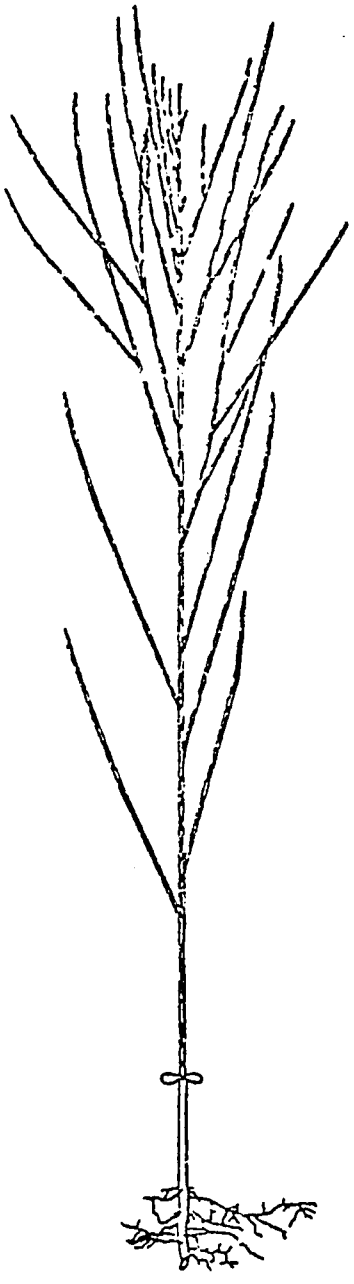

FINAL REPORT

TREE SEED

AND

OTHER PLANT MATERIALS ASPECTS
OF AID – SUPPORTED
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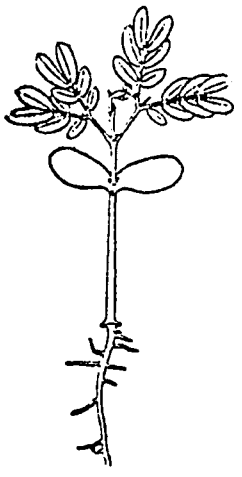

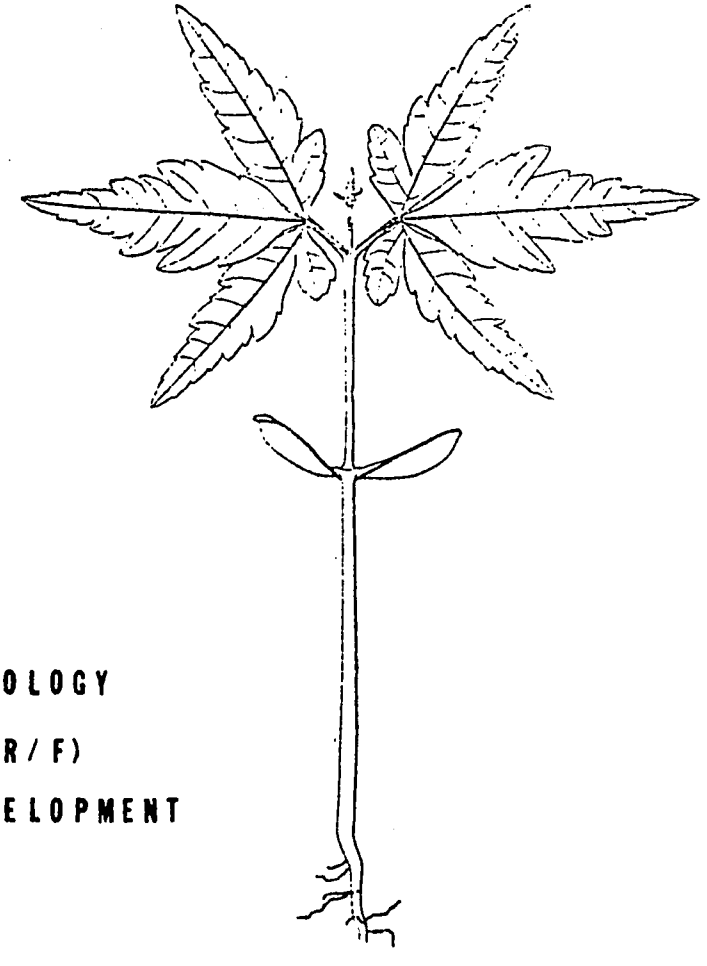

BUREAU FOR SCIENCE & TECHNOLOGY
FORESTRY DIVISION (S&T/FNR/F)
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C.

19 FEBRUARY 1982

FINAL REPORT

TREE SEED AND OTHER PLANT MATERIALS ASPECTS OF US A.I.D. - SUPPORTED REFORESTATION PROJECTS

US A.I.D. CONTRACT NO. DAN-1406-C-00-1091-00
BUREAU FOR SCIENCE AND TECHNOLOGY
OFFICE OF FORESTRY, ENVIRONMENT AND NATURAL RESOURCES
FORESTRY DIVISION (S&T/FNR/F)
AGENCY FOR INTERNATIONAL DEVELOPMENT (US A.I.D.)
WASHINGTON, D.C.

SUBMITTED BY

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FEBRUARY 1982

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TREE SEED AND PLANT MATERIALS ASPECTS OF US A.I.D. - SUPPORTED REFORESTATION PROJECTS

SUMMARY

In the late 1970's the US Agency for International Development (US A.I.D.) resumed a program for helping fund reforestation projects in a number of Lesser Developed Countries (LDC). In addition to the goal of restoring depleted or no longer existent forests on land easily accessible to the rural poor (villagers), so that they can become self-sufficient in meeting needs for fuelwood, forage, fruit, poles, small timber, medicine, and other familiar forest products, US A.I.D. reforestation projects are being designed with other long-term benefits in mind: (a) to restore agricultural productivity, (for both home consumption and as cash crops); by moderating the erosive effects of wind, rain, and sun on the soil; by enriching the soil through deposition of nutrient-containing litter and by nitrogen fixation (leguminous species plus Alnus and Casuarina species) (8) at the root level; by providing shade for humans, livestock, and many other forms of life; etc.; and (b) to improve water quality and raise water tables. The magnitude of US A.I.D.'s reforestation activities in the 1978-1986 period are discussed in Sections III.A. and III.C. and itemized in Annexes 1 and 2. (Projects completed before 1981, those not expected to be initiated until 1982 and those which will not be completed by 1986 have not been included.)

This report is concerned primarily with recognition of the importance of tree seed, or other reproductive plant materials such as cuttings, in meeting US A.I.D.'s reforestation objectives. As noted in one reference (13), the result of planting the best adapted provenance (geographic source) of Eucalyptus camaldulensis in some trials in the Mediterranean region gave a yield 8 times (800%) greater than when planting the least adapted source.

Over the last 30 years results of species and provenance trials in many countries have similarly, although not to the same magnitude, indicated the importance of using seed which is inherently capable of producing maximum yields in each environment. For US A.I.D. projects it is believed essential that technical advisers qualified in matching environments of seed source and planting site: (1) be assigned to each forestry-related project at its conception; (2) be available for consultation during all reforestation planning and seed procurement, and (3) have responsibility for advising on documentation of results.

Planning of seed procurement should begin at least 1 year, preferably 2 years before seed will be sown in a nursery. In the past, planning for seed procurement has often been superficial until after final approval of reforestation projects. Sometimes planning occurs only a month or two before seed should be sown.

Calculations in Section III.B. reveal that cost of tree seed is usually less than 1% of total reforestation costs and much less than 1% of total project costs. Considering that plantation yields may be zero if ill-suited seed is used, there is no economic justification for failing to plan for and to procure the seed which should grow best on each site. Furthermore, if villagers are given seedlings which are inherently doomed to fail, the work of the sociologists, extensionists, and foresters can be quickly destroyed.

Reforestation is a relatively long-term activity with a minimum of 3 to 5 years from the first planning of seed procurement to the first significant harvest. It is believed highly desirable to have the type of continuity in planning, execution, and documentation that can be provided by a person or group of persons such as a university faculty, a research institution or the US A.I.D.-funded Forestry Support Program staff.

PROJECT BACKGROUND

I. Introduction

US A.I.D.-supported reforestation projects which became active in Fiscal Years (FY) 1978-1982 and which terminate by FY 1986 involve life of project (LOP) expenditures of some $485,000,000. It is highly desirable that these long-term projects produce maximum quantities of forest products, such as fuelwood, fodder, food, and construction materials, while favorably influencing microenvironments. Achieving these objectives will require a scientific approach to ensure that only the best adapted tree species are planted. The step between choosing species and planting, the procurement of tree seed with an inherent potential for desirable growth, is the main subject of this report.

Proposed to "examine and report on tree seed aspects of US A.I.D. projects", this report hopes to create an increased awareness in US A.I.D. - involved countries that plantation yields depend on the inherited ability of seed to thrive on selected sites. The wise selection of species and provenance, and the timely procurement of seed can mean the difference between complete failure and a highly successful plantation. Yet in the implementation documents (PP) for 55 projects, seed was specifically mentioned in only 3. In many projects, selection of species to plant is not made until after final approval of the PP.

II. US A.I.D.-supported reforestation projects defined[1]

If US A.I.D. is contributing funds to a project involving reforestation, that project's seed needs are included here. In most cases US A.I.D. funds are designated for institution building, training, technical expertise, etc., which will increase the host government's long-term capacity to reforest and to manage forest and related natural resources. These contributions are essential to reforestation during the project and to ensure that it continues after the project ends.

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[1] Hereafter referred to as "AID Projects".

Food for Work[2] Projects (FFW, PL-480), which are partially supported by a US A.I.D. grant or other direct funding are noted. Available reports indicate that FFW projects have reforested larger areas per dollar of funding than direct-funded projects. However, the reports do not reveal (1) the degree of care used in acquiring seed for the project (that is, were the species/provenances planted known to be the most productive for available sites, or did seed on hand result in use of other provenances?); (2) anticipated plantation maintenance for a year or two, as needed (weeding, possible watering and protection from livestock and premature harvest); (3) documentation of the projects success or problems, an important guide in planning future reforestation efforts; or (4) whether training had been given in seed, nursery, and reforestation planning and execution techniques.

A recommendation for more technical assistance and monitoring of FFW projects is made later.

Although the US contributes food commodities to FAO-administered World Food Program (WFP) reforestation projects, these projects have been omitted from Tables 1 and 2. Data on AID contributions to these projects was nebulous as this report was written (14).

III. Magnitude of US A.I.D. projects

A. Number of Countries; Projects; Funding; Area of Planting; Number of Trees;

As of 30 September 1981, 27 countries had 55 projects in an active or definitely scheduled status (See Appendices, Table 1). Some of the projects listed will be formally designed in 1982. Projects to be financed in part by PL-480 funds (FFW) are indicated in Table 1, the source of the following summary:

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[2] Food for Work (FFW) projects are funded under PL-480.

Region/ Countries	No. of Project	Aid Funding ($U00)		Planting Area (Ha)		No. of Trees 000's
		Total	Refor	77-81	82-86	
Africa 11	25[4]	102,517	6,489	3,807	18,218	37,252
Asia 6	13[3]	174,526	16,268	70,524	107,830	286,514
L. America 8	15[1]	110,258	15,244	26,967	85,288	157,928
Near East 2	2[2]	97,000	40,400	0	40,400	44,900
4/27	55	484,301	78,401	101,298	251,736	526,594
GRAND TOTAL:				353,034		

B. Cost of tree seed: a small fraction of project and reforestation costs.

Cost of tree seed (13,29,30) is often less than 1% of total reforestation costs (Eucalyptus species, Pinus caribaea var. hondurensis, P. radiata, etc.). It is usually much less than 1% total costs. (See calculations below, based on data from references and from a November 1981 cable from US AID/Panama.) However, when species with large seeds, such as teak, (Tectona grandis) (6,9) have to be imported, costs of purchased seed may be as much as 2 to 10% of reforestation costs, but less than 2% of total project costs. In countries where seed production areas have been established with desirable provenances of exotics, local seed collection costs are usually less than half of imported costs/Kg.

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[1] Projects financed mostly by FFW (PL-480): 1(5); 2(1); 3(2); 4(2).

The results of the following calculations are comparable with those obtained by the writer in the 1960-1981 period in the USA, Malaysia, and Turkey.

EXAMPLE (Panama Data, 1981) (Project No. 525-0191)

1.	Total Life of Project (LOP) Cost:		$16,800,000	(AID and Host Govt.)	
2.	Total LOP Reforestation Costs:		$ 7,450,000	(AID and Host Govt.)	
3.	Total LOP Plantation Area:		Ha 10,650		
4.	Reforestation Cost/Ha		$ 700		
		Pinus caribaea		Tectona grandis	
5.	Seed Cost/Kg (Purchased)	$ 150	(a) Purchased	$ 110	
			(b) Local Coll.	$ 52	
6.	Plantable Trees/Kg	27,500		1,000	
7.	Trees to Plant/Ha	1,111		250	
8.	Plantable Ha/Kg (6/7)	25		4	
9.	Seed Cost/Ha (5/8)	$ 6	(a) Purch 5a/8	$ 28	
			(b) Coll 5b/8	$ 13	
10.	Seed Cost/Refor Cost (9/4)	% 0.9	(a) 9a/4	% 3.9	
			(b) 9b/4	% 1.8	
11.	Seed Cost/Total LOP (9/1/3)	% 0.4	(a) 9a/ (1/3)	% 1.7	
			(b) 9b/ (1/3)	% 0.8	

From the above it can be seen that for a large scale project the cost of tree seed is only a small fraction of total reforestation and project costs. Yet a reforestation project is doomed to failure unless seed is acquired which has a high potential for producing the desired products on a given site. There is no economic excuse for not procuring seed with potential for optimum performance.

The C.S.I.R.O. in Australia reports that it now sells seed at a price of $5 per seed lot plus $3, $4, or $5 per 10 grams, depending on the species (13). This would be $300 to $500/Kg. In the same publication "Cubaexport" in Havana advises that it is selling 4 Pinus species at $136-138/Kg, FOB Havana, and two Eucalyptus species at $233 and $308/Kg, respectively. Even at these prices, the cost/Ha for seed remains less than 1% of reforestation costs.

C. Quantity of seed needed during LOP

An abbreviated summary of Table 1, Annex 1, is given below for genera which will be planted during the life of US A.I.D. projects. The data used were the best available (15,23,24,26,30,31,32,33). However, there were several unknowns requiring assumptions and approximations. For example, if the only given fact is that 1000 hectares of "Eucalyptus species" are to be planted, several assumptions are possible which will significantly affect the volume of seed needed. That is, whether spacing will be (1) 2m X 2m or (2) 4m X 4m (2,500 versus 625 trees/Ha)? Which Eucalyptus species will be planted? (3) Eucalyptus globulus produces about 70,000 trees/Kg of seed and (4) E. camaldulensis about 700,000 (6,9). A combination of (1) and (3) would require 40 times as much seed as (2) and (4).

LOP Estimates of Seed Required

Genera	No. of Species	No. of Seedlings	No. of Kgs	Kgs To Be Imported
Eucalyptus	(6)	180,317,000	1,387	146
Pinus	(4)	114,130,000	7,083	550
Casuarina	(1)	26,800,000	38	10
Gmelina	(1)	26,700,000	22,250	200
Azadirachta	(1)	23,719,000	7,906	500
Acacia	(5)	20,064,000	755	125
Leucaena	(1)	28,965,000	2,797	400
Albizia	(2)	22,135,000	1,643	15
Sesbania	(1)	11,700,000	1,170	200
Anacardium	(1)	9,080,000	60,535	500
Prosopis	(1)	5,327,000	213	100
Tectona	(1)	1,550,000	1,000	250
Coffea	(1)	800,000	400	200
Guilielma	(1)	600,000	300	0
Other [1]	(63)	39,550,000	2,155	83
Totals 90 Species		526,594,000	109,742	3,279

1 Includes fruit trees.

The above table indicates that about 97% of the total seed needs will come from local plantations of indigenous or exotic species or from indigenous stands. The table assumes that all areas will be planted. Direct seeding will require 2 to 20 times more seed (19,27).

IV. Factors determining availability of seed or clonal materials

A. Law of Supply and Demand

Availability of tree seed is subject to the law of supply and demand just as everyday items like lumber and paint. For example, as the demand for Eucalyptus and Pinus species has developed, so have sources of supply. With an insured demand, seed suppliers can justify costs of collection and long-term storage. An example of an increased demand for tree seed is given in a report on Pinus caribaea var. hondurensis (P. caribaea)(2). Bell states that the annual worldwide demand for P. caribaea was about 6300 Kg in 1971. At the late 70's rate of increase, he expected a demand of about 11,000 Kg/yr. by the mid-80's.

Fiji's P. caribaea plantation program illustrates yet another phase of demand and supply. Fiji began planting P. caribaea in 1955 and by 1980 had established over 40,000 ha. Until 1970, when it had planted over 4,000 ha, it imported all of its seed. By 1977 Fiji's local seed production exceeded its needs, although its planting program was increased to about 6,000 ha/yr. In a 1979 paper (2), Bell stated: "Fiji is a major producer of P. caribaea seed and offers a substantial excess for sale".

On the commercial scene, by 1969 demand for P. caribaea seed had grown so that orders for 50 Kg could be filled from stock by at least three companies (in France, The Netherlands, and the USA) (27). In 1981, Australia indicated (13) that several seed suppliers operating in Australia are expected to be able to meet commercial requirements for seed. (C.S.I.R.O., Division of Forest Research, P.O. Box 4008, Canberra ACT 2600, Australia, can provide a list of suppliers).

Another example of a growing seed demand is documented in "Eucalypts For Planting", (12, P.585). Based on some 4 million hectares of worldwide plantations established and planned as of 1972, an increased demand of about 5%/yr. was predicted. In terms of seed, based on the following assumptions, the increase in seed demand to plant an additional 5,000 Ha/yr., could be 15-30 Kg. (Assumptions: 5,000 Ha, 1,000 trees/Ha, 200,000 to 400,000 seeds/Kg. Note: The increase in seed would vary with two major unknowns: Species: E. deglupta has about 4,000,000 viable seeds/Kg; E. globulus about 70,000; etc. Trees planted per Ha: this varies from about 625 (4m x 4m) to 2,500 (2m x 2m), occasionally to 10,000 (1m X 1m). Nursery efficiency is still a third variable).

As another example, in Senegal, by 1980 an adequate supply of Eucalyptus camaldulensis seed of the best provenance was available in local trial plots to plant about 700 Ha.

In the summary of seed needs for US A.I.D. reforestation projects, it is estimated that a total volume of some 109,742 Kg of seed will be needed. It is believed that as much as 97% of this seed will be produced locally in various types of plantings or collected from indigenous species (III.C; Table 3).

B. Long-range planning is essential if seed procurement is to be successful. For most tree species, seed from external sources should be ordered at least a year in advance. Missions should seek the advice of professional foresters or other sources who have up-to-date information on potential suppliers of tree seed (28).

One facet of long-range planning involves the establishment of seed production areas to permit local harvest of suitable provenances of exotic species. This would be a worthwhile AID activity. (See IV.D.4.)

Another reason for long-range planning is that some species do not bear collectible crops of seed each year. When dealing with this problem, one option is to buy enough seed in a good year to last until the next crop. Where this is necessary, seed storage facilities will be needed.

Still another factor is that seeds of some species, such as neem (1) and some of the tropical Dipterocarps, (27) can be safely "stored" only a few days. If seed maturity does not coincide with the planting season, a solution is to "store" seedlings in tubes or nursery beds until ready to plant. In any event, the planning of collection and subsequent handling of the seed must be done well in advance.

C. Clonal materials, a special case

Before planning to use clonal materials to produce improved seed or to plant large areas, AID missions should seek professional advice (25,28). Use of clonal materials introduces a high risk factor (15). If a large plantation is established with cuttings from a small number of parent trees, an insect or disease attack could quickly become epidemic and destroy most of the plantation.

Use of clonal materials (grafted scions, rooted cuttings or cloning by tissue culture) to establish small seed production or seed orchard areas is desirable, however, assuming that many clones will be involved. If tissue culture becomes developed for fast growing species, this would be acceptable if the same precautions are observed as for grafting.

Suppliers of clonal material will need special orders before committing their resources. Contacts will have to be developed many months ahead.

D. Seed supplies

1. Outside sources. With proper planning tree seed is usually available from two major types of organizations:

a. Commercial suppliers. In a number of countries, including Australia, Canada, Costa Rica, Cuba, France, The Netherlands, and the USA, for example, there are companies who deal wholly or in part in tree and shrub seeds. Most of these are listed in one of the following references (11,18,20,21,22).

If large quantities or special collections are desired, arrangements can usually be made, given sufficient notice, with one of these companies. However, in writing about expected commercial seed demands for the next decade Gallegos (5) expresses serious concerns about the possibility of importing the large quantities his company will require. The writer experienced similar import problems while in Malaysia in 1968-72 (one 40 Kg shipment was never received and two 50 Kg shipments had lost all viability upon receipt).

In view of US A.I.D.'s involvement in large-scale FFW projects, the agency should be expressing an interest in the quality, both viability and inherent potential for growth, of the large quantities of seed used. Whether local or imported seed, quality should be monitored just as the quality of cement is monitored on construction contracts. The returns can be even more rewarding because of the many benefits of successfully establishing forest plantations.

b. Government and quasi government institutions, including major universities, and international agencies.

For small, research type projects seed may sometimes be obtained at cost or on an exchange basis from units classed variously as forest research institutes, institutes of forest

genetics, tree seed institutes, forest institutes, forestry departments, etc. A review of the "Research Contacts" appendix, pages 205-214 of the National Academy of Sciences "Firewood Crops", 1980 (18), will reveal a number of the organizations in this broad category as will the 1976 IUFRO World Directory of Tree Seed Workers (21). (Copies of the former are available from N.A.S., 2101 Constitution Avenue, NW, Washington, DC 20418 USA.)

From some institutes, such as C.S.I.R.O., Division of Forest Research, P. O. Box 4008, Canberra ACT 2600, Australia, free or exchange seed, in small amounts for research, will continue to be offered to developing countries as a contribution to international aid (13).

c. Although the AID/W Funded Forestry Support Program, (USDA/Forest Service, P. O. Box 2417, Washington, DC 20013), might provide limited assistance on an interim basis, the Agency should examine more satisfactory long-term alternatives for meeting this mission service requirement.

2. Local seed production. Developing self-sufficiency from local seed production or seed orchard areas is highly desirable in most countries. This can be done in at least three ways. Each will serve to reduce costs of seed, to give local governments control over seed supplies and to ensure that each plantation is established with trees with a great potential for growth on that site.

a. Locate and develop existing research trials or plantings of any kind. If these plantings are on sites representative of areas to be planted, they can be developed as seed production areas.

b. Establish new trials or demonstration plots on representative sites. These can later be used for seed production if the poor-performing individuals are removed. If sites are not representative of planting areas, results may be marginally effective.

It is important to use statistically-analyzable planting designs when establishing species and provenance trials. Without scientifically designed trials, a difference of 10 to 15% between the genetic potentials of two species/provenances could be masked by microsite differences, yet a 10% better growth rate is more than enough to pay for a tree improvement program. At the same time, trials should be designed so that significant differences have a visual impact on visitors as well as on statistical outcome. Unless there is local expertise available, appropriate technical assistance should be requested (28) before ordering seed and selecting trial sites and in designing trials.

For example, Christel Palmberg (13) cites a report indicating that Eucalyptus camaldulensis provenance tests in 21 countries have shown differences of up to 800% in volume growth between provenances. The report (by Lacaze, 1978) notes clear indications that the Lake Albacutya provenance from Victoria (state) in Australia gives optimum results in winter-rainfall areas. In summer rainfall areas, Katherine and Petford provenances from the Northern Territory and Queensland are best.

c. Use clonal material from the best trees on representative sites to establish seed orchards and seed production areas. This is the most rewarding but also the most time consuming. It is essential that seed production areas be developed on representative sites which have approximately the same climatic and soil conditions as the plantation sites. The greatest gains in increased production should come from this approach.

d. Fiji is a country which has reached self-sufficiency for Pinus caribaea var. hondurensis, and at the same time has learned which of 22 provenances will locally produce the greatest volume concurrently with desired stem and branching characteristics (2,3). These two papers are recommended reading and can be obtained from the address given in the bibliography.

E. Three categories of institutions which export seed.

1. Commercial suppliers. Seed companies are the major sources of supply for large quantities. Some concerns concentrate on collection from certain regions, such as Mexico and Central America. At least one company will make special collections in Honduras/Guatemala if the quantity is large enough. The same company usually maintains some inventory of the Central American species and provenances most in demand. Other companies merely act as brokers in selling seed. Such companies usually have research quantities of seed from a limited number of provenances.

Since most of the LDC have not recognized the value of a tree seed certification program for their own protection, it will probably be a number of years before seed origin from such countries is verified or certified for export.

A number of commercial suppliers operate in Europe, United States, Latin America, and Africa. Some of them are listed in these references (11,18,20,21,22).

2. Government or quasi-government institutions or privately funded institutions (Ford Foundation, etc.). Three examples are given.

a. CSIRO (Australia's quasi-government Commonwealth Scientific and Industrial Research Organization) (13) has developed a seed supply service over the years in response to a demand for

seed to reforest over 4,000,000 hectares outside of Australia with Eucalyptus species. CSIRO will send a list of commercial seed suppliers which has been developed in response to the same demand. CSIRO will also give seed, in small research quantities to LDC and will sell seed at Australian dollars 300 to 500/Kg to countries which can pay. The CSIRO label is a form of certification.

b. In the USA the U.S. Forest Service Tree Seed Laboratory at Macon, Georgia, serves the same function as the CSIRO. The Macon center provides research quantities of species native to the U.S. (based on number of seedlings wanted) to LDC at cost. Under certain conditions it can make special collections if it has enough advance notice.

c. The Danish Forest Tree Seed Center at Humlebaek maintains a small inventory of tropical and sub-tropical species which are in demand for research trials. A small charge is made to cover seed cost and handling.

d. Many government forestry departments in developed countries, MDC and LDC alike, will sell or exchange seed whenever the request can be met.

3. Intermediaries.

The UN/FAO (Food and Agriculture Organization of the United Nations) in Rome can sometimes be of assistance as an intermediary in obtaining seed for research purposes. This is a special service of the Forestry Division to LDC to help them establish species and provenance trials. FAO does not maintain an inventory or make purchases of seed, but upon request will do all possible as an intermediary to help an LDC obtain seed.

The International Union of Forest Research Organizations (IUFRO) has published a world directory of forest tree seed workers to assist LDC and others in locating sources of seed of the species and provenances needed for research trials (21).

Factors influencing success of US A.I.D. projects.

A. General.

Plantation success is achieved as a result of interconnected steps. This report deals only with tree seed and reproductive plant materials aspects. However, it is recognized that there are many other links in the chain such as social/cultural, nursery, and site preparation through protection of planted trees. Each is important and will be discussed very briefly below. Unless seed with a genetically suitable potential for the site is used, however, the other factors have little or no utility. If villagers are given seedlings which are inherently doomed to fail, the work of the sociologists, extensionists, and foresters can be destroyed quickly.

B. Social/Cultural.

Most villagers have yet to realize that they must start growing their own tree crops (fuelwood, fodder, food, fruit, etc.) if they and their children are to continue to occupy the same land while living above a bare-existence level. They must become committed to planting, tending (weeding, perhaps watering the first year), and protecting the trees from browsing and from premature harvesting. (Where they have been assured harvesting rights in India, commitment had been obtained ... plantations were doing well after two growing seasons.

C. Matching environments of seed origins and planting sites.

Genetic research with tree and shrub species has revealed that each species does best under a specific set of environmental conditions. A professional approach to reforestation dictates that US A.I.D. foresters recognize the special adaptations of potential species and match these requirements with the specific soil and climate characteristics of the available plantation areas. For example, one of the present miracle trees, Leucaena leucocephala, can grow in a comparatively wide range of conditions, but to display its heralded productivity it requires a basic pH of 7.0 to 7.5, a well-drained, fertile soil, well distributed annual rainfall of 1000-1250 mm, an elevation between 0 to 500 meters, etc. (16,17,18,29).

Matching environments is a major step in successful introduction of an exotic species or in moving an indigenous species to a site where it was not found previously. While it is not possible to match all of the measurable factors, (rainfall amounts and pattern of distribution, temperatures, water table depth, biological competitors, etc.), it is reasonable to try to match major climatic and soil conditions.

Foresters and other professionals (in soils, climate, etc.) versed in the art of matching environmental factors can play major roles on US A.I.D. project identification, design, and implementation teams. They can participate in the examination of existing and proposed plantation sites and make valuable recommendations for selection of the sites most suitable to the fast growing species which they recommend.

AID/W has shown its recognition of the need for this type forestry expertise by funding a Forestry Support Program (FSP) within the USDA/Forest Service/W. Staff members of FSP include a genetics/tree improvement specialist and six others with reforestation experience and/or an appreciation of the value of matching seed source and planting site requirements. The seven specialists, four in Washington and three in regional offices, are available to the missions upon request. In addition, FSP maintains a roster of potential consultants in all phases of forestry who are available to assist the missions (4,28).

D. Establishing species/provenance trials or demonstration plots is necessary to ensure that the best adapted provenances of each species are being used (See IV.D.2.b.). When new trials are established, it would be wise to include the most promising indigenous species as controls. Under plantation conditions, a fully-adapted local species may prove to be more productive than any imported species.

Once trials or plots are producing seed, they will become valuable collection areas if they have been planted on representative sites.

E. Protection of plantations.

With the potential for plantation damage by fire, by goats and other livestock, and by premature harvest, this factor is believed worthy of comment in addition to that in Section V.B. In India, non-damaged plantations were observed two growing seasons after planting.

The key is commitment by villagers. The basis for this commitment has been to have the villagers plant the trees and in turn, to give them harvest rights to the trees they plant and protect. Without this type protection, even the best seed is of no value.

F. Nursery operation to convert seeds to plantable trees.

Observation of nursery operations in two African and two Asian countries indicates that this is usually not a problem. Most villagers are farmers who are adept at growing things. However, when asking villagers to grow species with which they are not familiar, advice should be given on pregermination treatments, if needed, depth of sowing seed, control of fungi, etc. This operation has been the subject of how-to books and papers (6,9,10). Although a vital link in a reforestation program, it is not believed pertinent to go into detail in this report.

G. Seed collection and processing, planting.

Most US A.I.D.-involved countries have been collecting and processing seeds from plantations and natural stands for a number of years. However, if a mission knows that new species are to be used, it should ascertain if local expertise is adequate. If not, the mission should seek appropriate technical assistance.

VI. Problems with tree seed procurement

A. Background

From US A.I.D.'s standpoint, there are two principal problems involving tree seed procurement. The first is a lack of recognition of the important role which seed plays in any reforestation scheme.

The second involves the provision of required technical advice and assistance in procuring seed from external sources and in collecting the seed with the greatest potential if local collections are planned.

Even among foresters the relationship between the species and provenance of seed used and the success of a plantation is often overlooked. A plantation failure, for example, is likely to be judged the result of a single climatic or soils factor when the real cause was that those responsible for seed procurement did not recognize that the available site could not supply the environmental requirements of the species or provenance chosen for planting.

Adequate recognition of the importance of procuring seed with a high potential on a specific site cannot become a reality until appropriate technical expertise is available from the early stages of design of each project. The second problem for US A.I.D. is to provide this required technical advice and assistance. Success is believed dependent upon a program ensuring continuity over a number of years, finding individuals with a background in forest genetics principles and reforestation practices and who are available when requested to advise missions on factors such as choice of species or provenances, whom to contact to procure seed from overseas, and the principles to consider when collecting seed domestically.

B. Problems procuring quantities of seed

1. Local

a. Annual quantities of locally grown seeds are often reduced by poor crop years due to inadequate flowering, insect damage, etc., and by competition for labor when seed collecting conflicts with labor intensive crop growing and harvesting seasons. The scattered location of seed producing stands and lack of rural transport are other potential collection problems.

These problems can be minimized by storing seeds of those species which can retain viability for a year or more. However, if planting is to be done with species such as neem (Azadirachta indica) which produces seeds which can be stored safely for only a few days, a poor seed crop means a year's delay or until the next crop (6,13).

b. In countries which have not had a strong genetic research program to complement a dynamic forestry department, thought is seldom given to the advantages of collecting seed only from trees which have exhibited their inheritance of superior growth characteristics. Although the benefits of breeding cattle or fruit trees for specific traits are recognized, the potential is still not widely appreciated for many tree species.

c. Another seldom recognized problem concerns the use of seed with a narrow genetic base (that is, using seed from only a few trees, which may have had common parents, to reforest large areas). This can occur with local (indigenous) species if large quantities of seed are collected from a small area. It can occur with exotics which may have been introduced many years ago with a handful of seed, possibly all from the same tree. Unless it can be determined that host government personnel are taking precautions to maintain a broad genetic base when making local collections, the project budget should include funds for both overseas and local training programs to eliminate this problem.

2. Overseas procurement problems

a. (i) It is often difficult for host government forestry departments to obtain even a few hundred dollars of foreign exchange (US $) to buy tree seed versus items which are more important politically. US A.I.D. project seed should be included as a specific item in AID contributions. (ii) Not

knowing whom to contact is another problem for some countries desiring seed. US A.I.D. missions can help by supplying references (11,18,20,21,22) or by arranging contacts with professional foresters or other sources who are known to have up-to-date information on potential suppliers of tree seed.

b. Less well known problems include: (i) The importance of long-range seed acquisition planning. Due to unpredictable demands, commercial seed suppliers are hesitant to hold large quantities of seed in inventory. If advance planning, specific with regard to species, provenance and quantities of viable seed, is not done at least a year ahead, the desired seed may not be available when needed. Even a year's notice is not enough for some species which do not bear collectible crops every year. For non-storable species such as neem, advance arrangements are also needed so that collection teams can be put into the field as soon as seeds start to mature. (ii) A need for continued provenance testing for species which naturally occupy obviously different environmental niches. US A.I.D. projects can make maximum contributions to villagers by helping discover the species/provenances which will yield the greatest quantities of the products they want and need most.

I. Assumptions

As a basis for making the following recommendations some assumptions had to be made:

A. In addition to achieving long-range political objectives, US A.I.D. is sincere in helping fund projects to produce maximum quantities of fuelwood, fodder, food (fruit, etc.), and other forest by-products which will be available for the intended beneficiaries, the rural poor (villagers).

B. As a means of accomplising A above, US A.I.D is willing to arrange for the technical expertise and funding needed to ensure the first major step in any reforestation program: Getting adequate quantities of tree seed which is inherently adapted to grow well on the sites made available in various AID-assisted countries.

II. Recommendations

A. Each project should be designed primarily to meet the needs of the principal beneficiaries, the villagers. The choice of species, location, and size of plantations, etc., should be made after consultation with those who will harvest the products of the social (agro) forest type plantings. The total commitment of the villagers to the project is and will be essential to its success. (Note: In India, on the site of the Madhya Pradesh Project, evidence of such commitment can be observed.)

B. Technical and administrative input into forestry components of US A.I.D. projects.

It is recommended that AID/W and Mission Directors insist on more technical and administrative input into reforestation portions of US A.I.D. projects. Some current projects involving several million dollars contribution to the forestry component, have not had adequate advice from foresters with a reforestation background. This is especially true of projects funded with FFW contributions.

FFW projects are generally reported to be planting large areas with little or no technical assistance nor documentation. Reforestation should be done to a high standard. Increased care is needed in selection of species/provenances, in planting and subsequent maintenance (weeding, protection). On some projects consideration should be given to reducing the number of hectares to be planted with the extra funds or food used concurrently and subsequently to ensure successful plantations.

C. Better long-range planning of reforestation in general and seed requirements in particular is strongly recommended. More technical and administrative monitoring of seed procurement is needed to ensure maximum production of fuelwood, forage, etc. The gap between productivity of the land available for forestry and the demand for forest products widens daily as the land is degraded and the number of people and livestock increases. Only by using the same genetic principles as have been used for corn, wheat, etc., can forestry maintain its present level of production with the reduced area of less fertile land. Since seed costs will involve less than 1% of total project costs, it is believed indefensible to allow poor planning and staffing to prevent getting the best available seed for each US A.I.D. project.

D. Establishment of a procedure to make pre-project funds available, specifically designated for overseas seed procurement and local seed collection, is recommended, especially on projects requiring long lead times because:

1. It will permit the purchase of seed well-adapted to planting sites in adequate time for nursery sowing. Although there is a calculated risk in acquiring seed before the project implementation paper (PP) is approved, the risk is small, the advantages great. The alternative is to risk total failure of the plantation due to getting ill-adapted seed, or to delay the project by a year.

2. LDC forestry departments often have difficulty getting approval to spend limited foreign exchange reserves for overseas seed procurement. Use of US A.I.D. funds for local collection would also ensure having seed when required. Funding both activities would give US A.I.D. a better opportunity to monitor this critical phase of the projects.

Even though only about 3% of the seed needs shown in Table 2 will be imported, it should be remembered that this seed is expected to be the basis for the trial plantings which will furnish information on which to base reforestation of many thousands of hectares. Selection of the species and provenances should be based on the advice of appropriately trained forestry professionals.

E. Meeting professional advisory support requirements.

It is recommended as an interim solution, that a staff member of the (International) Forestry Support Program/USDA/US A.I.D., Washington, D.C., be assigned the responsibility for reviewing reforestation plans at the PID stage, approving or recommending the choice of species/provenances to be planted, and for coordinating procurement of all seed which will be imported for a project. It is further recommended that the agency examine alternative means of providing needed professional advisory support on a stable and adequate long-term basis. That support would include provision for maintaining a current list of institutions of all kinds which would be able to supply seed of the species which have promise for use in AID-involved

countries. Following PID reviews, advice should be provided to AID-mission personnel, who would make arrangements for seed acquisition. Technical support should also be made available to advise host governments and US A.I.D. design and implementation teams on matters of seed procurement and use. In working with host governments, technical advisors would maintain close contact with forest research unit.

F. Technical recommendations

1. Seed procurement sources

Acquisition of seed on an international scale involves contacts with numerous organizations: commercial seed suppliers; administrative and research branches of governments and universities; international organizations such as UN/FAO that serve as intermediaries, voluntary groups such as Rockefeller Foundation and a Baptist mission in Haiti as well as herbaria and individuals who have been involved in international seed trade. Lists of contacts are given in these references (11,18,20,21,22).

It is recommended that:

a. Missions that do not have seed procurement expertise seek appropriate professional assistance before purchasing seed.

b. Any arrangements made by US A.I.D. for providing advisory service support should include the preparation of an up-to-date list of international seed suppliers.

2. Development or procurement of plant materials, other than seed, for reforestation.

Rooted cuttings or clonal seedlings from tissue culture or other means may have merit for use on some projects. If it is feasible to expect the host government to use available techniques after the project is terminated, it is recommended that experimental

plots be established by one or both techniques during the project's life. If such clonal techniques are to be used, caution is needed in preserving a broad gene base, i.e., clones of many (not a few) parent trees should be represented in any trial or plantation to prevent inbreeding and possible catastrophic losses from insects, disease or other unforeseen factors such as hurricane-force winds, and unusual drouth period.

Both techniques may be useful for small scale establishment of seed orchards or seed production areas even though not economical or otherwise practical on a large scale.

3. It is highly recommended that seed production areas and seed orchards be developed to produce locally large quantities of species/provenances which are known to be very productive. In a few years these areas will repay their cost through more dependable, less expensive supplies of seed. For example, Panama reported in November that locally produced teak seed cost $52/Kg versus $110 for imported seed (30). There is less chance of damage to the seed, also, for it will not have to go through quarantine and it will not have to be transported long distances.

In some instances, however, local production may not be feasible. Malaysia's year-long growing season, with rainfall every month in an average year, was not conducive to production of collectible crops of Pinus caribaea var. hondurensis (27).

When establishing such areas, it is recommended that help in design and establishment techniques be requested from appropriately qualified professional sources.

4. It is recommended that host government personnel be given training in both local and overseas seed procurement. Visiting consultants should give training locally in evaluating plantation sites as a prelude to establishing species and provenance trials. If old plantations are available, they should be used for training purposes. Training should also be given overseas at genetics and seed institute facilities and in making field evaluations. Such training should be specified in project documents.

5. Either as part of identification activities for a reforestation project or as a separate activity, it is recommended that AID missions evaluate their host government's seed collection and storage facilities. If it is determined that inadequate structures and equipment are lowering the volume and quality of reforestation, it is then recommended that a small project or grant be proposed to supply needed facilities and equipment.

6. International control over tree seed labeling.

   It is believed impractical at this time to recommend that all imported tree seed used on US A.I.D. projects be certified as to geographic origin or other factors. For seed which comes from some of the lesser developed countries, it will be necessary to continue to trust the integrity of the commercial seed supplier. For small amounts of tree seed which come from a government agency or research unit, there is seldom need for certification of data on the label. For local seed, no certification is needed.

   Possible alternatives on US A.I.D. projects might include informal checking by a representative of US A.I.D. working in the country of collection.

   As a matter of history, it was not until the European OECD (Organization for Economic Common Development) decided to require certification of imported seed that most states in the USA adopted a formal tree seed certification program. From most US areas, certification today does not imply genetic quality except as to species and geographic origin of the collection. In developing countries, certification of seed origin is more or less unknown (7).

7. Interpretation of existing plantations in US A.I.D.-involved countries.

   It is recommended that an evaluation be made of existing plantations. Documentation of the results would serve as possible guidelines to planning of future reforestation efforts.

There is a serious lack of documentation, except those established by research units. For example, Leucaena leucocephala has been planted in Africa for about 100 years. Records are scarce. It is not known why Leucaena is found in "large" quantities in only two countries, Tanzania and Malawi (16). Perhaps there are available areas where the improved varieties would grow very well if planted properly and tended for the first 1 to 2 years. The same questions can be asked for other potentially valuable species.

8. A recommendation is made for continued provenance testing for species which naturally occupy obviously different environmental niches. US A.I.D. projects can make maximum, long-term favorable contributions to villagers (the rural poor) by helping discover the species/provenances which will yield the greatest quantities of the products the villagers want and need most (fuelwood, fodder, food (fruit, seeds, etc.), and other by-products).

III. Conclusions

The importance of using the best-adapted tree seed on US A.I.D. projects has often been overlooked, except in countries such as Senegal, which has an active forest genetics research unit working cooperatively with a dynamic forestry department. The oversight is not unique to US A.I.D. projects, nor is it easy to correct.

The underlying problem is that most people have a misconception about the ability of a forest tree species to grow under different sets of environmental conditions. This creates a belief that every tree of a species has an equal ability to grow on all sites within its natural range. The report by Lacase (13), however, stated that "Eucalyptus camaldulensis trials established in 21 countries have shown striking differences of up to 800% in growth in volume between the provenances."

Future US A.I.D. projects can avoid many of the oversights and misconceptions by:

A. Employing long-term forester/geneticist specialists to help plan, implement, and follow-up on projects, with especial concern for tree seed factors.

B. Informing high-level AID administrators of the need to insist on the procurement or collection of the best-adapted seed at least a year in advance. (This will prevent having to use seed which was available but not of the best-adapted provenance.)

C. Within countries where long-term reforestation programs are to be carried out, establishing local seed production areas, seed orchards, etc., so that a country can become self-sufficient in meeting its seed requirements.

D. Establishing new trials and demonstrations to test additional species and new provenances of species which have already shown promise. The best-adapted seed source may yet to be tested (8,15).

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LEGEND

UN/FAO	Food and Agriculture Organization of United Nations
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
NAS	National Academy of Sciences, U.S.A.
USDA/FS/FSP	U.S. Dept. of Agriculture, Forest Service, Forestry Support Program
USDA/OICD	U.S. Dept. of Agriculture, Office of International Cooperation and Development
US State AID/S&T/FNR	U.S. State Dept., Agency for International Development, Bureau for Science and Technology, Office of Forestry, Environment, and Natural Resources
ROCAP	Regional Office for Central America Programs (AID-Guatemala)
MDC	Moderately Developed Countries
LDC	Lesser Developed Countries
OPG	USAID funding grant
FFW	Food for Work (type of AID funding under PL 480, Title II)
WFP	World Food Program (FAO)
PVO	Private Voluntary Organization
CRS	Catholic Relief Service (a PVO)
PC	Peace Corps
REFOR	Reforestation
PID	Project Identification Document (AID)
PP	Project Paper (AID)
LOP	Life of Project (AID)
Ha	Hectare (= 2.47 acres)
Kg	Kilogram (= 2.2 pounds)
000's	Thousands
ISTA	International Seed Testing Association

TABLE 1

US A.I.D. - SUPPORTED REFORESTATION PROJECTS

COUNTRY/ PROJECT NO.	FUNDS ($000) TOTAL LOP	FUNDS ($000) REFOR.	AREA TO PLANT (Ha) 78-81	AREA TO PLANT (Ha) 81-86	NO. TREES LOP (000's)	TYPE PLANTING (SEE LEGEND, PAGE 1-4)
AFRICA						
Botswana 633-0077	3,780	207	6	80	86	Fuelwood, Poles
Cape Verde 655-0006	6,275	58	51	119	450	Erosion, Fuelwood
The Gambia 635-0205	1,575	671	297	1,053	13,500	Industry, Multi-Purpose
Guinea 698-0410.35	500	13	0	3,000	1,500	Erosion, Fuelwood
Kenya 615-0205	4,800	483	0	760	1,500	Fuelwood, Forage
Mali 625-0937	495	100	0	25	50	Woodlots, Research
Mauritania 682-0201	6,151	107	0	130	130	Woodlots
Mauritania 682-0205 (0220)	10,675	1,332	400	3,179	3,179	Woodlots
Niger 683-0230	3,800	281	0	400	583	Research
Niger 663-0240	13,582	434	0	434	656	Woodlots
Senegal 685-0219	3,100	2,100	800	2,360	2,000	Industry, Fuelwood
Senegal 685-0224	8,000	100	0	1,400	750	Woodlots

TABLE 1 (cont)

US A.I.D. - SUPPORTED REFORESTATION PROJECTS

COUNTRY/ PROJECT NO.	FUNDS ($000) TOTAL LOP	REFOR.	AREA TO PLANT (Ha) 78-81	81-86	NO. TREES LOP (000's)	TYPE PLANTING (SEE LEGEND, PAGE 1-4)
AFRICA (cont)						
Senegal 685-0243	126	40	100	80	1,000	Woodlots, Africare
Senegal 685-0247	211	48	5	355	3,600	Woodlots, Africare
Tanzania 621-0143	14,591	0	2,000	2,500	6,525	Woodlots
Tanzania 621-0160	500	53	0	60	60	Woodlots
Tanzania Ambass. S.H.	100	4	75	0	75	Ambassador Self-Help
Upper Volta 686-0221	9,457	0	0	10	10	Woodlots
U.V. 686-0231	5,000	50	63	87	90	Multiple-Purpose, Africare
U.V. 686-0235	5,958	0	0	500	250	Education, Research
U.V. 625-0937.08	56	0	0	12	12	Demonstrations, Agro-Forestry
U.V. 625-0939	50	0	0	12	12	Demonstrations, FFW
Upper Volta 686-0250	2,300	250	0	160	134	OPG, PVO, PC, FFW
Upper Volta 686-0254	1,025	158	0	1,490	1,100	OPG, Africare, PC, FFW
Upper Volta 686-0937	50	0	0	12	12	OPG, PC, FFW
Sub	102,517	6,489	3,807	18,218	37,252	

TABLE 1 (cont)

US A.I.D. - SUPPORTED REFORESTATION PROJECTS

COUNTRY/ PROJECT NO.	FUNDS ($000) TOTAL LOP	FUNDS ($000) REFOR.	AREA TO PLANT (Ha) 78-81	AREA TO PLANT (Ha) 81-86	NO. TREES LOP (000's)	TYPE PLANTING (SEE LEGEND, PAGE 1-4)
ASIA						
India 386-0475	25,000	11,419	0	63,430	158,000	Social Forestry
India OPG & FFW	---	---	4,550	0	2,840	OPG, CRS, FFW
Indonesia OPG & FFW	1,626	0	62,340	0	37,404	OPG, PVO, FFW
Indonesia 497-0245	12,500	0	80	80	200	Erosion, Multi-Purpose
Indonesia 497-0281	22,850	2,435	0	2,435	2,700	Erosion, Multi-Purpose
Indonesia 497-0276	24,000	110	0	200	120	Agro-Forestry
Nepal 367-0132	27,500	754	20	10,308	25,800	Woodlots
Nepal 367-0129	26,700	1,070	200	9,159	3,250	Multi-Purpose
Philippines 492-0289	5,000	40	120	390	700	Multi-Purpose
Sri Lanka 383-0055	4,350	0	3,182	19,818	54,350	Erosion, Multi-Purpose
Thailand 493-0294	10,000	127	0	120	300	Woodlots, Erosion
Thailand 493-0304	5,000	212	32	928	200	Erosion, Woodlots
Thailand 493-0308	10,000	101	0	1,052	650	Erosion, Woodlots
Sub	174,526	16,268	70,524	107,830	286,514	

TABLE 1 (cont)

US A.I.D. - SUPPORTED REFORESTATION PROJECTS

COUNTRY/ PROJECT NO.	FUNDS ($000) TOTAL LOP	FUNDS ($000) REFOR.	AREA TO PLANT (Ha) 78-81	AREA TO PLANT (Ha) 81-86	NO. TREES LOP (000's)	TYPE PLANTING (SEE LEGEND, PAGE 1-4)
LATIN AMERICA						
Bolivia PL480-Title III	1,518	1,518	1,450	5,630	15,678	Industry, PL480-III
Costa Rica 515-0146	9,800	850	0	2,700	3,000	Multi-Purpose, Research
Dominican Republic 517-0135	10,800	240	0	800	200	Erosion
Haiti 521-0122	8,000	2,100	0	2,800	3,000	Erosion, Woodlots
Honduras 522-0168	15,000	5,462	0	5,462	10,000	Woodlots
Jamaica 532-0065	7,500	0	0	40	100	Research, Fuelwood
Jamaica 532-0046	15,000	749	735	398	2,300	Erosion
Panama 525-0191	10,000	3,965	5,422	5,247	10,000	Erosion, Multi-Purpose
Peru 527-0155	11,000	196	328	1,072	1,500	Erosion, Industry
Peru 527-0183	200	17	137	0	337	OPG, CARE, Industry, FFW
Peru 527-0206	490	0	18,154	0	27,793	OPG, CRS, Industry, FFW
Peru 527-0196	500	0	648	560	1,500	OPG, FWD, FFW
Peru 527-0231	450	0	0	60,000	80,000	OPG, PVO, FFW
RDO/Caribbean 538-0030	12,500	147	0	194	2,100	Erosion
ROCAP (CATIE) 596-0089	1,500	0	93	385	420	Research
Sub	110,258	15,245	26,967	85,288	157,928	

TABLE 1 (Cont)

US A.I.D. - SUPPORTED REFORESTATION PROJECTS

COUNTRY/ PROJECT NO.	FUNDS ($000) TOTAL LOP	FUNDS ($000) REFOR.	AREA TO PLANT (Ha) 78-81	AREA TO PLANT (Ha) 81-86	NO. TREES LOP (000's)	TYPE PLANTING (SEE LEGEND, PAGE 1-4)
NEAR EAST						
Tunisia						
664-0312	22,000	440	0	400	500	Erosion
Morocco						
PL480-Title I	75,000	40,000	0	40,000	44,400	Erosion, Industry
Sub						
GRAND TOTAL | COUNTRIES: 27 PROJECTS: 55	484,301	78,401	101,298	251,736	526,594	Except for WFP (2 Projects)
				353,034 (LOP)		
PL480 TOTAL | COUNTRIES: 6 PROJECTS: 12	83,209	41,943	87,279	107,864	211,210	PL480 Projects
				195,143 (LOP)		
NET TOTAL | COUNTRIES: 21 PROJECTS: 43	401,092	36,458	14,019	143,872	315,384	Grand Total Minus PL480
				157,891 (LOP)		

TABLE 2

US A.I.D. LIFE OF PROJECT
SEED QUANTITIES NEEDED

(Estimates as of 1/82)

SPECIES	PLANTABLE SEEDLINGS/Kg	No. of SEEDLINGS	No. of Kgs	Kgs to be IMPORTED
Eucalyptus species	200,000	43,104,000	212	70
Eucalyptus camaldulensis	770,000	20,208,000	26	5
Eucalyptus globulus	70,000	55,855,000	798	50
Eucalyptus citriodora	120,000	36,050,000	300	20
Eucalyptus deglupta	4,000,000	100,000	1	1
Eucalyptus tereticornis	500,000	25,000,000	50	0
	SUB	180,317,000	1,387	146
Pinus species	30,000	25,080,000	836	500
Pinus caribaea	50,000	15,190,[illegible]	304	50
Pinus roxburghii	10,000	12,000,000	1,200	0
Pinus occidentalis	20,000	577,000	29	0
Pinus radiata	13,000	61,283,000	4,714	0
	SUB	114,130,000	7,083	550
Acacia species	20,000	8,345,000	415	20
Acacia auriculiformis	40,000	6,120,000	153	100
Acacia catechu	40,000	5,000,000	125	0
Acacia senegal	7,000	40,000	6	5
Acacia albida	10,000	559,000	56	0
	SUB	20,064,000	755	125
Albizia lebbek	10,000	13,635,000	1,360	0
Albizia (falcataria)				
Albizia (moluccana)	30,000	8,500,000	283	15
	SUB	22,135,000	1,643	15

TABLE 2 (cont)

US A.I.D. LIFE OF PROJECT
SEED QUANTITIES NEEDED

(Estimates as of 1/82)

SPECIES	PLANTABLE SEEDLINGS/Kg	No. of SEEDLINGS	No. of Kgs	Kgs to be IMPORTED
Casuarina equisetifolia	700,000	26,800,000	38	10
Gmelina arborea	1,200	26,700,000	22,250	200
Azadirachta indica	3,000	23,719,000	7,906	50
Leucaena leucocephala	10,000	28,965,000	2,797	400
Sesbania grandiflora	10,000	11,700,000	1,170	200
Anacardium officinale	150	9,080,000	60,535	500
Prosopis (juliflora)				
Prosopis (chilensis)	25,000	5,325,000	213	100
Tectona grandis	1,550	1,550,000	1,000	250
Coffea arabica	2,000	800,000	400	200
Gulielma gasipaes	2,000	600,000	300	0
Cajanus cajan	10,000	800,000	80	40
Cedrus species	9,000	1,000,000	110	0
Cupressus lusitanica	200,000	1,883,000	11	0
Terminalia ivorensis	10,000	460,000	46	30
Cassia siamea	37,000	1,150,000	31	3
Grevillea robusta	100,000	30,000	1	0
Calliandria species	10,000	7,330,000	733	5
Swietenia macrophylla	2,000	2,506,000	1,253	5
(No. Species - 36)				
TOTALS	-----	487,044,000	109,742	3,279
Misc. Species[1] (54)		39,550,000	0	
GRAND TOTALS (90)		526,594,000	109,742	3,279

[1] Composed largely of fruit trees or other locally produced species.