (3) the State Coordinator role would be filled by appointed ICAR scientists who would keep other colleagues up-to-date on project deadlines, reports, schedules, etc. They would not receive data reports. All data reports would go to the designated central compiling unit.

Suggested Program and Estimate of Timeframes
(some times will be concurrent--see chart)

1. Administrative structure (timeframe--2 months)

   ICAR will determine organizational scheme, participants, locations, and manpower allocations.

   Note: Simplest structure expedites execution.

2. Training workshop (timeframe--3 months)

MSU will prepare materials for a training workshop regarding collecting and compiling necessary data for the seed manual. Time--2 months.

ICAR will determine workshop participants and arrange site for workshop. Time--2 months.

Trainees selected will prepare for workshop by making a list of the most important agroforestry and forestry species of their area. Time--2 months.

Workshop presentation by MSU participants. Time--1/2 month.

Species list will be determined; chapter and genera assignments agreed upon.

3. Compiling existing data (timeframe--24 months).

Scientists will collect seed data from available sources; data will be compiled according to workshop methods. species will be addressed according to order of priority set at workshop. Areas of incomplete information will be identified and plans made to obtain the data. Other scientists will be trained by workshop participants.

4. Collecting new data (timeframe--30 months).

Research and testing of species identified for inclusion in the manual. Will include phenological studies, seed collection, handling, testing, and storage methods. Completion of missing data.

Material will be collected for manual illustrations, i.e., photographs and drawings. Herbarium specimens can be prepared for identification, classification, and reference. Confirmation of identification by taxonomist.

5. Data transfer (timeframe--24 months).

Collected, compiled data will be sent to a central compiler. Data may be on computer diskettes or by printed documents written to format. Collected illustrative material will be sent to location for photography and drawings.

6. Program reviews (timeframe--annually for project duration).

Annually, 3 MSU scientists will spend 10 days in India reviewing the status of the project and will make appropriate recommendations. They will confer with Indian scientists with whom they are co-authoring chapters for the manual, review project progress, identify new collaborative research areas, and confer about ongoing collaborative research with Indian counterparts.

7. Seed Tech Chapters (Manual Part I) (timeframe--24 months)

Indian and U.S. scientists will write general seed technology chapters for the manual. A draft copy will be completed in sufficient detail so that a publication could result following the end of the two-year period. Co-authors will be determined at the workshop on the basis of scientist interest and expertise.

8. Genera and Species Chapters (Manual Part II (timeframe--44 months).

Indian scientists will write information on the species assigned and send their material to the central compiler. Final reports will be a synthesis of compiled existing data and new data generated through research.

9. Composition--first draft (timeframe--44 months).

The senior compiler will review all material for conformation to a common format, revising as necessary. Likewise, all illustrations will be in a standard format. The first complete draft will be written.

10. Review and editing (timeframe--4 months).

The initial draft of the manual will be reviewed by scientists designated by ICAR. Following review, the manuscript will be revised as necessary by the senior compiler. The revised manuscript will be sent for printing.

11. Printing (timeframe--4 months).

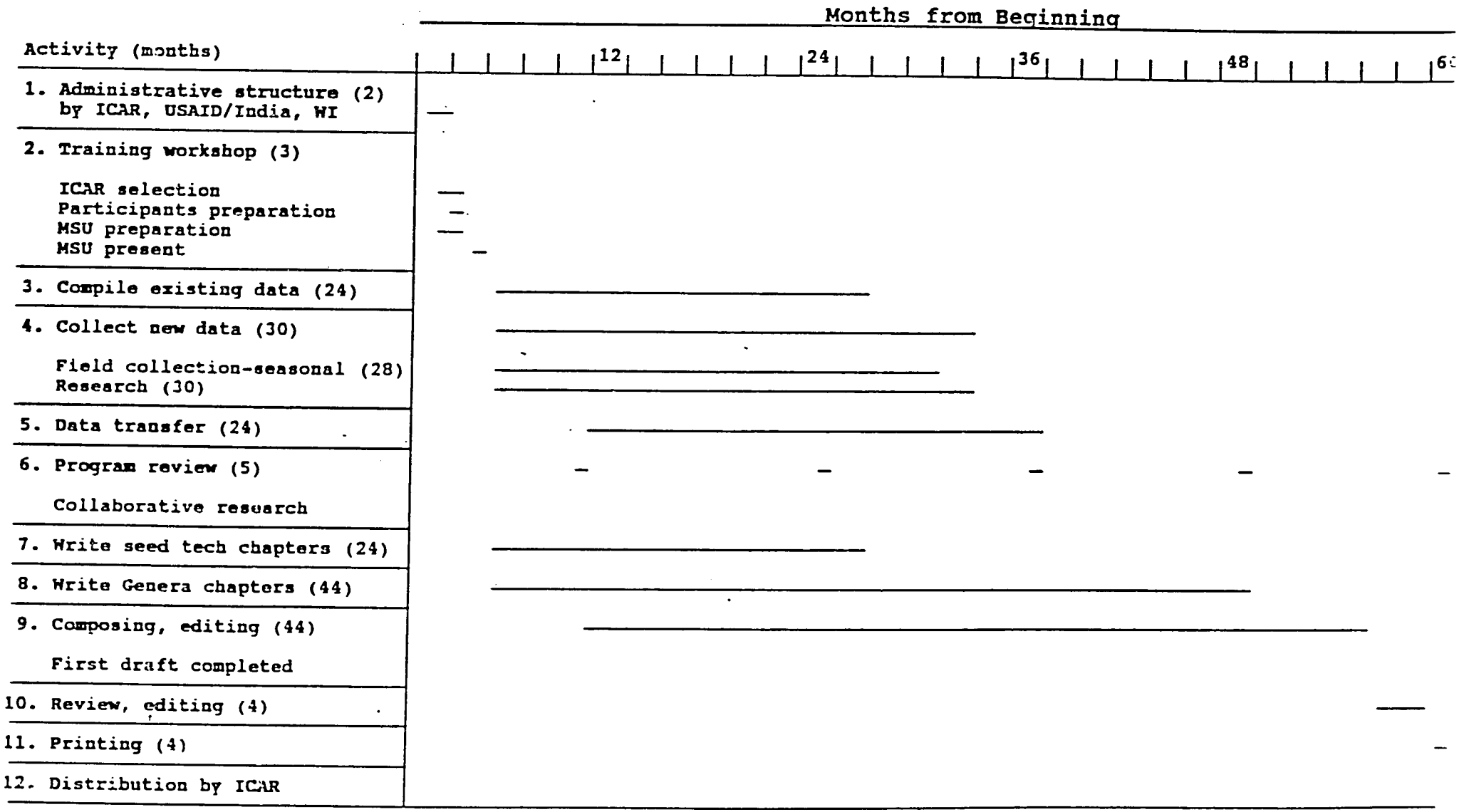
By a firm designated by ICAR.

12. Distribution.

Distribution will be through ICAR.

Total time involved - 60 months.

PROPOSED ACTIVITY SCHEDULE FOR PREPARATION OF WOODY PLANT SEED MANUAL FOR SELECTED SPECIES IN INDIA



PROJECT OUTPUTS

1. A procedural manual on seed data acquisition and compilation.
2. A training workshop.
3. A definitive manual on the seed of the 1,000 most important agroforestry and forestry woody plant species in India.
4. The compiled data of the above on computer diskettes.
5. Identified areas of mutually beneficial collaborative research.
6. Tree seed research.

FOLLOW-UP OPPORTUNITIES

This project, which encompasses only those species deemed as the most important in forestry and agroforestry, lays the groundwork for other research and development opportunities.

The most obvious is to continue the program and include additional worthy woody plant species. Given the large number of valuable species in India this would be very desirable.

Another natural outgrowth of the project will be the increase in collaborative research endeavors between U.S. and Indian scientists and between Indian scientists.

A more important spin-off, however, could be the establishment of a national tree seed testing and/or research laboratory. The testing and research necessary for the completion of the proposed Woody Plant Seed Manual lays the foundation for developing such a facility. The USDA National Tree Seed Lab is a similar facility in the U.S.

The development of such a facility could begin concurrently with the compiling, research, and writing of the Woody Plant Seed Manual. It is natural outgrowth and is recommended for consideration.

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Budget Estimate Summary--60 months
MSU Participants

Budget Item	Year (1)	(2)	(3)	(4)	(5)
Workshop Preparation	$14,000				
Workshop Presentation	$14,000				
Consultation-- 3 scientists 30 man-days @ $465	$14,000	$14,000	$14,000	$14,000	$14,000
Travel (to Delhi) @ $4,300)					
a. Workshop presentation	$13,000				
b. Project review	$13,000	$13,000	$13,000	$13,000	$13,000
Per diem--@ $100/day					
a. Workshop--30 man-days	$3,000				
b. Project review--30 man-days	$3,000	$3,000	$3,000	$3,000	$3,000
Miscellaneous					
a. Supplies	$500	$500	$500	$500	$500
b. Clerical support	$500	$500	$500	$500	$500
Total	$75,000	$31,000	$31,000	$31,000	$31,000

Travel and Per Diem Estimates

Item	Year (1)	(2)	(3)	(4)	(5)
1. Travel (to Delhi)					
a. Workshop $4,300 x 3	13,000				
b. Project Review $4,300 x 3	13,000	13,000	13,000	13,000	13,000
2. Per Diem					
a. Workshop 30 man-days	3,000				
b. Project Review 30 man-days	3,000	3,000	3,000	3,000	3,000
Total	32,000	16,000	16,000	16,000	16,000

Does not include estimate for inflation.

Budget Option--Computer-Aided Information Retrieval Service (CAIRS) at MSU

Item	Year (1)	(2)	(3)
Literature Searches*	2,500	1,000	1,000
Personnel Services:			
a. Graduate Student Stipend	12,000	12,000	12,000
or b. Research Assistant	30,000	30,000	

*Average cost per abstract--$1.00.
Average 10 abstracts/species.

General Outline

Title: Seeds of Selected Woody Plants in India--
with special reference to agroforestry species.

A two-part manual on seeds of selected trees and shrubs of India. Part 1 to contain chapters on seed biology and the principles and general methods of producing, harvesting, and handling woody-plant seed. Part 2 to be a compilation of seed data on species which are considered to be the most important woody plants in India, especially in agroforestry. This data to include flowering and fruiting dates, seed handling methods, storage parameters, seed yield and weights, methods of overcoming seed dormancy, germination tests, and photographs and illustrations.

Contents

Part 1

Principles and General Methods of Producing and Handling Seed

I. Seed Biology (by Indian and American coauthors)

A. Woody Plant Life Cycles

1. Juvenile or Vegetative Period

2. Floral Initiation and Early Development

a. Timing

b. Influencing Factors

3. Flower Development

4. Pollination and Fertilization

a. Pollen Development and Dispersion

b. Pollen Viability

c. Fertilization - Angiosperms

d. Fertilization - Gymnosperms

B. Fruit and Seed Development

1. Anatomy and Morphology

a. Angiosperms

b. Gymnosperms

2. Physiological Development

a. Moisture Content

b. Hormones

c. Biochemical Changes

C. General Types and Classification of Mature Fruits

1. Angiosperms

2. Gymnosperms

D. Maturity and Dispersal

1. Maturity Indices

2. Dispersal Timing

3. Dispersal Methods

E. Factors Affecting Flower, Fruit, and Seed Production

1. Physiological Factors

2. Weather

3. Biotic Agents

a. Insects

b. Diseases

c. Birds

d. Mammals

F. Dormancy

1. Occurrence

2. Causes

a. Physiological

b. Physical

3. Treatments to Break Dormancy

a. Stratification

b. Physical

c. Chemical

G. Germination

1. Environmental Requirements

a. Moisture

b. Temperature

c. Gas Exchange

d. Light

2. Biochemical Changes

3. Physical Development

II. Principles of Genetic Improvement of Seed (by Indian and American coauthors)

A. Understanding and Preserving Genetic Variation

B. Species and Provenance Variation

1. Species-Site Adaptation

2. Species Hybridization

3. Adaptive Variation and Populations Within Species

4. Hybridization Between Trees of Different Provenances

C. Character Variation Among Individual Trees

1. Tree Selection

2. Testing Progeny

3. Breeding Systems

D. Changing Genes and Chromosomes

E. Use of Improved Varieties

III. Production of Genetically Improved Seed (by Indian and American coauthors)

A. Unclassified Stands

B. Classified Stands

C. Seed Production Areas

1. Purpose and Advantages

2. Stand Selection

3. Crop-tree Selection and Release

4. Isolation

5. Cultural Treatments and Protection

6. Yields

7. Seed Harvesting and Coats

D. Seed Orchards

1. Purpose and Advantages

2. Selection of Desired Crop-trees

3. Vegetative Propagation

4. Site Selection

5. Isolation

6. Site Preparation

7. Design and Establishment

8. Cultivation and Cover Crops

9. Fertilizer Treatments

10. Irrigation

11. Pruning

12. Traumatic Stimulation of Flowering

13. Protection

14. Harvesting

15. Costs and Economic Gain

IV. Harvesting, Processing, and Storage of Fruits and Seeds (by Indian and American coauthors)

A. Preharvest Planning

1. Determining Sources

2. Legal Aspects

B. Harvesting

1. Collection Timing

2. Maturity Indices

3. Seed Yields

4. Harvesting Methods

a. Manual

b. Mechanized

5. Post-harvesting Care

C. Processing

1. Cones

2. Fleshy Fruits

3. Dry Fruits

4. Quality Control

D. Storage

1. Factors Influencing Seed Longevity

2. Storage Factors

3. Storage Methods

4. Orthodox Seed

5. Recalcitrant Seed

V. Presowing Treatment of Seed to Speed Germination (by Indian and American coauthors)

A. Treatments for Hard Seedcoats

1. Acid Scarification

2. Mechanical Scarification

3. Other Treatments

B. Stratification Treatments

1. Cold Stratification

2. Warm and Cold Stratification

C. Combination Treatments

D. Chemical Treatments

E. Timing of Sowing

VI. Seed Testing (by Indian and American coauthors)

A. Development of Standard Test Procedures and Rules

B. Testing of Seed

C. Sampling

1. Sample Size

2. Sampling Equipment

3. Sampling Procedure

4. Shipping of a Sample

D. Physical Characteristics

1. Purity

2. Weight

3. Moisture Content

4. Genuineness and Origin

E. Potential Germination

1. Germination Test

2. Rapid Tests for Viability

F. Vigor

1. Speed of Germination

2. Seedling Growth

3. Indirect Tests

G. Interpreting and Applying Test Results

VII. Tree-Seed Marketing Controls

A. Phytosanitary Regulations

B. Tree-Seed Certification

1. Conception and Development

2. Minimum Standards

3. OECD Scheme

C. International Programs

Part 2

Specific Handling Methods and Data for Seed of Important Agroforestry Species

Outline of data to be included in each chapter.

I. Title of Chapter - Scientific family and genus name by (compiling scientist)

II. Narrative Description of Genus and Included Species

- A. Growth Habit, Occurrence, and Use
  - 1. Distribution
  - 2. Number of Species of Importance
  - 3. Uses
- B. Flowering and Fruiting
  - 1. Flower
  - 2. Fruit
  - 3. Seeding Habits
- C. Collection, Extraction, and Storage
  - 1. Timing
  - 2. Methods
  - 3. Conditions
- D. Pregermination Treatments
- E. Nursery and Field Practice

The above information to be presented in descriptive format with proper citations as to source of information.

III. Graphical Presentation of Genus Information

A. Figures

1. Photographs of Seed of the Species

2. Drawing of Longitudinal Section of a Seed of the Genus.

B. Tables

1. Nomenclature, Occurrence, Height, and Use

a. Scientific Names and Synonyms

b. Common Names

c. Occurrence (location)

d. Height at Maturity

e. Uses

f. Year of First Cultivation

g. Data Source

2. Phenology of Flowering, Fruit Ripening, and Seed Dispersal

a. Species

b. Location

c. Flowering Dates (from - to)

d. Fruit Ripening Dates (from - to)

e. Seed Dispersal Dates (from - to)

f. Data Source

3. Pod Size and Cleaned Seed Per Kilo

a. Species

b. Pod Size (length, width)

c. Cleaned Seed Per Kilo (range, average, samples)

d. Data Source

4. Pregermination Treatments, Germination Test Conditions, and Results

a. Species

b. Seed Source (country, etc.)

c. Seed Pretreatment

d. Germination Test Conditions (medium, light, temperature, duration)

e. Germinative Energy (amount in %, period in days)

f. Germinative Capacity (average in %, # samples)

g. Data Source

IV. Literature and Other Data Sources Cited

Genus and Species _____

INFORMATION FOR PART I

Significance of local races (Chapters 2 and 4).

Acreage in seed orchards and seed production areas, and product objectives of each (Chapter 4).

Harvesting and processing procedures (Chapter 5).

Treatment of seed for control of insects, disease, or rodents and special storage methods (Chapter 5).

Dormancy-breaking treatments (Chapter 6).

Quick viability tests (Chapter 7).

Marketing controls (Chapter 8).

OTHER PERTINENT INFORMATION

SEED MANUAL WORK SHEETS FOR SPECIES

Compiled by _____ Date _____

Family	Genus	Species and Author	Variety and Author

Synonyms:

Accepted common name followed by synonyms:

1. Growth habit	Height Lo	Height Hi	1. Flowering Habit	2. Natural Range	2. Range Extensions	3. Uses
Deciduous ___ Tree ___ Evergreen ___ Shrub ___	m	m	Monoecious ___ Dioecious ___ Bisexual ___ Bisex.+♀ ___ Bisex.+♂ ___			T ___ H ___ W ___ S ___ E ___

4. PHENOLOGY

First cultivated in year ___

Location	Min. seed-bearing age	Flowering dates	Fruit ripening dates	Seed dispersal dates	Natural germination date	Seed crop interval
	yrs					yrs

5. FRUIT COLLECTION AND 6. PROCESSING INFORMATION Dry fruits. Type:

5. Fruit color		Sp. Grav. when ripe	Liquid for float tests	6. Fruit drying				6. Seed separation and cleaning meth
				in air		in kiln		
pre-ripe	ripe			days	oC	hrs.	oC	

Fleshy fruits. Type:

5. Fruit color		5. Other ripeness criteria	6. Pre-maceration treatment	6. Seed drying	
pre-ripe	ripe			Time	Temp. oC

7. SEED YIELDS AND WEIGHTS

Location	Wt. of a bushel of fruit	Yield of cleaned seed per 50 k of fruit	Yield of cleaned seed per 50 l of fruit	Cleaned seed counts Low	Cleaned seed counts Ave.	Cleaned seed counts High	Moisture Content	Samples
	kilo	lbs	lbs	no./k	no./k	no./k	percent	number

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PRE-GERMINATION TREATMENTS FOR SEED

Genus and Species _____

Seed Age	Dormancy-breaking treatments						Pest control treatments		
	8. Scarification			9. Stratification					
	Medium	Temp.	Time	Medium	Temp.	Time	10. Insects	11. Diseases	12. Rodents
yrs		oC	hrs		oC	days			

13. GERMINATION TESTS

Seed Source	Seed age	Pre-treat-ment	Test conditions			Test dura-tion	Germin. energy		Germ. capa-city	Samples	Testing agency
			Medium	Day temp.	Night temp.		Amt.	Time			
	yrs	(code)		oC	oC	days	%	days	%	no.	

14. STORAGE

Pre-treat.	Seed Moisture	Temp.	Containers
(code)	percent		

15. COMMERCIAL HARVEST

Seed harvest 19__-19__	Major Processors	Retail dealers	Minimum Standards	
			Purity	Viability
lbs/yr.	number	number	percent	percent

16. NURSERY PRACTICE

Nursery location	Seed age	Pre-treatment	Seedling density	Sowing depth	Mulch	Tree percent	Seedling treat-ment for pests	Outplant-ing age
	yrs	(code)	no./sq.m	cm				yrs

APPENDIX B

EXAMPLE PAGES OF USDA HANDBOOK 450

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Magnoliaceae—Magnolia family

MAGNOLIA L. Magnolia

by David F. Olson, Jr.,[1] R. L. Barnes,[1] and Leroy Jones[2]

Growth habit, occurrence, and use.—The genus *Magnolia* is composed of about 35 species of deciduous or evergreen trees or shrubs which occur in North and Central America, eastern Asia, and the Himalayas (*22*). Some of the species produce valuable lumber, and the bark and fruit of some are used occasionally in medicine. Many magnolias are used in ornamental planting, because of their showy flowers and fruits, and attractive foliage. The seeds of some species are eaten by birds. There are nine species of *Magnolia* native to the United States. The seeds of only four species have been used extensively for planting (table 1). *M. acuminata* and *M. grandiflora* are large trees, 60 to 90 feet high (*17, 19*). *M. fraseri* and *M. virginiana* are small trees, 20 to 40 feet high (*19*).

Flowering and fruiting.—The large, solitary, perfect flowers are borne singly at the ends of the branches in the spring and summer (*2, 4, 15, 18*), and range in color from greenish yellow to white. Pollination is carried out by insects (*14, 16*). The red or rusty brown, conelike fruits are 2 to 5 inches long and ½ to 1½ inches in diameter (5 to 12.5 cm. long and 12 to 37 mm. in diameter), and consist of several coalescent one- to two-seeded fleshy follicles (fig. 1 and color plate) which ripen in late summer to early fall (*2, 4, 15, 18*). At maturity the seeds are ¼ to ¾ inch long (6 to 18 mm.) (fig. 2), are red or scarlet, and are drupelike. The removable outer portion of the outer seedcoat is fleshy, oily, and soft, and the inner portion is stony. The inner seedcoat is thin and membranous, and encloses a large, fleshy endosperm in which is embedded a minute embryo (fig. 3). The seed usually is suspended from the open follicle for some time by a slender, elastic thread. Seed dispersal is by wind and birds (occasionally by water), and occurs soon after ripening. Southern magnolia (*M. grandiflora*) is a prolific seed producer, and one of the most fruitful forest trees. Trees often produce seed 10 years after planting, and bear good crops annually (*3*).

Collection of fruits; extraction and storage of seeds.—The fruits may be picked from standing trees, or from trees recently felled in logging, as soon as they turn red or rusty brown, but picking may be delayed until the follicles have begun to open. The fruits should be spread out to dry in shallow layers (one fruit deep). After a few days, the seeds can be shaken out of the open fruits. Seed to be used in the near future should have the fleshy part of the outer seedcoat removed by maceration in water or by rubbing on

[1] Southeastern Forest Exp. Stn.
[2] State and Private Forestry, USDA Forest Service.

TABLE 1.—*Magnolia: nomenclature, occurrence, and uses*

Scientific names and synonyms	Common names	Occurrence	Uses[1]
M. acuminata L. var. *acuminata*. *Tulipastrum acuminatum* (L.) Small.	cucumbertree, cucumber magnolia.	New York to Illinois, to eastern Oklahoma to Georgia (*19*).	T, H, W, E
M. fraseri Walt. *M. auriculata* Lam.	Fraser magnolia, mountain magnolia	Mountains of Maryland, West Virginia, and Virginia, south to northern Georgia, Alabama, and South Carolina (*18*).	T, H, W, E
M. grandiflora L. *M. foetida* (L.) Sarg.	southern magnolia, evergreen magnolia.	Coastal plain from southeastern North Carolina to central Florida, and to eastern Texas (*9*).	T, H, E
M. virginiana L. *M. glauca* L. *M. australis* Ashe.	sweetbay, sweetbay magnolia	Coastal swamps from Massachusetts to Florida, west to eastern Texas (*19*).	T, H, E

[1] T: timber production, H: habitat or food for wildlife, W: watershed, E: environmental forestry.

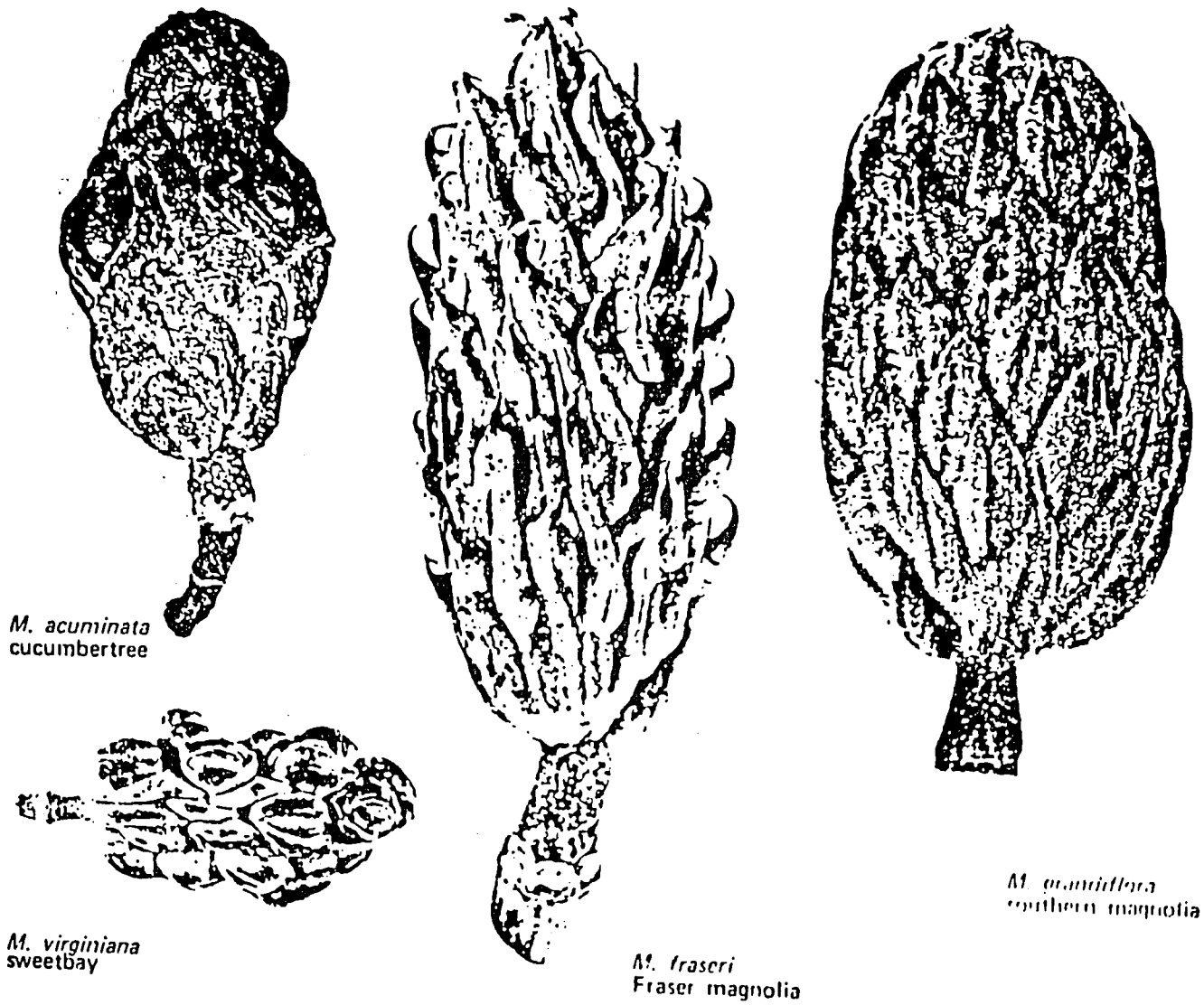

FIGURE 1.—*Magnolia:* conelike fruits consisting of coalescent follicles, 1

hardware cloth. Average number of seeds per pound does not vary widely among the species of *Magnolia* (table 2). Magnolia seed can be kept either cleaned or in the dried pulp for several years with little loss of viability if stored in sealed containers at 32° to 41° F. (*1*, *22*). Seed stored at higher temperatures should not be cleaned. *M. grandiflora* seed loses its viability if stored over winter at room temperature (*22*).

TABLE 2.—*Magnolia: cleaned seeds per pound*

Species	Range	Average	Samples	Data source
	Number	*Number*	*Number*	
M. acuminata	2,900-6,600	5,150	15	*12, 21, 23*
M. fraseri	2,480-5,650	4,550	12	*21, 23*
M. grandiflora	5,800-6,800	6,450	8	*22, 23*
M. virginiana		7,530	5	*23*

Pregermination treatments.—Magnolia seeds exhibit embryo dormancy which can be overcome by 3 to 6 months of low temperature stratification (32° to 41° F.) (*1*, *5*, *6*, *7*, *21*). Fall sewing provides natural stratification (*22*).

Germination tests.—Germination is epigeal, and occurs rapidly following proper stratification (*6*) and placement in a standard germination medium (table 3). A fairly close estimate of viability in *M. acuminata* can be made by removing the seedcoats, lightly scratching the surface of the endosperm, and then placing the

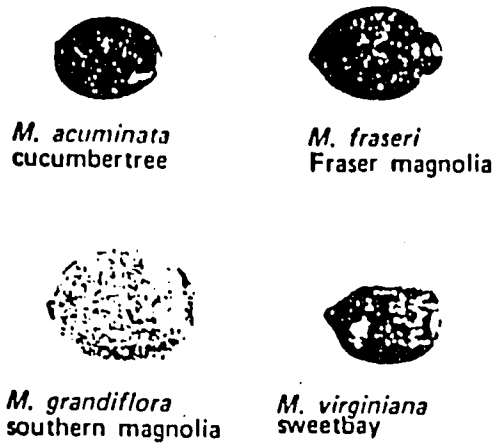

FIGURE 2.—*Magnolia:* seeds showing outer fleshy layer, 1 ×.

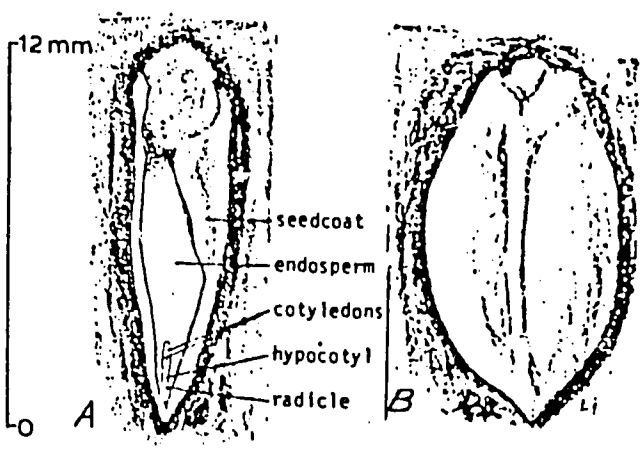

FIGURE 3.—*Magnolia grandiflora*, southern magnolia: seeds after removal of fleshy layer, 3 ×; *A*, longitudinal section through the embryo; *B*, surface of stony layer of seedcoat.

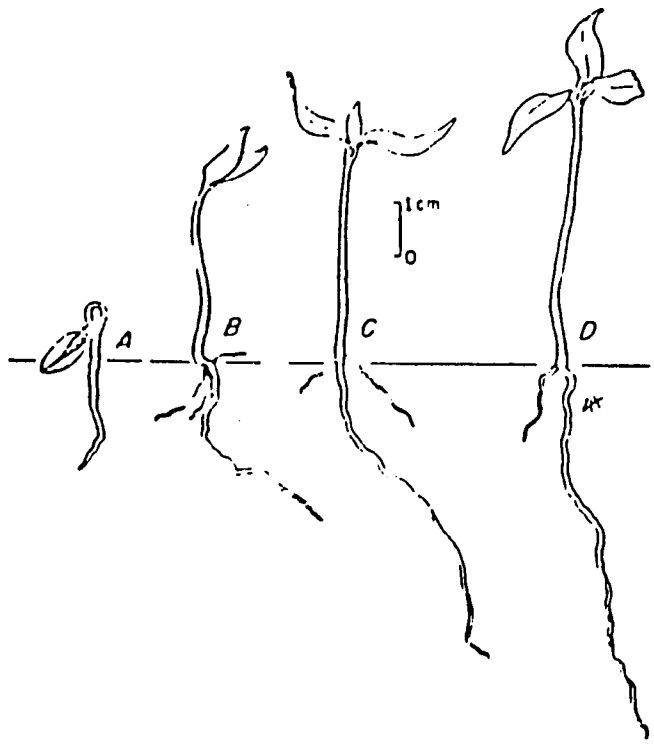

FIGURE 4.—*Magnolia grandiflora*, southern magnolia: seedling development at 1, 5, 13, and 31 days after germination.

seeds on moist cotton or blotting paper in covered dishes at germinating temperatures (*1*). Viable seed produce green pigment in the vicinity of the scratches in 2 to 3 days. Seeds of *Magnolia* have been tested successfully by the excised embryo method (*10*).

Nursery practice.—Magnolia seed may either be fall sown or stratified several months and sown in late winter or spring (*9, 11, 22*). In fall sowing, clean seed or seed in the pulp should be drilled in rows 8 to 12 inches apart and covered

TABLE 3.—*Magnolia: germination test conditions and results for stratified seed*

Species	Germination test conditions				Germinative capacity		Data source
	Medium	Temperature		Duration	Average	Samples	
		Day	Night				
		°F.	°F.	Days	Percent	Number	
M. acuminata	Sand : perlite Kimpac	70-86	59-68	35-60	8-86	4	*1, 20, 22*
M. fraseri	Sand : perlite Kimpac	86	68	40-100	8-21	6	*23*
M. grandiflora	Sand : vermiculite Kimpac	86	68	30-50	43-90	9	*7, 13, 23*
M. virginiana	Kimpac	86	68	17-61	32-50	4	*23*

with about ¼ inch of soil. The beds should be mulched to prevent freezing of the seed, and the mulch should not be removed until all danger from late spring frosts is past. The young seedlings (fig. 4) need half shade during much of the first summer. Nursery germination of *M. grandiflora* is 60 to 70 percent and begins in about 3 weeks (*22*). Spring sowing following stratification appears to be the best method of planting in areas where the rodent problem is serious. Normally, plantings are established with 1–0 seedlings.

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GLOSSARY

abortive imperfectly or incompletely developed as abortive seed.

abscission natural separation of leaves, flowers, and fruit from plants generally associated with deterioration of a specialized layer of thin-walled cells.

afterripening enzymatic processes occurring in seeds, bulbs, tubers, and fruit after harvesting; often necessary for germination or resumption of growth.

achene small, dry, nonsplitting, one seeded fruit with seed attached to ovary wall at only one point as in *Cowania* and *Eriogonum*; or pericarp fused with calyx tube and embryo completely, filling the ovarian cavity as in *Artemesia* and *Chrysothamnus*.

aggregate fruit formed from the several separate or fused ovaries of a single flower, as in *Rubus* and *Magnolia*. Compare multiple fruit and simple fruit.

allele one of an array of genes possible at a certain position (locus) on a given chromosome. Alternative (Mendelian) effects on the same character are produced by different alleles, e.g., as met in green or albino seedlings. If the array contains more than two genes, the genes are called multiple alleles. Multiple alleles arise by repeated mutations of a gene, each with different effects. No more than two alleles can be present in a given diploid organism.

ament see catkin.

angiosperm member of the group of plants having seeds which develop in a carpellary ovary. Compare gymnosperm.

anthesis 1. stage of full flower expansion or period when fertilization occurs. 2. bursting of anthers with release of pollen.

apomixis 1. all forms of asexual reproduction that tend to replace sexual regeneration. 2. reproduction from seeds or seedlike organs but without fertilization.

apophysis 1. an enlargement or swelling of the surface of an organ. 2. visible portion of a scale in a closed cone.

aril exterior covering or appendage of certain seeds that develops after fertilization as an outgrowth from the point of attachment of the ovule as in *Celastrus* and *Euonymus*.

asexual reproduction reproduction by purely vegetative means accomplished in woody plants usually by rooting stem cuttings, air layering, grafting, or budding.

berry pulpy indehiscent fruit developed from a single pistil and containing one or more seeds but no true stone as in *Ligustrum*, *Lonicera*, and *Ribes*.

bisexual having both stamens and at least one pistil in the same flower; *syn.* complete flower, perfect flower. Compare unisexual.

bract 1. modified leaf subtending a flower of floral axis. 2. modified leaf subtending a scale in female cones.

broadcast sowing scattering seed uniformly over an area; *syn.* broadcast seeding.

browse *n.* shoots, twigs, and leaves of trees and shrubs eaten by livestock and wild animals. *v.t.* to eat such material.

bur prickly or spiny casing around a fruit; the involucre in *Castanea* and *Fagus*.

calyx outermost group of floral parts; whorl of sepals.

capsule dry, usually many-seeded fruit composed of two or more fused carpels that split at maturity to release their seeds as in *Kalmia*, *Koelreuteria* and *Populus*.

carpel simple pistil or single member of a compound pistil.

carpellary pertaining to a carpel.

carpellate having carpels.

catkin spike of unisexual flowers or fruits with imbricated scaly bracts as in *Alnus* and *Betula*. *syn.* ament. Compare strobile.

certified seed seed attested by a recognized certifying agency to be from trees of proven genetic superiority, as defined by that agency, and produced so as to assure genetic identity. *syn.* elite seed. Compare selected seed and source-identified seed.

cline a gradual change in a phenotypic characteristic among individuals of a population; usually associated with a gradient in an environmental factor over the range of the population.

clone group of genetically identical plants produced by vegetatively propagating a single plant over one or more vegetative generations; accomplished in woody plants by rooting stem cuttings, budding, grafting, or air layering. Compare ortet, ramet.

combining ability capacity of a parent in crosses with other parents to transmit genes for a specific character. Good *general combining ability* (GCA) of a parent signifies high average performance of its progenies in various crosses, as compared to progenies of other parents in the same test. The "breeding value" of a parent is twice its GCA. Good *specific combining ability* (SCA) refers to two parents which, when crossed together, produce progeny better than expected on the basis of the parental GCA values.

cone 1. one of the reproductive structures of conifers. A female cone consists of a central axis supporting imbricated bracts each of which subtends a scale bearing naked (noncarpellate) seeds. A male cone consists of a central axis supporting spirally arranged microsporophylls each of which bears pollen sacs containing pollen grains. *syn.* strobilus. 2. any seed-bearing structure having a conical shape as in *Magnolia* and *Liriodendron*.

conelet immature female cone of gymnosperms, sometimes described as a flower.

corolla inner set of floral leaves consisting of separate or fused petals that surround the carpels.

corymb a flat-topped floral cluster as in *Rhododendron* and *Kalmia*.

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INDEX OF COMMON NAMES FOR PART 2

Preferred common names are listed in boldface type and other common names are in lightface roman type. The scientific name of the genus in italics follows each primary entry. The genus units are arranged in alphabetical order of the scientific name and each page is tabbed with the genus name. This arrangement enables the reader to locate a particular genus without referring to page numbers.

Aaronsbeard, *Cotinus*
abele, *Populus*
acacia, *Acacia*
  black
  black-wattle
  blackwood
  green-wattle
ailanthus, *Ailanthus*
álamo, *Populus*
álamo blanco, *Populus*
álamo de la sierra, *Abies*
Alaska-cedar, *Chamaecyparis*
Alaska cypress, *Chamaecyparis*
Alaska yellow-cedar, *Chamaecyparis*
albizzia, *Albizia*
  Molucca
  silktree
alder, *Alnus*
  American green
  black
  European
  European black
  European speckled
  gray
  green
  hoary
  hazel
  mountain
  Nepal
  Oregon
  Pacific Coast
  red
  river
  Sierra
  Sitka
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  speckled
  thinleaf
  wavyleaf
  western
  white
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aliso, *Platanus*
Allegheny sloe, *Prunus*
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American bittersweet, *Celastrus*
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American smoketree, *Cotinus*
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American yellowwood, *Cladrastis*
amorpha, *Amorpha*
  California
  dwarfindigo
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Amur corktree, *Phellodendron*
Anderson desert-thorn, *Lycium*
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  sweet crab
  western crab
  wild
  wild crab
  wild sweet crab
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aralia, bristly; *Aralia*
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  columnar
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  American
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  eastern
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  oriental
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arbutus, tree; *Arbutus*
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aromatic wintergreen, *Gaultheria*
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arrowwood, Indian; *Philadelphus*
arrowwood, *Viburnum*
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  mapleleaf
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ash, *Fraxinus*
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  Biltmore white
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bay, *Umbellularia*
bayberry, *Myrica*
  northern
  Pacific
  southern
bead-tree, *Melia*

APPENDIX C

INDIAN PARTICIPANTS IN TREE SEED WORKSHOP

INDIAN SCIENTISTS WHO STUDIED AT MSU

PROPOSED MSU SCIENTISTS

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List of participants attending the Indo-US Forest Tree Seed Technology Shortcourse cum Workshop on 22 May - 3 June, 1989. Tamil Nadu Agricultural University, Coimbatore.

Name	Designation	(Degree)	Home Location
Dr. M. G. Dasthagir	Associate Professor	(Forestry--Ph.D.)	Mettupalayam, Tamil Nadu
K. Ganesamurthy	Assistant Professor	(Ag. Plant Breed-M.S.)	Coimbatore, Tamil Nadu
Dr. M. S. Hooda	Assistant Professor	(Forestry--Ph.D.)	Hisar, Haryana
Edwin Jeyaraj	Asst. Conserv. of Forests	(Forestry--B.A.)	Coimbatore, Tamil Nadu
Dr. Amar Nath Jha	Assistant Professor	(Agronomy--Ph.D.)	Samastipur, Bihar
Ajay Kumar Khare	Technical Assistant	(Agriculture--M.S.)	Jabalpur, Madhya Pradesh
Dr. S. K. Majhi	Lecturer	(Agronomy--Ph.D.)	Kalyani, West Bengal
Thomas Mathew	Assistant Professor	(Agronomy--M.S.)	Palghat, Kerala
S. Nayar	Regional Manager	(Agriculture--M.S.)	Madras, Tamil Nadu
B. N. Patil	Associate Professor	(Soc. Forestry--M.S.)	Nagpu, Maharashtra
S. C. Patil	Research Assistant	(Ag. Plant Breed.--M.S.)	Rahuri, Maharashtra
A. S. Ponnuswamy	Assistant Professor	(Ag. Seed Tech.--M.S.)	Mettupalayam, Tamil Nadu
I. P. Pradhan	Sci. SI	(Agro. For.--B.S. & AFC)	Gangtok, Sikkim
S. S. Rathore	Sci.-I	(Agronomy--M.S.)	Jodhpur, Rajasthan
S. Selvaraj	Asst. Seed Officer	(Ag. Seed Tech.--M.S.)	Coimbatore, Tamil Nadu
S. K. Sharma	Assistant Scientist	(Agronomy--M.S.)	Naumi Solan, Himachal Pradesh
Dr. R. C. Singh	Scientist	(Agronomy--Ph.D.)	Jhansi, Uttar Pradesh
Dr. R. R. Singh	Associate Professor	(Horticulture--Ph.D.)	Hisar, Haryana
S. Srinivasan	Department Director/Agriculture	(Agriculture--B.S.)	Kudumiamalai, Tamil Nadu
K. K. Suresh	Assistant Professor	(Agronomy--M.S.)	Metupalayam, Tamil Nadu

List of Indian Scientists who trained at Mississippi State University in Tree Seed Technology and Nursery Management and Forest Genetics and Tree Improvement.

Name	Program	Location
Dr. M. S. Hooda	Tree Seed Technology (12 Months)	Haryana Ag. University Hisar, Haryana
Dr. J. C. Rajput	Genetics (12 Months)	Konkan Krishi Vidyapeeth Dapoli, Maharashtra
Dr. D. P. Singh Nandal	Tree Seed Technology (12 Months)	Haryana Ag. University Hisar, Haryana
Dr. R. V. Singh	Tree Seed Technology (12 Months)	G. B. Pant University Ag. & Tech Hill Campus Ronichawi, U.P.
Dr. K. Vanangamudi	Tree Seed Technology (12 Months)	Tamil Nadu A. U. Ag. Research Station, Tamil Nadu
Dr. J. S. Zope	Tree Seed Technology (12 Months)	Punjabrao Krishi Vidyapeeth Akola, India
Dr. U. S. Sharma	Tree Seed Technology (12 Months)	J. N. K. U. V., Jabalpur 482004, M. P.
Dr. K. Sudhakara	Tree Seed Technology (12 Months)	College of Forestry Trichur, Kerola
Dr. O. P. Toky	Tree Seed Technology (5 Months)	Haryana Ag. University Hisar, Haryana
Dr. C. V. Sarswat	Tree Seed Technology (4 Months)	Dr. Y. S. Parmar Univ. of Hort. & For., Nauni, Solan, H. P.
Dr. S. S. Bisla	Genetics (12 Months)	Haryana A. U. Hisar, Harayana
Dr. S. T. Khajjadoni	Genetics (12 Months)	Univ. of Ag. Sci. Krishi Nagar Dharwad Karnataka

Proposed US Scientists to be Associated with the Project. (All have served as mentors to visiting Indian Scientists at MSU.)

1.	Dr. W. W. Elam, Professor	Dept. of Forestry, MSU
2.	Dr. F. T. Bonner, Adj. Professor	USDA Forest Service
3.	Dr. S. B. Land, Professor	Dept. of Forestry, MSU
4.	Dr. J. A. Vozzo, Adj. Professor	USDA Forest Service
5.	Dr. J. D. Hodges, Professor	Dept. of Forestry, MSU
6.	Dr. T. E. Nebeker, Professor	Dept. of Entomology, MSU
7.	Dr. G. H. Weaver, Associate Professor	Dept. of Forestry, MSU

APPENDIX D

EXAMPLES OF COMPUTER AIDED INFORMATION RETRIEVAL SYSTEM DATA (CAIRS)

CAIRS
Computer Aided Information Retrieval Search

Examples of information compiled by CAIRS at the Mississippi State University Library. The search assessed only 2 data bases, AGRICOLA and CABS, other data bases are available.

The program requested information on seed of the two species, Dalbergia sissoo (shisham) and Tectona grandis (teak). The first list of references contained 15 citations on shisham and 62 citations on teak. After reviewing the titles to determine applicability, abstracts were requested for 7 references to Dalbergia sissoo and 35 references to Tectona grandis. A copy of the requested information was printed and put on a diskette for a Personal Computer. The cost for this service has averaged about one (1) dollar per abstract obtained.

6/6/39 (Item 13 from file: 50)
0848946 UF050-04267
Influence of host plants on growth of sandal.

6/6/40 (Item 14 from file: 50)
0841961 UC059-05946; 7C015-01159; UF051-01800
Proactive strategies to mediate tree-root damage to sidewalks.

6/6/41 (Item 15 from file: 50)
0840059 1F012-01209; 7Y003-00213
Fuel characteristics of selected four-year-old trees in Nigeria.

6/6/42 (Item 16 from file: 50)
0786434 UF050-00963; 7G012-01173
Studies on growth and development of some forest tree species in red mud soil Balco Korba.

6/6/43 (Item 17 from file: 50)
0781000 UF050-00799; 7G012-00855
Triplet seedlings in shisham (Dalbergia sissoo Roxb.).

6/6/44 (Item 18 from file: 50)
0780992 UF050-00888; 7G012-00958
Teak plus trees for specific traits.

6/6/45 (Item 19 from file: 50)
0774936 UF050-00069; 7G012-00831; 7Y002-00154
Effect of size of containers and different soil media, on the germination behaviour and growth of Acacia nilotica, Albizia procera and Dalbergia sissoo.

6/6/46 (Item 20 from file: 50)
0760981 UF049-08416; 7G011-03596; UU042-00463; 61006-00354; 7Y002-00191; 7X010-00139
Presence of germination inhibitors in the leaf leachates of some farm grown trees.

6/6/47 (Item 21 from file: 50)
0760977 UF049-07793; 7G012-00430; 7Y002-00140; 7S015-01397
Performance of some firewood species in nursery of alkali wastelands.

6/6/48 (Item 22 from file: 50)
0690081 UF049-03559; 7Y001-00573; UU051-12723
Effect of application of biofertilizers on the growth and nodulation of seven forest legumes.

6/6/49 (Item 23 from file: 50)
0651841 UF049-00367; 7G011-00491
Peculiar trees of teak at Nilambur, Kerala.

6/6/50 (Item 24 from file: 50)
0647090 UF049-00096; 7G011-00440
Preliminary study on germination of pretreated seed of teak (Tectona grandis) under nursery conditions in Zomba, Malawi.

SELECTED ABSTRACTS FOR DALBERGIA SISSO AND TECTONA GRANDIS

6/7/2 (Item 2 from file: 10)
89001397 89022393 Holding Library: AGL
Storage of sissoo (Dalbergia sissoo) seed
Robbins, A.M.J.;
Banko janakari : a journal of forestry information for Nepal. Autumn 1988. v. 2 (1) p. 57-59.
Kathmandu : Forestry Res. and Info. Centre, Forest Survey and Res. Off., Dept. of Forest.
DNAL CALL NO: SD356.54.N42B3
Language: English
Includes references.
Subfile: OTHER FOREIGN;
Document Type: Article

6/7/4 (Item 4 from file: 10)
88121495 89003478 Holding Library: AGL
Effect of size of containers and different soil media, on the germination behaviour and growth of seedlings of Acacia nilotica, Albizia procera and Dalbergia sissoo
Maithani, G.P.; Bahuguna, V.K.; Singh, H.P.
Indian journal of forestry. Mar 1988. v. 11 (1) p. 56-59.
Dehra Dun : G.S. Gahlot. ISSN: 0250-524X CODEN: IJFOD
DNAL CALL NO: SD223.I53
Language: English
Subfile: OTHER FOREIGN;
Document Type: Article

6/7/5 (Item 5 from file: 10)
88121443 89003426 Holding Library: AGL
Seed abortion in wind-dispersed pods of Dalbergia sissoo: maternal regulation or sibling rivalry?
Ganeshaiah, K.N.; Shaanker, R.U.
Oecologia. 1988. v. 77 (1) p. 135-139.
Berlin, W. Ger. Springer International. ISSN: 0029-8549 CODEN: OECOBX
DNAL CALL NO: QL750.O3
Language: English
Includes references.
Subfile: OTHER FOREIGN;
Document Type: Article

6/7/12 (Item 12 from file: 10)
86010035 85037373 Holding Library: GUA; AGL
Effect of solar eclipse on germination of Dalbergia sissoo Roxb. and Toona ciliata Roem. seed
Kumar, A.; Phulera, R.P.; Sood, O.P.
The Indian forester. Dec 1984. v. 110 (12) p. 1184-1191.
Dehra Dun : N.K. Mathur. ISSN: 0019-4816 CODEN: IFORA8
DNAL CALL NO: 99.8 IN2
Language: English
Includes references.
Subfile: ENE (ENERGY IN AGRICULTURE:EXPANDED); OTHER FOREIGN;
Document Type: Article

6/7/44 (Item 18 from file: 50)
0780992 0F050-00888; 7G012-00958
Teak plus trees for specific traits.
Vakshasya, R. K.; Uniyal, D. P.; Rawat, M. S.
Indo-Danish Project on Seed Procurement & Tree Improvement Cent., For. Res. Inst. & Coll., Dehra Dun, UP, India
Indian Forester 1988. 114 (3): 168-169 (5 ref.)
Language: English
Document Type: NP (Numbered Part)
Status: REVISED
Subfile: OF (Forestry Abstracts); 7G (Seed Abstracts)
The authors state that until now the emphasis on teak plus tree selection has been for vigour, good form and crown characteristics. Three different types of selection are reported here. The first is a tree with wavy grain from a wet zone in Kerala. Wet zone teak has previously only been reported with straight and even grain. Trees with less straight grain have been reported as occurring sometimes in the dry zone; this has been attributed to stress conditions. This report suggests that the wavy grain tree may be a genetic variant. The 2 other clones mentioned (for which seed orchards have been established at the Forest Research Institute) are a highly frost resistant strain which also gives good germination, and a strain exhibiting better growth.

6/7/50 (Item 24 from file: 50)
0647090 0F049-00096; 7G011-00440
Preliminary study on germination of pretreated seed of teak (Tectona grandis) under nursery conditions in Zomba, Malawi.
Ngulube, M.
For. Res. Inst. Malawi, PO Box 270, Zomba, Malawi.
Forest Ecology and Management 1986. 17 (2-3): 147-151 (5 ref.)
Language: English
Document Type: NP (Numbered Part)
Status: REVISED
Subfile: OF (Forestry Abstracts); 7G (Seed Abstracts)
Germinated seeds were counted weekly for 20 wk after sowing in the nursery to assess the effect of 10 different pretreatments on germination. Germination ranged from 0% to 32.5%. The 96-h stream-soaked pretreated seed demonstrated superiority, followed by seed pre-treated by container soaking for 96 h, and alternate drying and wetting for 1 week. Scorching led to no germination at all, whereas stream soaking for 72, 48 and 24 h achieved only about 3% germination each.

6/7/64 (Item 38 from file: 50)
0426097 0F047-02341
A preliminary note on pollen in teak in relation to fruit-set.
Subramanian, K.; Seethalakshmi, T. S.
Ex Silviculturist, Pune, Maharashtra, India.
Indian Forester 1984. 110 (10): 1023-1029 (6 ref.)
Language: English Summary Language: Hindi
Document Type: NP (Numbered Part)
Status: NEW
Subfile: OF (Forestry Abstracts)
A study was made of pollen grains of teak from Chanda, Chikhalda,