AGROFORESTRY OUTREACH PROJECT

Evaluation and Follow-On

USAID/HAITI

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Washington, D.C. 20523
April 1, 1985
(Revised)

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5045A:vol03:MDB:4/3/86

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Evaluation and Follow-On

A. TASK:

My primary task in the Evaluation of the Agroforestry Outreach Project (AOP)--and subsequent follow-on activity--was to make recommendations for the genetic improvement of tree species used in the project (Appendix I). An elaboration is found in Section D.2. of this Report and in Appendix II. However, it would be a waste of A.I.D.'s limited resources and my time to propose a program to genetically improve trees unless the Mission undertakes other scientific and technological measures necessary to upgrade the quality of the products delivered under the AOP: e.g., inoculating trees with mycorrhizae, Rhizobium or frankia; providing adequate information storage and dissemination; conducting relevant research; and providing good soil testing facilities. Without these improvements, USAID is providing a gross disservice to the Haitians, whom we are supposed to be helping.

B. SUMMARY:

The AOP is working, and working very well in spite of its many technical flaws. These flaws are not the fault of the grantees, for they are underfunded for the amount of work that they are doing, are required to do, and should be doing. Rather, they are the fault of poor project design. The AOP does not provide for adequate technical and scientific support to enable the grantees to do a better job.

B.1. The AOP extension should no longer focus on just delivering large numbers of trees; rather, emphasis should be on the quality of the product delivered and on extension services; e.g., to provide the wherewithal to enable farmers to gain maximum benefit from these products. However, extension cannot be improved unless the field reps and agronomes are furnished good information; this can be accomplished only by establishing an Agroforestry Information Clearing House and Outreach Center (Appendix III). The Mission is now funding a second class project, when for a little more effort through scientific and technological improvements, it could be funding a first class one.

B.1.a The field reps and agronomes are employed full time in delivering trees and do not have enough time to do necessary extension. Extension is more important now, since many trees are

2-3 years old. There is a need to circle the wagons and reassess the quality of work that is being done.

B.1.b. There is a greater demand for trees from Haitian farmers than the AOP can deliver; in fact, the numbers of trees delivered has been drastically reduced because of lack of funds.

B.1.c. Therefore, the importance and need make it imperative to fund a genetic tree improvement program in the AOP extension in order to deliver to the farmer the best tree possible for optimum survival, growth and production.

B.1.d. Furthermore, there is need to establish an Agroforestry Information Clearing House an Outreach Center to support extension, genetic improvement and other necessary changes and improvements in the AOP Extension (Appendix III).

B.1.e. The Haitian farmers traditionally maintain two "bank accounts": their pigs and certain trees (often the mango, which complements the pigs). Now that the Haitian farmers have lost their pigs, they are placing a greater value on tree planting as an alternative banking system.

B.2. Secondly, to think that the AOP (or sub-components) will reach the stage of self-sustainability in the next few years is

naive. Reforestation of any kind is a long-term effort and to educate peasants to realize the value of trees (to a stage where they purchase trees if they can afford them) will take 10 to 15 years. Also, the most of the small PVOs do not have the wherewithal in terms of technical competence or purchasing power to be self-sustaining. Increased food production should be the primary focus of the PVOs in Haiti, and most have adopted this approach to development.

B.2.a. The PVOs are already trying to do too much with too little manpower and monetary resources. If the Mission cuts off funds for tree planting through the AOP, the PVOs can't be expected to continue emphasizing tree planting before we have proven that it benefits agricultural production (such as hedgerows) and rural income. Once demonstrated, adoption will follow. The AOP has not had enough time to prove this.

B.2.b. ODH is the one PVO that will be self-sustaining with or without assistance from the Mission. ODH has a "commitment" to continue agricultural and agroforestry improvement in Haiti, and has a profit motive from which it derives self-sustaining funds for increasing its technical assistance to Haitians. ODH does not depend entirely on funding from the Mission and the outside, as do other PVOs, which have stated that if Mission funding is cut off for their Haiti forestry activities, their programs will be closed.

B.2.c. The AOP should encourage the PVOs to concentrate more in one region. PADF is trying to cover too large an area in the Les Cayes region with too little manpower and other resources.

B.3. Third, if the scientific and technological improvements recommended in Section D are carried out in the AOP follow-on activity, they will provide the backbone of support for the proposed Les Cayes Watershed Project. But without them, the Les Cayes project will be impossible to implement competently. For example, in the Les Cayes Targeted Watershed Project several assumptions are made on increasing farmers yields and on what kind of plants/crops will be planted and grown; however, baseline data, such as soil pH and nutrient content, is not known. A competent soil test for pH and macro and micro nutrients cannot be made in Haiti (see Recommendation D.4). This makes the proposed project a $15 million gamble.

Another example: An estimated 900,000 kg of seed at an in-country cost of $900,000 will be needed to establish vegetative barriers (of only one species) on 30,000 hectares in the Les Cayes Watershed. The overwhelming amount of seed and plant material required to establish vegetative barriers has not been computed for the Les Cayes Project, nor has the necessary nursery support to grow other kinds of plant material. This is a very dangerous pitfall and could cause this project to fail to meet stated outputs. The AOP Extension can provide much of the plant material required for the Les Cayes Project [see Section D.2.m.(1)].

C. CHARGE:

The Director Of the Office of Agriculture and Rural Development, Dr. Vince Cusumano, charged the Evaluation Team with the following:

1. The results of our evaluation should provide the basis for a follow-on activity to the AOP, which will be a Project Amendment.

2. The follow-on activity will last three years.

3. The Evaluation Team should not limit their creativity for the follow-on activity by placing a funding constraint on the AOP extension.

4. Technical feasibility should be linked with institutional capacity.

5. The Team should think of designing the AOP Extension in terms of tree planting and other activities vis-a-vis soil erosion, which is the primary focus of the Mission's Action Plan.

6. The follow-on activity should provide support tc or transition into support for the Targeted Watershed Management project in the Les Cayes.

7. The Team should make recommendations as to the future institutional relationship between the AOP and MARNDR.

8. The AOP follow-on activity should minimize recurring costs, e.g., financial viability of nurseries.

9. What should/will be done with the information generated under the AOP?

10. The Team should define the relationship of the fruit tree projects to the AOP; e.g., remain separate or integrated into the AOP.

Elaboration:

C. The funding level of the AOP should be increased to support the recommended scientific and technological activities needed to enhance the success and impact of the AOP, and to provide a basis of support for the Targeted Watershed Management Project in Les Cayes.

An explanation is not needed for some of Dr. Cusumano's Charges; therefore, these will not appear below. Those needing explanation follow:

C.1. --- ...

C.2. ---...

C.3. ---...

C.4. The technical feasibility of the activities recommended in Section D. are linked with institutional capacity, elaborated upon especially in Sections: D.2., Genetic Improvement of Trees; D.3., An Agroforestry Information Clearing House and Outreach Center; D.4., Soil Testing Center; D.5., Mechanization of "Haitian Mix"; D.7., Centralized Purchasing Unit; D.8., Refocus of Research, D.10., Increased AOP Relationship with MARNDR and Other Projects and Activities; and D.11, Changes in the Fruit Tree Projects (see below).

C.5. Tree planting is linked to soil erosion control through the recommended establishment of demonstrations of Leucaena contour hedgerows in Section D.9.

C.6. How the AOP Extension will provide support to or transition into support for the Targeted Watershed Management Project in Les Cayes is explained in the Summary, and in fact, all of the recommended activities will support this project, and in particular, Sections: D.2., the genetic improvement of trees, the

introduction of new plant material, the establishment of seed orchards (Appendix II); D.3., Establishing an Agroforestry Information Clearing House and Outreach Center (Appendix III); D.4, upgrading of a private sector Soil Testing Center; C.7., establishing a Centralized Purchasing Unit; and D.11., Changes in the Fruit Tree Projects.

C.7. The AOP Extension Project should form a closer relationship with MARNDR by sharing documents/reports and information, introducing project participants (to include members of evaluation teams and technical support), and by inviting MARNDR to second a person to the proposed Agroforestry Information Clearing House and Outreach Center (Appendix III) as suggested in Section D.3.

C.8. There is potential to make some of the activities under the AOP self-sustaining. Examples follow:

C.8.a. Once the value of contour hedgerows (alley-cropping) is demonstrated (see Section D.9.), farmers should begin to establish hedgerows on their own. For example in Indonesia, farmers picked up on demonstrations carried out by a PVO and established over 10,000 hectares of contour hedgerows without help (Appendix IV). The same has happened in the Philippines. The promise of contour hedgerows (alley-cropping) has attracted the attention of two

international agriculture centers, IITA and ILCA (Appendix V), which are conducting workshops and training courses and have just established an alley-cropping research network for Africa.

C.8.b. The establishment of school tree nurseries, linking reforestation to child nutrition, offers promise of making nurseries self-sustaining in Haiti. I understand that CARE is proposing this strategy in its future activities under the AOP follow-on/extension (Appendix VI).

C.8.c. The AOP is just on the brink of demonstrating that growing some trees species (those matched to site and of good genetic quality) can be profitable for farmers (an example is trees now being harvested for charcoal). Once this idea gets across to the farmers, sustainability of AOP activities will be enhanced.

C.8.d. Once that the objectives of the fruit tree projects are demonstrated (improved budwood which produces a better quality of fruit with higher yields), and markets for the improved fruit are developed, increasing profitability, farmers will begin to purchase the fruit trees.

C.8.e. Sustainability of PVO nurseries could be enhanced if they used WINSTRIPS rather than the Canadian root trainer, which lasts a maximum of 3 years. In some nurseries they last less than 2 years

before they disintregate. WINSTRIPS are made of a much heavier material and will last much longer; however, they would probably cost more, and replacement in PVO nurseries would probably have to be subsidized. The Canadian root trainer should be replaced with WINSTRIPS with cavities larger than the #6 Canadian root trainer, which would enhance establishment and growth of seedlings (ref. section on research).

C.8.f. There has been a lot of discussion about each nursery making its own "Haitian Mix" compost in order to become self-sustaining. This is impractical: I urge you to read the literature! There is a plethora of scientific research and information listing the difficulties of making a viable compost mix for use in nurseries. It takes a high level of technical competence and considerable amount of time to make organic nursery mixes, which unfortunately most PVOs do not have.

C.9. All information generated under the AOP and the AOP Extension should be compiled, evaluated, stored and disseminated in/by the Agroforestry Information Clearing House and Outreach Center, (Section D.3.), which will provide valuable information for the Les Cayes Targeted Watershed Project.

C.10. The relationship of the fruit tree projects to the AOP Extension is elaborated in Section D.11., Changes in the Fruit Tree Projects.

D. RECOMMENDATIONS:

The AOP Extension should have an increased level of funding, and have as its primary objective the creation of support for the Targeted Watershed Management Project in Les Cayes. The AOP should also form a closer relationship with MARNDR. The following recommended changes and new components for the AOP Extension and Follow-On are not necessarily listed in order of importance, and most are interdependent:

1. A Technical Assistance Component

2. A Tree Genetic Improvement and Plant Introduction Program

3. An Agroforestry Information Clearing House and Outreach Center

4. A Soil Testing Center

5. Mechanization of "Haitian Mix"

6. Inoculating Haitian Mix with Mycorrhizae, and inoculation of seedlings with Rhizobium and frankia.

7. Centralized Purchasing Unit

8. Refocus of Research

9. Fund Demonstration Sites of Leucaena Contour Hedgerows

10. Increasing AOP Relationship with MARNDR and Other Projects/Activities:

11. Changes in the Fruit Tree Projects

12. Continued Support to ODH for Plantation Forestry

Elaboration:

D.1. Technical Assistance--I recommend that a sum of money be set aside in the AOP extension for a Technical Assistance Component. Examples of support needed include:

D.1.a. The first priority should be TA for the biological control of the plant hopper that is attacking Leucaena in Haiti (though the introduction/proliferation of Ladybird and Ladybug beetles and a Caribbean wasp, see Appendix X).

D.1.b. The above mentioned development of a soil testing lab within the private sector could be funded under the Technical Assistance component.

D.1.c. The above mentioned technical support for the introduction of mycorrhizae in the Haitian Mix could also be funded under this component.

D.1.d. Technical assistance for developing rural production of cooking oil is greatly needed in Haiti (see Section D.2.n.(1).).

D.1.e. Technical assistance for the development of a market for neem derivatives as a pesticide. Extrapolated data indicates that a gross of $9,000-162,000 could be realized from pesticide extracts from one hectare of neem (retail value of finished product, dependent on the percentage of pesticide in the seed, yield of seeds per tree, and density of trees per hectare). Neem has a naturally occurring, non-toxic chemical that makes an excellent pesticide with the potential to replace many of the more toxic ones such as DDT (Appendix VII). However, certain small technical problems need to be worked out, like identifying the actual percentage of the chemical/pesticide contained in neem seed in Haiti (neem seed from Africa has a higher level than that tested from India). A higher percentage of the chemical in the seed yields a higher profit percentage. Testing of seed is necessary if investors are to be convinced about the economic feasibility of investing in the production of neem pesticides in Haiti.

D.1.f. Technical assistance is needed to see if livestock in Haiti (goats and cattle) have in their rumens the bacteria that break down DHP, the toxic chemical in mimosene, in Leucaena (Appendix VIII). Leucaena has the most promise of any plant for livestock feed: both cattle and goats. Goats are very destructive, destroying a large number of newly planted seedlings and food crops, and suppress natural regrowth of vegetation. The only way the farmer will tether goats and cut-and-carry feed to them is if they have a surplus of feed, which Leucaena can provide.

D.1.g. There are many other technical assistance needs for both the AOP and to backstop the Les Cayes Targeted Watershed Management Project and other present and planned activities related to soil erosion control and agroforestry. Many are unforeseen at this time, and often this TA is not available through centrally funded S&T projects, such as FSP, especially if specific individuals are needed who are not U.S. Government employed (illegal under OICD rules). An example of such TA is a cashew disease expert employed by a university.

D.2. Genetic Improvement of Trees--I recommend that the Mission fund a program for the Genetic Improvement of Trees in the AOP Extension, funded by a three-year grant to ODH, but subcontracted to the private sector. This contract should allow for the sale of

seeds to the AOP, to other USAID projects, to non-USAID projects, and to the private sector, but USAID projects should have the first priority for purchase.

The genetic improvement of trees should not be done by the University of Maine or other U.S. universities or the Forest Service, for they are too tradition-bound! A 20-40% gain in establishment, growth and yield can be achieved in a relatively short time by using plant material of good genetic quality. I observed during the evaluation of the AOP that there is a drastic need for the genetic improvement of the trees distributed under the AOP.

The modus operandi should be as follows: (1) identifing trees of superior phenotypes, (2) renting these trees from farmer/owners, (3) gathering seed from these trees, (4) propagating them in ODH's nursery (inoculated with appropriate mycorrhizae, frankia and/or Rhizobium), (5) planting and managing them in seed orchards on land leased by the ODH contractor, (6) introducing plant material of superior phenotype and repeating the above process, and (7) tissue culture of trees. The grant to ODH and the subcontract to the private sector entity should provide that in case the private entity should not continue to manage these seed orchards in some future time, ODH will take over the land leases and will continue to maintain and manage them.

The first priority of this program will be the identification, reproduction and seed orchard establishment of clones of Leucaena leucocephala that are resistant to the plant hopper existing in Haiti. The second priority should be the importation, reproduction and seed orchard establishment of other resistant K numbers that have been identified by Dr. James Brewbaker, N.F.T.A. (see Appendix X). Leucaena, neem and casuarina head up the list of those species identified for improvement under the AOP extension.D.2.a. A grant to ODH for a sub-contract to a private firm would be the most practical means of accomplishing the objectives of such a program. The private firm should be in the position to take over the entire operation after three years and provide improved seed to reforestation activities in Haiti at costs much less than currently imported (at this time most imported seed has not been genetically improved) and for export. The estimated cost of a three-year program would be $900,000. An elaboration of the budget for this activity can be found in Appendix IX.

D.2.b. ODH is identified as the most appropriate organization because:

D.2.b.(1). it is the only group that has storage facilities for seed, Rhizobium, frankia, etc.;

D.2.b.(2). a genetic improvement program has to be coupled with central nursery operations (where the plant material can be traced from the cradle to the grave);

D.2.b.(3). soil and trees and other plant material have to be inoculated with mycorrhizae, Rhizobium and frankia in the nursery (Johnson & Menge, 1982, Appendix XVII) in order to obtain optimal performance (ODH has the best nursery and technical capacity to do this);

D.2.b.(4). in order to be successful, the genetic improvement program must be located close to a central purchasing unit for the purchase of seed, Rhizobium, etc.; and

D.2.b.(5). ODH has the capacity and experience in establishing large areas of seed orchards, and has access to land. Part of ODH's grant under the AOP was for developing tree plantations.

D.2.c. At a minimum, the program should employ one full time expat scientist and one computer programer (with computer), and each region should employ a full time Haitian agronome. This program should act independently of the AOP (and the University of Maine), but should receive full cooperation from the other AOP participants (including the University of Maine, if it receives further funding). This program, with its computer programmer and computer

could supplement/complement the Agroforestry Information Clearing House and Outreach Center attached as Appendix II. This program was outlined in my August 2, 1985, Memorandum on "Procurement, Establishment and Management of Select Seeds/Plant Material for Semi-arid Areas, for Saline Soils and for Other Areas in Haiti" to Vince Cusumano, Bob Wilson and Wendy King attached as Appendix II.

D.2.d. Leucaena comprises over 1/5 of the entire species outplanted under the AOP, and it is the most versatile and useful tree planted by the Haitian farmer. Leucaena is also the most promising plant species for vegetative-contour hedgerows to increase crop yields and reduce erosion. Leucaena is prolific and easy to plant and manage. More often, it defies the lack of technical input, and grows even when not inoculated or planted properly. Leucaena survives in the very dry areas, where other transplanted trees die.

Nevertheless, Leucaena is not infallible, and growth in many areas is severely retarded because of attacks of the aphid-like nymph of the plant hopper, Heteropsylla incisa (Appendix X). This could be extremely damaging to the AOP and possibly to the Les Cayes Targeted Watershed Project.

Therefore, I recommend that the AOP immediately fund the importation of pest-resistant cultivars of Leucaena leucocephala. Seed orchards of these cultivars should be established by ODH through the recommended Genetic Improvement Program.

D.2.f. The potential gains in productivity of trees that can be achieved simply by the selection of the best adapted provenances for prevailing environmental conditions could amount to several hundred percent (Palmberg, 1981). Further genetic improvement of tree species can result in an increase of 40-60% in yield within a short time (OTA, U.S. Congress, 1984).

At a minimum, the three-year genetic improvement program should comprise the following (see Appendix IX for Budget elaboration):

D.2.f.(1). A management entity, preferably a private company/organization

D.2.f.(2). One expatriate tree/horticultural expert (need not be a geneticist, but have extensive knowledge in this area)

D.2.f.(3). One local-hire data base expert

D.2.f.(4). Three Haitian regional agronomist assistants

D.2.f.(5). One local hire secretary/logistician

D.2.f.(6). Addional technical consultancy

D.2.f.(7). Vehicles for travel (jeep/pickup for expat and motorcycles for agronomist assistants)

D.2.f.(8). Computer and software

D.2.f.(9). Adequate support services

D.2.f.(10). Tissue culture/vegetative propagation and technology development component

D.2.f.(11). Seed production from already existing plus trees

D.2.f.(12). Germplasm aquisition, storage and distribution

D.2.f.(13). Seed orchards and multiplication stands

This activity will also be supported by the research grant from the Office of the Science Advisor with support from S&T small activities funds (Appendix XI).

D.2.g. In Haiti, where increased production to enhance the farmers' well-being is the objective, only species that are compatible in and complement agroforestry systems and are high producers of quality products should be used in the AOP. For such species it is important to grow only superior stock, which will optimize productivity.

D.2.h. The nature of any individual (its phenotype) is the result of its genetic makeup (genotype) and the environment in which it grows. Because of the outbreeding nature of most trees, any population will have individuals of both outstanding and poor genotype. Even Leucaena outbreeds to a certain extent depending upon crown proximity, insect and wind activity. The "normal" statistical distribution approximates the genotype variation within a population.

By selecting only the best genotypes for the site and the management system in which they are grown, productivity can be increased significantly and offspring from these individuals will generally be far higher on the average than the original population. A production increase of 15% is often gained in the first generation of selected population and up to 45% in succeeding generations. This is where agroforestry can be supreme by being a most economical user of superior seed or, better still, cloned material from the best known trees--through vegetative propagation

to include tissue culture (Appendix XII)--can be a short-cut to better genetic stock of some species for agroforestry. This involves the selection and cloning of superior trees (phenotypes) which are immediately tested for their genotypic quality.

D.2.i. The cloning of superior phenotypes of Prosopis (to include thornless and/or high biomass and pod producers, See Appendix XI), salt-tolerant eucalyptus, sterile hybrid casuarinas, and pest-resistant varieties of Leucaena are but a few high-pay-off opportunities for Haiti.

D.2.j. The establishment of seed orchards of non-sterile plant material of superior phenotypes would provide a marked improvement in the availability of plant material resources in Haiti. This would short-cut the normal lengthly selection and reproduction process by several years, making it possible to produce enough superior plant material for massive outplantings in 3-5 years.

However, it is recommended to incorporate plant material of widely different genetic origins interspersed into systems which entail large scale plantings, such as in hedgerows, plantation forestry, etc. The narrow gene base of Leucaena and neem is a danger to larger scale plantings of this plant material, already evidenced by the plant hopper infestation and damage to Leucaena. Incorporating plant material of widely different genetic origins provides a

greater security against disease and pestilence because of genetic variability.

D.2.k. There is a lot of material (often referred to as genetic garbage) that was from unidentified parentage and sources distributed to farmers which showed very poor form. However, it was very difficult to establish this fact in all cases because other basic accepted procedures were not being followed, such as inoculation with mycorrhizae, Rhizobium and frankia and emphasis on selecting trees for soil pH (which was unknown in most cases), altitude, soil type, etc.

Much of the seed used in nurseries did not come from outstanding genotypes, rather they were just gathered from whatever trees were growing in the area. For example, in one location, Leucaena comprised 1/5th of the trees planted. By using seed from only the best genotypes, the production for the entire planting program in that area could have been improved by as much as 10%.

D.2.l. A few of the trees planted under the AOP show desirable genetic traits, have genetic variability (necessary to decrease the chance of disease or pest problems) or have high market value, and could/should be used in a genetic improvement program. Field representatives and agronomes knew where a few outstanding trees were growing. Unfortunately, this information will be lost when

these people leave the area unless it is documented, mapped and centrally filed (both computer disk and paper copy) as soon as possible.

Some outstanding phenotypes of boa blanc, shen, cipre, Cassia samea, boa pele and other species have been noted by field reps and agronomes. These trees need to be identified, mapped, recorded and put into an information system for improved genetic material.

Many of the other species could be improved by purchasing seed from a competent dealer, who could hire a trusted person to select seed from superior trees grown in other countries and match them to similar sites in Haiti. The best company candidate is Tree Seeds International, which was the only company that could collect and import to Haiti quantities of neem seed of new genetic material. The best country candidate for this is Australia, but seed from Thailand, Malaysia and elsewhere need to be identified and imported.

D.2.m. During the evaluation, a list was made of trees that had been suggested for genetic improvement. Leucaena, neem, casuraina, and thornless Prosopis headed the list, and a variety of other species were suggested:

D.2.m.(1) Leucaena is the most promising and versitile tree planted under the AOP. However, the plant hopper is very dangerous problem that is lurking in Leucaena leucocephala trees, and has become a serious pest in Haiti and elsewhere. In the Philippines, a 80% die-back has been reported in some areas Appendix X). This could be very damaging to the AOP and to the Les Cayes Watershed Project, for Leucaena shows the most promise in some areas for establishing vegetative erosion control barriers for crop yield improvement. Leucaena is probably the most promising, diverse and popular tree planted in the AOP and in Haiti.

Leucaena is also the easiest to work with to establish and to produce seeds. The damage to Leucaena by the plant hopper seems to be genetically related, for some clones within certain K-numbers (varieties) show resistance and other K-numbers within the species show resistance. Other species of Leucaena within the genera also show resistance (Appendix X). Therefore, it is of primary importance that the AOP immediately launch the establishment of plantation-seed orchards of this resistant genetic source.

Therefore, it is imperative that new germplasm offering resistance to this pest must be imported and reproduced or the AOP and other projects are in serious trouble. Also, clones of this species which are already in country and show resistance must be identified and reproduced (Appendix X).

I would suggest selecting Leucaena for the following traits: (a) resistance to the leaf hopper, (b) a minimal crown for interplanting with agriculture crops and for poles and lumber, (c) a general, all-purpose one for forage production, (d) maximum wood production, not necessarily straight, for charcoal and firewood production, and (e) a general potpourri of genes for hedgerows. There is a possibility of combining one or more of these traits.

Near Bas Marchand, one farmer had three superior Leucaena leucocephala trees in his field which had very straight boles and a small-high crown creating minimum shade. These trees have excellent form for intercropping with food crops for their canopies are small and cause minimal shading effect. Seeds from these trees should be collected and propagated, and seedlings distributed to farmers.

Leucaena was reported to lose its leaves during the rainy season in the Chambellan area (Mike Bannister's area). This should be investigated, and if it does, seed should be gathered and seed orchards of this germplasm established and tested to see if it is a genotype. If so, this tree is ideal for intercropping with food crops.

Germplasm of Leucaena diversifolia is needed for higher elevations. Wally Turnbull has grown some very promising trees, but there is a need to set up a seed multiplication program.

Over 900,000 kg of seed would be required to establish vegetative barriers of Leucaena on 30,000 hectares (major output of the Les Cayes Targeted Watershed Project)--if the barriers were only 10 meters apart. (A stated objective of the project is to establish vegetative barriers on 30,000 ha of species such as Leucaena.) A distance of 5 meters between Leucaena hedgerows is most often recommended for effective erosion control on hillsides. Leucaena is the most promising plant to establish contour hedgerows for soil erosion control and crop yield improvement in Haiti (in elevations under 800 meters). By using a distance of 10 meters between hedgerows, more than 30 kg of viable seed is needed per hectare for 30,000 hectares.

Leucaena seed purchased off shore costs about $25/kg (a good price, Brewbaker charges $80 or more), which would amount to $22.5 million. This same seed from subsidized seed orchards in Haiti could probably be purchased for $1/kg (the price PADF is paying to some farmers), which would amount to $900,000, a substantial savings. It would take 3,000 hectares of Leucaena to produce enough seed required to plant 6,000 hectares (X 5 yrs = 30,000 ha)

of vegetative barriers each year, the project output of the Les Cayes Targeted Watershed Management Project. This amount is required if the establishment of the barriers were evenly distributed over five years (calculated at 1/2 kg seed produced by each tree X 250 trees per hectare. Some trees produce more than 1/2 kg/tree).

D.2.m.(2). Neem--Neem has tremendous potential for Haiti, for pesticide extracts, organic mulch, poles and wood. It is estimated that a gross of $9,000-162,000 (see D.1.d.) could be made from one hectare of neem grown and processed for pesticides (based on the retail value of the pesticide). The neem in Haiti is of a very narrow germplasm base, and new genetic material should be introduced to reduce the disease/pest potential. This genetic material is very difficult to introduce, for it has to be hand-carried from its origin and it remains viable for little more than 3 weeks. Some new genetic material was brought in from India by Tree Seeds International. An attempt was made to bring in germplasm from Burma, but S&T and FSP received reports that this material did not germinate. Mike Bannister reported that he thought that some of the Burmese germplasm (20 trees) was planted and growing at DCCH in Les Cayes. Is this true or not? What a waste of time and money when this information is not recorded, mapped and disseminated!

Selection of neem should be for: (a) high percentage of azadirachtin in the seed, (b) maximum seed production (large canopy), (c) high value pole production (straight bole), and (b) charcoal production (multiple stems). It is possible that all three could be accomplished by selecting a multiple-stemmed tree.

Before determination, research should first be conducted on coppicing a multiple stemmed tree to see if the coppice would produce straight, quality poles. Multiple stems should also provide maximum canopy for seed production. This is the type of research that the University of Maine should be doing in their coppicing trials.

Under a German project some very good looking trees are planted near Kafe Paul (halfway between Anse Rouge & Goanives). Superior phenotypes could be identified and rented, and collected seed used for planting in the Northwest. There are also a number of neem trees with good form in front of Damien and on the road going north that should be marked and seed gathered for the establishment of seed orchards.

D.2.m.(3) Casuraina for high altitudes--The fastest growing casuraina in Haiti is a sterile hybrid grown in the Limbe region. This would necessitate vegetative reproduction of clones of these trees and ODH has the connection with a biotech lab at Kentucky

State University, which can provide assistance in this area.

D.2.m.(4). Thornless variety of Prosopis--Dr. Peter Felker would be the ideal person to do this work, for he has developed some thornless clones (Appendix XI).

D.2.m.(5). Shen (local oak) brings a premium price in Haiti. Shen is a slow grower, but it is of better quality and form. Shen is reported to develop best in an understory, in more humid environments and in better soils. When planted out of this environment, it may not grow true to form. Selecting seed from trees with good form may help overcome this problem.

D.2.m.(6). Frene (Semarua glauca) grows twice as fast but is of poorer quality. It is of general utility for construction, but rots quickly. Frene regenerates by itself; therefore, when it is offered to farmers through the AOP, they are not interested.

D.2.m.(7). Catalpa longisima (myrtle) is also very valuable as a wood. These two are the most preferred wood in Haiti. Land-races from these trees need to be reproduced for diffusion elsewhere.

D.2.m.(8). Columbrina seems to be a good tree, but usually it is of poor form. This could be a result of genetics or environment. A literature search should be made for information on this species by

an Agroforestry Information Clearing House and Outreach Center. Columbrina may need shade to develop good form with minimal branching. Survival may be enhanced if it is shaded. Farmers often mistake it for a weed species and cut it down.

D.2.n. Introduction of New Plant Material--There is a wide variety of other plant material that should be introduced which would support the AOP and the fruit tree projects. These include:

D.2.n.(1). Oil Palms--The major cash outlay of the rural Haitian is for the purchase of cooking oil. Oil palms show great promise for solving this problem. The A.I.D. Office of the Science Advisor has given two collaborative research grants to the New York Botanical Garden (NY BG) for ethno-botanical studies of Orbignya and other oil palms extensively used by peasant farmers for cooking oil and charcoal production throughout Central America and northern South America. This research seems to dovetail into the goals and objectives of the AOP. A suggested strategy is for the NYBG, through the AOP, to hire a local Haitian Agronome, supported by an economic botanist from NYBG, to exploit and proliferate oil plant resources to aid Haiti farmers. The cost of this TA will have to be worked out with the NYBG (see Appendix XIII).

D.2.n.(2). Bananas and Plantains--Improved varieties of bananas and plantains should be introduced and the advantages of this improved germplasm demonstrated. AID just put some money into maintenance of a germplasm bank for bananas and plantains, and IPBRG at FAO Rome is in charge of maintaining this germplasm bank. The International Insititute for Tropical Agriculture (IITA) in Ibadan, Nigeria, is conducting research on banana and plantain production and would be a good source of information. Improved germplasm, if identified, can be obtained through the S&T/AGR Plant Introduction Project with USDA's Plant Introduction Center. ORE, ODH and others expressed interest in improved bananas and plantains.

D.2.n.(3). Dwarf coconut--Disease-resistant dwarf coconut should also be introduced into Haiti. I believe that this could eventually become a self-sustaining private sector operation if a small starter grant was provided. ODH is the most likely candidate for this small grant.

D.2.n.(4). A disease-resistant dwarf avacado of export quality should be introduced. Avocado is very important for improving nutrition in Haiti, because oil is one of the primary dietary deficiencies. Avcados used to be a primary source of feed for pigs. The quality was very poor (stringy) and did not bring a good market price. Hurricanes destroyed many of the trees because they were too tall and had a large crown, and others were cut down when

the farmers' pigs were killed. Many U.S. varieties of avacados are of a dwarf nature. Grafted avacodo will fruit in 2 1/2 years (includes nursery time), has 80% less wood and is 2/3 shorter than the Haitian variety, making it less susceptible to hurricanes.

D.2.o. The more species selected for improvement, the higher the cost of the program. First it must be decided what will be the end use of the species. This decides your selection criteria. And the evaluation did not lead to any decisions.

D.3. Agroforestry Information Clearing House and Outreach Center--There is no institutional memory in the AOP. When PVOs, field reps, agronomes, Project technical experts and managers leave, so does the information contained in their heads, never committed to a central information system. A shameful example is CARE at Gonaives!

D.3.a. I would make the following few changes in my original Memorandum of January 14, 1986, "Assessment of PADF's Proposal--The PADF Position on a Multi-year Project Extension to Broaden Small Farmer Agroforestry Options and Support in Haiti." (Appendix III).

D.3.a.(1). The establishment of an Agroforestry Information Clearing House and Outreach Center now would provide primary backstopping for the proposed Les Cayes Watershed Management Project.

D.3.a.(2). A mechanism through which such a center could be established is by establishing a Haitian private foundation (PVO).

D.3.a.(3). The GOH could have access to, and participate in, such a Center by seconding an employee to work with the foundation. Through this mechanism, the GOH would not have control over the center, but would have a moral and technical commitment to support it.

D.3.a.(4) The center would have as one of its functions the maintenance of records on the genetic improvement of trees.

D.3.b. Without first establishing an Agroforestry Information Clearing House and Outreach Center, it would be impossible to implement a program to genetically improve trees. It was consistent that few, if any, of the field personnel of the grantees really knew where the germplasm of most of the trees originated. One of the few exceptions was seed purchased from Tree Seeds International. Even in these cases, seldom was the passport

information (seed origin, site chacteristics, etc.) recorded and passed onto the field reps.

Passport information on the majority of the seed purchased under the AOP was not furnished. Thus, if the germplasm is not good and the source is unknown, the same mistakes can be repeated. Likewise, if the germplasm is good, there is little possibility that the more of the same can be obtained.

D.3.c. The importance, need and impact of the establishment of an Agroforestry Information Clearing House and Outreach Center are fairly well laid out in my January 14, 1986, Memorandum."Assessment of PADF's Proposal--The PADF Position on a Multi-year Project Extension to Broaden Small Farmer Agroforestry Options and Support in Haiti."

D.3.d. The recent evaluation reinforced the crying need for such a center. Poor record keeping (and loss of the CARE records), misinterpretation of and lack of basic information were the rule rather than the exception, found throughout the grantees. These problems can only be solved by a central record keeping system in the Agroforestry Information Clearing House and Outreach Center.

D.3.e. Misinformation is being disseminated to the farmers under the AOP, by field reps and agronomes. An example is that Leucaena seeds and leaves make very good pig feed. It is dangerous to feed pigs more than 5% dry weight of their entire ration. Cattle can be fed 50% and goats (if they have the right bacteria in their rumen) 100% with no harmful effects. We found farmers planting Leucaena to grow feed for their pigs (if they ever get any), after being told by agronomes that it makes good feed. Information on the feed value of Leucaena has been sent to the Mission on several occasions, and I found several copies in the Library (AID/DSB Technical Series Bulletin No. 25--English and French, attached). I have reproduced and recently sent 100 copies in French to the AOP Project Manager for distribution. Also, valuable information such as my publication on how to use Leucaena as a living yam pole never left the Mission (Appendix XV). I am having this translated into French and will again reproduce and send copies to the Mission for distribution. Information on how to scarify teak seed had also been sent to one or more of the PVOs, but it was never shared with others. An Agroforestry Information Clearing House and Outreach Center would solve these problems.

D.4. Soil Testing Center--I recommended that under the Agroforestry Project Extension, A.I.D., through the private sector, fund the creation of a competent soil analysis lab. This lab

should be capable of making accurate soil tests in terms of pH and macro and micro nutrient levels in the quantities needed to adequately serve the AOP, the proposed Les Cayes Watershed Management Project and other A.I.D. activities. This soil testing center should also have the capability to do foliar analysis.

D.4.a. The establishment of this laboratory should be within the private sector of Haiti, since the public sector does not have this capability. Agriculture Services, Ltd. (ASSA, John Correlli, Tel: 24268) already has an existing laboratory with limited capability. This company would be the most likely candidate for such a lab. However, additional laboratory equipment and technical personnel (and training) would be necessary to bring this up to the level and volume needed to serve the Mission and other customers. This technical assistance would be a one-shot deal, and the laboratory should be able to become self-sustaining from profits within a reasonable time. Many of the contracts would be with the Mission and MARNDR.

D.4.b. Technical assistance for the costing out, the upgrading and the maintenance of this lab and for assurance of a quality product can be obtained from Ag. Services International, P.O. Box 667, Orange City, FL 32763, Dr. J. Walter Fitts, President, Tel: (909) 775-6601. Dr. Fitts set up and maintained soil labs throughout Latin America for A.I.D. for over 10 years.

D.4.c. It is impossible to make competent and accurate scientific and technical recommendations for technology transfer, crop improvement, reforestation and the planting of living, natural soil erosion control barriers as purported in the AOP, the Les Cayes Watershed Management Project and other proposed projects unless one has basic information about the soil. There is a wide range of soils, varying in pH and macro and micro nutrients, within the various A.I.D. project sites, where we are spending or proposing to spend millions of dollars on guesswork.

D.4.d. A classic example of the need for soil testing is in the Hinche region where Leucaena and neem will grow very well in one area and maybe a mile or two down the road it will bomb out. This is probably due to microsite difference and more specifically the soil type and fertility and/or pH. (Possibly the problem is a micronutrient defeciency of molybdenum which stimulates the functioning of Rhizobium. This can be corrected for about $1/ha). How can the AOP have the audacity to waste farmers' time and AID money by gambling on the unknown, telling the farmers to plant trees that don't grow? For a few dollars more, you could do a first class job by giving the farmer the right information and increase his income from tree planting. By assuming this hit-and-miss attitude toward development, the AOP is turning a lot of farmers against planting trees. Once burnt, twice wary.

D.4.e. Seed for a new high-performance tree, grass or food crop cultivar (such as that identified for planting in the Les Cayes Targeted Watershed Project) is a common product of modern agricultural research. The plant that emerges from the seed or clone, however, is sensitive to the environment in which it is planted. When the seed or clone of the cultivar is transferred to new locations, the cultivar does well in certain places and poorly in others. For the new cultivar to perform well in a new location, the person and agency responsible for making the transfer must make sure that the environmental characteristics of the transfer site match the environmental requirements of the new cultivar. Most transfers are made, however, without complete knowledge of the environmental requirements of the transfer object and the environmental characteristics of the site. The success of such transfers therefore often depends on chance. Since faulty technology transfers are as costly to the recipient as successful transfers are profitable, one aim of agricultural research is to maximize successful transfers and to minimize failures.

Two things are needed to properly evaluate a country's soil resources for agrotechnology transfer: a soil classification system that serves as a guide for making and interpreting soil surveys, and a soil survey of the area itself (Soil-Based Agrotechnology Transfer, J.A. Silva, Ed., Appendix XVI). Haiti has neither.

The production capability of any plant is limited to the capacity of the soil and the environment in which it is planted. Unless you know the capacity or limitations of the soil, you cannot make accurate predictions or recommendations on improving crop yields or for tree planting and agroforestry. After 10 years' assistance, it is appalling to find that the Mission has yet to develop in Haiti the capacity to test soils beyond pH, and perhaps a sometimes inaccurate assessment of N-P-K. Both, I understand, have to be done by a private company, which has limited capacity and often does not have the time. The testing of soil samples by sending them to the U.S. is inadequate, too time consuming, and inappropriate. They are lost, mixed up or never done.

D.5. Mechanized Haitian Mix With Microbiological Component-- I urge the Mission to give a grant to ODH to establish a central, mechanized operation to make a Haitian Mix for supply to all nurseries. This would also provide needed backstopping for the upcoming Les Cayes Watershed Project. Ideally, ODH will find a Haitian(s), who would want to do this as a private sector venture (in fact they already have), and ODH would provide them technical and managerial assistance until it could become self-sustaining and profitable. (See D.6. for mycorrhizal component)

D.5.a. There has been a lot of discussion about each nursery making its own "Haitian Mix" compost in order to become self-sustaining. This is impractical: I urge you to read the literature! There is a plethora of scientific research and information listing the difficulties of making a viable compost mix for use in nurseries. It takes a high level of technical competence and considerable amount of time dedicated to making organic nursery mixes, which unfortunately most PVOs do not have.

D.5.b. It is also impractical to think that the smaller PVOs could purchase peat moss offshore without assistance. The volume that each would require is small; therefore, they would pay a premium price--at least double what they now pay through the project--and they would meet untimely delays in the importation of these small amounts. And this peat moss is without mycorrhizal fungi!

D.6. Inoculating Haitian Mix with Mycorrhizae, and inoculation of seedlings with Rhizobium and frankia--I recommend that the Mission contract for technical assistance for inoculating Haitian Mix with mycorrhizal fungi, through the S&T/AGR-funded project with NifTAL at the University of Hawaii. Growth media such as peat moss, vermiculite, perlite, builders' sand and pine bark are devoid of mycorrhizae (OTA, 1985, Appendix XVII). ODH's Haitian Mix is also devoid of mycorrhizal fungi since it is self-sterilizing through

heating during composting. Mycorrhizal inoculum can best be applied in the nursery, and once the trees become infected, the benefits can be transferred to wherever the trees are grown (Johnson, and Menge, 1982, Tab B). NifTAL could also provide expertise on inoculation with Rhizobium and frankia (see below).

D.6.a. Under natural conditions, trees cannot survive without mycorrhizae. Actually, the greatest need for mycorrhizae is when the seedling is outplanted.

D.6.b. Legumes, such as Leucaena, form a symbiotic association not only with Rhizobium, but also with a group of beneficial soil fungi known as vesicular-arbuscular mycorrhizal (VAM). Legumes such as Leucaena depend on these fungi for the uptake of immobile nutrients, such as phosphorus and molybdenum. The former is necessary for plant growth, the latter for the proper functioning Rhizobium, the nitrogen fixing bacteria also associated with the root system of Leucaena and other trees (Taufigul & Habte, 1985, Appendix XVII).

D.6.c. Research at the University of Hawaii shows that a significant increase in growth is gained when Leucaena is inoculated with an improved strain of mycorrhizal fungi (G. mosseae) than when it is not (Appendix XVII). This indicates that symbiotic effectiveness of indigenous mycorrhizal fungi is inferior to that of improved strains (South & Habte, 1985, Appendix XVII).

D.6.c.d Seedlings planted without mycorrhizae in a forest area (of which Haiti has few) will develop mycorrhizae, but it requires several months. In the meantime, intake of water and nutrients may be deficient and non-mycorrhizal roots may be invaded by harmful soil pathogens. There is evidence that mycorrhizae will protect roots from attack by root aphids and nematodes and even protect the plant from phytotoxins produced by soil microorganisms (Zak, 1975, Appendix XVII).

D.6.e. Inoculation with mycorrhizal fungi shows tremendous promise for improving survival and growth of trees on disturbed, eroded and other adverse sites, as well as on normal reforestation sites. Trees with abundant mycorrhizae have a much larger, physiologically active root-fungus area for nutrient and water absorption than trees with no mycorrhizae (Marx, 1977, Appendix XVII).

D.6.f. Inoculating citrus (grown in fumigated soil) with mycorrhizal fungi will increase the growth by as much as 1600% (OTA, 1985, Loc. cit.). Outplanting success of mycorrhizal-inoculated seedlings significantly exceeds that on nonmycorrhizal seedlings in most circumstances (Trappe, 1977, Appendix XVII).

D.6.g. Inoculating all fruit trees with mycorrhizae is a standard practice in the United States, Europe and elsewhere, and has been done for centuries. (Before commercial inoculant became available, roots from established fruit trees were chopped up and added to the soil in which seedlings were grown.)

D.6.h. It has been scientifically proven that casuarina species will not survive and grow unless inoculated with the right strain of frankia (NAS, 1984, Appendix XVII). Therefore, seedlings must be inoculated with frankia in the nursery (if healthy older casuarina are already growing nearby, the frankia from these trees can spread and inoculate adjecent seedlings). Yet the AOP consistently introduces and plants casuarina without incoulation. And these trees stagnate and finally begin to die within a year or two, much to the dismay of the AOP field reps, agronomes and farmers who scratch their heads and wonder why. I found that either the technicians working in the AOP were unaware that casuarina needed to be inoculated or they were unable to get inoculum because of logistical problems.

D.6.i. It has been scientifically proven that Leucaena performs better when inoculated with the proper strain of Rhizobium (Appendix XVII, 1984 IITA Report). However, this species has been consistently planted without inoculation or inoculated with expired inoculum that was probably dead. As a result, performance has been

spotty. Reasons given for not inoculating the Leucaena were: (a) unaware of need, (b) none was available, or (c) logistical problems.

D.7. Centralized Purchasing Unit--I recommend that in conjunction with the AOP extension, the Mission fund a Central Purchasing Unit to purchase nursery/agricultural supplies by either (a) funding a full time purchasing agent and assisting ODH to obtain a franchise for importing goods, or (b) contracting with a private company, such as the Agri-Supply Co., as long as it agrees to a fair profit margin.

D.7.a. The AOP and the fruit tree projects are severely handicapped by not purchasing supplies and equiptment through a Central Purchasing Unit. And if the AOP is terminated, the small PVOs will have to pay very high prices for commodities. For example, the price of peat moss will double. Since the PVOs buy in small quantities, they (a) pay higher prices, and (b) suffer inordinate delays.

A case in point is an order for fruit tree nursery supplies by St. Christo (Reboisement Total) which has not been filled, causing a delay of one season in the preparation of fruit trees for outplanting. The order was too small for a purchasing agent to really care about fulfilling it on time. The normal time for

St. Christo to produce a graft from seed is 7 months (ready for outplanting in 14 months), but due to this delay it will take 12 months (now 19 months).

D.7.b. Also, fruit trees were severely damaged by scab, because there was no pesticide (Benlate) in country, and it couldn't be brought in within a reasonable time. Both ODH (through its various companies) and a private company like Agri-Supply buy in large enough quantities so that a purchasing agent would provide timely service. Also, both would face minimum delays in clearing their supplies through Haitian customs.

D.8. Refocus of Research---None of the project participants were doing the quality, level and type of research necessary for proper scientific backstopping of the project. This includes, PADF, CARE, ODH and the U of M. The major reasons are:

D.8.a. Research by PVOs is in direct conflict with the time needed for the field staff to deliver the large number of trees required by the project design.

D.8.b. The research component should be refocused to provide direct and needed support to the AOP. PVO participants, CARE, PADF and ODH, should not have the responsibility for research, but

should be charged only with full cooperation with a separate research unit. Either funding should be provided to the above PVOs to hire agronomes, who would serve as full time research coordinators, to work with the research unit, or the research unit should have funds to hire agronomes and assign them to the PVOs.

D.8.c. The AOP should provide funds to pay for the participation of undergraduate students from the Faculty of Agriculture and Veterinary to conduct research within the scope of the AOP. This would be fertile training for future Haitian agronomes.

D.8.d. University of Maine (UOM)--<u>The research agenda of the University of Maine is not responsive to AOP and field needs</u> was the conclusion of the PVO field representatives and agronomes, nor did it lift the burden of research off their shoulders. The field reps and agronomes also felt that UOM'S research agenda should focus more on meeting farmers' needs. Furthermore:

D.8.d.(1). UOM's staff are not properly trained in scientific research methodology, clearly indicated by the reports that were written;

D.8.d.(2). The length of time that UOM's researchers spend carrying out specific tasks is too short;

D.8.d.(3). UOM's researchers do not have the necessary backstopping to do good research (e.g., access to soil testing, good germ plasm, Rhizobium, etc., record keeping facilities);

D.8.d.(4). Adequate research topics have yet to be identified by UOM and USAID for the AOP; and

D.8.d.(5). UOM is being required to do too much research during too short a time with inadequate staffing and training. Much of the research they are charged with is not directly related to the AOP and seems more related to the Les Cayes Targeted Watershed Project. Perhaps their best research is that of Balazano's, limited to two villages, which may have little relevance to the other areas in Haiti covered by the project.

In one quarterly report, Roland Dupuis reports, "It has been necessary for us to do the weeding and water catchment basin repairs ourselves. This has consumed large amounts of time originally not in the workplan which should have been spent measuring species trials." If the University of Maine doesn't have enough time to do good research, how can the PVOs be expected to plant trees and do research at the same time?

D.8.e. A unanimous expression by PVO field representatives and agronomes working under the various programs is that much of the research should be agroforestry-related. However, I do not recommend that the AOP spend a lot of time undertaking agroforestry research. But I do recommend that.

D.8.e.(1). There are many available agroforestry technologies that can be readily transferred and adapted in Haiti, an example being Living Yam Poles (Appendix XV). This paper had been sent to the Mission, but it never was translated or sent to the field. Another justification for the recommended Agroforestry Information Clearing House and Outreach Center (Section D.3.).

D.8.e.(2). The best agroforestry that the field technicians could introduce is improved plant material, such as the IITA pigeon peas which are perennial and grow a large amount of biomass (tree variety), while producing a large amount of pois.

D.8.e.(3). Several field reps and agronomes thought research is needed to identify and develop shade-tolerant plants for agroforestry systems. Most food crops that have been genetically improved have been selected for optimum production under full sunlight. Cucurbits and aeroids (coco yams) are some of the most shade-tolerant plants grown in agroforestry systems.

Wild yams, such as Discorea hispida, have condiderable shade tolerance; however, IITA, the international center, that has the mandate for research on yams, has not looked at Discorea because of its bias toward sunlight loving yams. If the Mission is interested in research on shade-tolerant yams, it should cable Dr. Nyle Brady, Senior Administrator for Science and Technology, to see if interest could be created within IITA to look at the genetic potential of these yams.

D.8.f. Species trials--The species trials that have been conducted under the AOP are of limited use unless the purpose is to prove which provenances of species (of unknown germplasm) will survive, with limited growth, on soils of unknown pH and nutrient content, with no scientific inputs.

D.8.f.(1). Two-thirds of the species planted in the species trials should never have been planted, for they were known not to perform on that type of site, were weeds and would be of no economic value to Haiti or the Haitian farmer.

D.8.f.(2) Field reps were not aware of previous species trials in Haiti, which could provide valuable insight. The rep in Les Cayes was unaware of species trials paid for and conducted by the Mission in the region of Levey Farm. Also, reps were not aware of the results of the FAO species trials conducted through MARNDR. The University of Maine just recently obtained a copy of it.

D.8.f.(3). There have been and continues to be a lot of reinventing the wheel and mistakes because of a lack of information pertaining to site conditions and environmental requirements of different species.

D.8.f.(4). Many species and provenances of species being recommended to Haitian farmers for outplanting are inappropriate for the site. In some of the trials, by reading available information, 2/3 of the species should never have been planted because they are known not to perform well on that type of site. Others could have performed well, but didn't because the germplasm was not right for the site, slight soil ameleoration was necessary, or the seedlings were not inoculated with frankia, Rhizobium or mycorrhizae (See Section D.6.). For example:

> The participants were unaware of soil pH and nutrient content on most planting sites, assuming that the soil was probably of a high pH, since it was derived from limestone. In one area, Leucaena leuceocephala showed the most promise for the farmer, out-performing other species; but due to microsite differences, it bombed out a few miles down the road, making the project look bad. Leucaena would probably grow equally as well on these other sites if soil differences were known and ameleorated.

D.8.g. Very little is known about why farmers are repeat planters of trees. From the quality of the trees being distributed and the poor performance of many, I might surmise that many of the repeat planters are searching for a winner because of past failures. They have faith in blanc and know that we must have something that works, if only they keep trying.

D.8.h. Research is needed to find the economic trade-offs of putting out a seedling that is a little stronger. This may be done in two ways: (1) by growing the seedlings in a larger container than the #5. Several of the field reps felt that this make a stronger tree and make the farmer dig a bigger hole, which increases water infiltration and reduces L & J-rooting; and (2) by growing the seedling for a longer time in the nursery. ODH found that survival and growth of out-planted Casuarina equisetifolia that had been held over was significantly higher than seedlings distributed for planting at a younger age (the normal recommended age). One explanation may be that nurseries in Haiti are not inoculated with mycorrhizae, and it takes several months for fungi to affix itself to plants that are not inoculated.

D.8.i. Most trees do much better planted on cultivated soil than on undisturbed land (such as State land in the Hinche area). Research is needed to determine how much soil needs to be disturbed to increase survival and growth. Research has shown that when a

seedling is planted in a larger hole, survival and growth are significantly increased over those planted in small holes. This is directly related to root development and water infiltration. Also, on cultivated soils, there is less competition for water and nutrients from weeds as compared to food crops.

D.8.j. Some field reps felt that the size of the root trainers should be increased from a #5 to at least a #6, which would produce a stronger seeding with a higher survival rate. Research by the University of Maine has already substantiated this. The reps thought that larger root balls on seedlings would also force more farmers to dig a larger hole and reduce the incidence of L & J rooting.

D.8.k. Direct Seeding--If reforestation costs are to be reduced and widescale reforestation is to be undertaken, we must develop direct seeding technology. Prosopis (mesquite) was spread throughout Mexico up through Texas along the cattle drive trails because the cows ingested the sweet mesquite seed pods and the seeds were scarified by the acid in their rumen and deposited along the trail in the nutrient-rich droppings. This is a fine example of direct seeding technology. This method has been duplicated with pasture grass and legume seed by feeding it to sheep. I recommend that the Mission initiate a small research project in cooperation with Winrock at Hinche feeding the goats Leucaena seed, with

inoculum and possibly other nutrients such as phosphorus and potassium (blood and bonemeal) to produce pelletized Leucaena seed. Stranger happenings have succeeded! I further recommend that NifTAL provide technical assistance for this research project since they have the expertise in Rhizobium production and inoculation.

D.9. Demonstration Sites of Leucaena Contour Hedgerows--Under the AOP funds should be provided to purchase seed and to establish demonstrations of Leucaena contour hedgerow technology on every PVO site and every farm of the animateurs and agronomes. Unless the agronomes and animateurs begin to set an example and practice what they preach, they will not have much of an impression on farmers. Many of them are neglecting their own farms while they work on the AOP. Once the benefits of this technology is demonstrated, farmers will pick up on it and begin to plant the contour hedgerows themselves. This has happened in countries such as Indonesia and the Philippines. Contour hedgerows (alley-cropping) are thought to benefit the farmer so well that three international research centers (IITA, ILCA and ICRISAT) are promoting this technology (Appendix V).

D.10. Increased AOP Relationship with MARNDR and Other Projects and Activities--I recommend that the AOP form a closer relatonship with MARNDR and other Mission projects and activities in order to serve Haiti and its people more effectively. Also, the AOP extension, if it incorporates the above recommendations, will provide the needed scientific and technical backstopping for the Les Cayes Targeted Watershed Management Project and other related activities, ongoing or planned.

Relationships include:

a. MARNDR
b. the Fruit Tree Projects
c. Winrock Goat Project
d. Other Present and Planned Mission Projects and Activities.

D.10.a. MARNDR--In spite of a certain reluctance within the Mission, the AOP should begin coordinating activities with the GOH. The following are suggested:

D.10.a.(1) Providing MARNDR with courtesy copies of reports, etc.

D.10.a.(2) All PVO participants who work on the AOP should be introduced to the Chief of the Natural Resources Division at MARNDR.

D.10.a.(3) The Chief of the Natural Resources Division should be offered the opportunity to meet all consultants (including project evaluators) on the AOP.

D.10.a.(4) MARNDR should be offered the opportunity to participate in the proposed Agroforestry Information Clearing House and Outreach Center by seconding a person to the Center. In this way MARNDR could from and give information to the Center.

D.10.a.(5) The AOP (CARE) could coordinate with MARNDR in the Northwest, if the Ministry were willing to undertake the establishment of windbreaks in the area of Exchange village. Although there is adequate rainfall in the area, the moisture is sucked out of the ground by the prevailing winds, and agricultural production could be increased in the area by establishing bamboo windbreaks (Appendix XVIII).

Bamboo grows prolifically in the area, goats do not eat it and it would provide raw materials for handicrafts and cottage industries if connected to markets. Villagers said that they used to make a lot of baskets from bamboo for export to other parts of Haiti. When asked why they stopped, villagers said there was no more market. With cottage industries such as this, the market is often lost when the villagers quit producing in volume, a result of lack of raw materials (they usually don't replant).

D.10.a.(6) MARNDR should incorporate fruit tree technology extension and germplasm improvement into their activities. If data, such as that being computerized by ORE, is processed into the proposed Agroforestry Information Clearing House and Outreach Center, it would be in a form that MARNDR could use.

D.10.b. The AOP should be supporting the fruit projects in a number of ways, such as technical assistance (entomologists and pathologists), importation of disease resistant plant material, soil testing, mycorrhizal inoculation, and complementary planting. For example:

D.10.b.(1) The fruit tree projects are severely handicaped by not purchasing supplies and equipment through a Central Purchasing Unit. As cited in D.4. (above), a case in point is an order for fruit tree nursery supplies by St. Christo (Reboisement Total) which has not been filled, causing a delay of one season in the preparation of fruit trees for outplanting. The order was too small for a purchasing agent to really care about fulfilling on time.

D.10.b.(2) Leucaena planted in a circle around the base of a fruit tree, and cut 3 or 4 times a year with cuttings placed around the base, can enhance earlier fruiting and increase yields.

D.10.c. Winrock Goat Project--For every goat distributed under the Winrock program, the recipient should have to plant 50 forage trees such as Leucaena. This could be in a form of hedgerow around the house or on the border of a field. A forage production activity should be undertaken in cooperation with the distribution of goats by Winrock. Goats are very destructive--they damage newly planted trees and prevent natural regrowth of vegetation. Farmers cannot be expected to tether and feed goats unless surplus forage is made available.

Though we often think that the Haitian farmer doesn't feed goats, it is biologically impossible for goats to survive without feed. Nevertheless, the farmer does not feed his goats well. However, improved goats have a much higher feed requirement than native species and must be given a more nutritious diet if they are to perform as expected.

D.10.d. Food-for-Work Program--The AOP should solicit support from the food-for-work program for windbreak establishment [see D.10.a.(5)], and for road repair. In the Northwest area, where CARE works, many roads are nearly impassable, and their repair would greatly facilitate the AOP work in that region.

D.10.e. Linking Tree Nurseries to Child Feeding--School tree nurseries can serve as an effective medium to teach the new generations in Haiti the value of trees. Schools can serve as focal points through which to introduce new technologies, conduct demonstrations and carry out extension. School nurseries and mini-parks, fuel plantations and fruit orchards (planted by the school children) can serve as practical laboratories and excellent mediums through which subjects such as biology, science and environmental studies can be taught. More efficient stoves can be demonstrated if hot meals are served at the schools.

Basic science concepts such as combustion and heat exchange can be taught, and fuelwood conservation--in terms of real monetary savings--could be calculated. This information can be easily disseminated through the school and by students to their parents and other villagers.

Each student is a potential extension agent, and can easily influence parents. Students will take home tree seedlings to plant around the house or in the kitchen garden. Unlike their parents who have already developed attitudes and mindsets, students have open minds, are eager to learn new things, are readily accessible, relish outside activities and are a captive audience. I understand that CARE is incorporating this approach for its future activities (Appendix VI).

D.11. Changes in the Fruit Tree Projects--The following changes are recommended:

D.11.a. Two of the three fruit tree projects should be incorporated into, or closely coordinated with, the AOP. A major share of the fruit trees should be distributed through the AOP, since these projects do not have a distribution system set up and have little money for this purpose. For transportation to difficult areas, a pack for donkeys and mules should be designed whereby plastic milk cases are attached to the panniers of the packs. A donkey or mule can be hired to pack the fruit trees for a couple of dollars a day and this would infuse money into the local economy while solving the transportation problem.

D.11.b. Either the SHEEPA Fruit Tree Project should be terminated, or a condition precedent be imposed to force them to hire a competent technician (comparable to the French technical expert employed by ORE) to upgrade the quality of the fruit trees.

D.11.b.(1). At the present time, I do not think that the quality of the plant material in the SHEEPA nursery justifies the expense of the project, and this project is earning a very bad name for the Mission. From interviews, it is concluded that SHEEPA is not grafting improved-imported budwood onto local root stock, rather local budwood is being used. Granted, the local budwood for the

orange may be a little sweeter than the sour orange, but it is not of export quality and will bring little more than sour oranges on the local market. I was told that the mangos and other grafted stock were of the same local quality.

D.11.b.(2). I was told by the 4-VEH nursery man (near Limbe) that SHEEPA brought a lot of grafted trees from them for distribution under the Mission funded project. These trees also used local budwood, which may be a cut better than that already planted by farmers, but it is not as good as imported budwood and should not be confused with it or distributed as improved trees.

D.11.b.(3). I saw a large number of "grafted" trees on which the buds were dead. The nurseryman at SHEEPA told me that these were trees that they had taught grafting techniques on. If they can't make the grafts take, they are teaching a "dead" technique, which the Mission shouldn't be wasting its money on. If they can't teach them right, they shouldn't teach them at all.

D.11.b.(4). I was told by knowledgeable people that SHEEPA did not distribute trees to anyone who couldn't plant 50 or more. This is not helping the small farmer, but perhaps these planters would be willing to furnish budwood to others in the future: <u>That is, if they were ever given grafted trees with improved budwood</u>.

D.11.b.(5). SHEEPA is growing many of its grafted trees in bags that hold more than 5 gallons (some looked to be 10 gal.). It will take a forklift to lift these and they will have to be transported by tractor-trailer.

D.11.c. I recommend that the fruit tree projects be provided additional funding to train animateur grafters to begin extending grafting into the villages. This is one way to make these projects more self-sustaining (in Jacmel, farmers pay up to $5 for a graft with imported budwood). It was reported that someone paid up to $130 for a imported grafted Mandarin orange in Jacmel and the fruit sells for 1 gourd each on the local market.

Grafting on site is cheaper and the trees bear improved fruit of higher quality much sooner than grafted seedlings distributed from a central nurseries, since the root stock is already established (the tree doesn't suffer transplant shock) and they are older. There are an estimated 20 million sour orange trees in Haiti. Many households have as many as 5 sour orange seedlings/trees in their kitchen gardens. By funding grafting extension, improved budwood can be established in each village in a very short time, and once they are demonstrated to be superior, other farmers will readily request that their trees be grafted.

D.11.d. The species of fruit trees should be expanded to include breadfruit (not to be confused with the breadnut tree). When asked which additional species should be added to the AOP, everyone (project grantees--AOP and fruit tree and Haitian peasants) listed breadfruit as the number one priority.

However, breadfruit is generally propagated from root cuttings and only a limited amount can be produced in this manner; therefore, a sum of money should be set aside for research on the vegetative propagation of breadfruit in order to increase seedling availability for distribution. This should be done under the program for the genetic improvement of trees (Section D.2) of the AOP extension. Plant material of shorter varieties should be imported, propagated and distributed; this makes them less susceptible to hurricanes.

D.11.e. The Mission must soon embark on a marketing program for the fruit produced from this improved stock, for the local market can absorb only a very limited amount and the farmer will not be any better off in the future than he is now with unimproved fruit trees. Most Caribbean nations are deficient in fresh fruit and must import to serve both local and tourist needs. The Mission should fund a market study through the private sector of the potential of exporting fruit from Haiti to the other Caribbean nations.

D.11.f. In light of the inevitable EPA ban on pesticides now used to prevent fruit fly infestation into the U.S., the Mission should consider providing some funding to the private sector for assistance on irradiation of fruit and other products so that they are acceptable for export to the United States and elsewhere.

D.13.g. Papaya trees die because of Mosaic. There is a mosaic-resistant papaya, and this germplasm should be introduced, reproduced and distributed in Haiti.

D.11.h. Cashew trees distributed by SHEEPA were dying of disease. Again there are resistant cashews, and this germplasm should be introduced, reproduced and distributed in Haiti.

D.11.i. ORE is developing a data base, recording the passport information on origin of improved grafting material, performance of grafts, survival rate, disease/pest problems, etc. This is very valuable information and should be done by the other fruit tree projects. This information should be programmed into a larger data base system in the Agroforestry Information Clearing House and Outreach Center.

D.11.j. ORE would like to expand its operations to put an additional fruit tree nursery at a higher elevation (728 meters, near Plantons), where pears, apples, peaches and other cooler

weather demanding fruit would grow well. This is very good in theory, but how and where would the fruit be marketed? Without a good marketing system, growing fruit at this elevation would do the farmers little good.

D.12. Continued Support to ODH for Plantation Forestry--The AOP must continue its support to ODH for research on plantation forestry and for nursery improvement if there is to be any substantial impact on the problems of deforestation in Haiti. There are two ways to reduce deforestation and the degradation of natural resources in Haiti: increase production and relieve the causes of the problem, which will allow natural regeneration of the vegetation. The Mission, through the AOP, must muster all forces to combat deforestation and facilitate reforestation. Small farmer production is one way; however, this is a very slow and painful process.

D.12.a. At the rate that small farmer tree production increases were accomplished under the AOP, it will be several generations until the needs of Haiti can begin to be met. Therefore, promoting plantation forestry among larger land owners is imperative if the Mission is to achieve tangible and measurable inroads in the problems related to deforestation in Haiti.

D.12.b. Plantation forestry can be very profitable, create jobs and produce raw materials needed for construction and small industries in Haiti if it is done right. Trees must be planted using good technology, as with any other agricultural crop such as tomatoes; using top quality germplasm chosen to match the site and desired product. You wouldn't plant tomatoes without doing soil tests to find out the pH, saline content, and nutrient availability. To grow good tomatoes profitably you fertilize them. The same goes for trees (see attached Tech. Series #7, Tab A). You also have to inoculate the trees and develop techniques to increase the hardiness of the seedlings (see D.8.h. of my report). These are the things that ODH must be funded to do through the AOP Extension if the Mission is to do the job right.

D.12.c. The mangrove estuaries are being destroyed in Haiti to produce charcoal and poles for the markets of Port-au-Prince and other population centers. On the waterfront going from the U.S. Embassy to the airport, you pass a market where poles are being sold. A primary tree species being sold there is red mangrove. If you want to reduce and/or stop the cutting of the mangroves, you must produce good cheap poles in plantations for sale on the market. Neem trees are a viable replacement for the mangrove poles, can be grown cheaply and quickly in plantations, and are very durable.

D.12.d. Port-au-Prince consumes a very large share of the charcoal produced in Haiti, and charcoal production is a major cause of deforestation. This energy need can be met by good plantation forestry near Port-au-Prince, which will relieve this pressure and allow the regrowth of natural vegetation.

D.12.e. Port-au-Prince also consumes a lot of firewood in small industries such as bakeries. Plantation forestry can also meet these needs.

D.12.f. Haiti imports most of its wood for woodcarving, furniture making, construction, etc. These needs can be met through plantation forestry if the right species are planted correctly.

D.12.g. Haiti imports most of the raw materials for livestock feed. Plantation forestry of Leucaena, coupled with the growing of agricultural crops, can meet most of these needs (once the import monopolies are wiped out).

D.12.h. ODH is the PVO to improve the "Haitian Mix" and inoculate nursery medium and seedlings with Rhizobium and mycorrhizae. ODH is also a possible candidate for a central purchasing agent and should subcontract the Genetic Improvement of Trees. Ane ODH should support the establishment and maintence of seed orchards and grow and sell new tree crops such as dwarf coconuts and breadfruit as recommended in this report.

E. OBSERVATIONS:

E.1. PVO field reps do not have the necessary equipment to do the job that they are supposed to do.

E.1.a. Each of the field reps should be provided with a small kerosene refrigerator and a small igloo portable ice chest for the transportation of Rhizobium, frankia, etc., to the field site and storage there. Field reps do not now have this equipment and cannot carry out necessary inoculation of seedlings in the nurseries. This would serve as a central storage facility, which would serve nurseries of smaller PVOs.

E.1.b. Under the AOP, CARE should build adequate housing for their field rep in Bombardopolis so that he (or she) will not have to spend so much time on the very poor and sometimes impassable roads. This would markedly increase the efficiency of their operation in that region and relieve unnecessary personal pressures on their field rep.

E.1.c. The CARE field reps in the Northwest need winches for the jeeps, for the roads are nearly impassable during the rains, and jeeps often slide off the roads. I cannot see why the AOP jeeps in Port-au-Prince have winches (when the people who drive them spend most of of their time on paved roads or drive on unpaved roads in the dry season), while field reps don't.

E.2. Some Leucaena trees planted on very rocky soil, which were about 2 1/2 to 3 years old tipped over because of the weight of the heavy foilage. The tap roots never penetrated the rocky soil. Probable causes are: The farmer never dug deep enough holes and the seedlings were J or L rooted when planted. Or the trees had been planted in a depression in a solid rock. If this is a frequent occurrence, I recommend that the trees should be harvested at about 2 years and allowed to coppice, reducing the weight of the canopy.

E.3. Cassia samea does not seem to be very good for interplanting with food crops because of root competition.

E.4. In the Northwest, Gayac (ironwood) is considered to make the best charcoal, Bayahond (Prosopis) is considered as second best and Leucaena makes the third best charcoal.

E.5. Field reps, agronomes and animateurs should encourage farmers to plant trees near their houses, where they would receive better care and be protected from animals. They should also be taught that trees such as Leucaena can produce large volumes of forage if planted as hedgerows around their houses, and once they learn this the farmers would be more apt to adopt a cut-and-carry system for their livestock.

E.6. Top pruning Leucaena seedlings causes excessive branching and the tree will be of poor form. Top pruning other species may have the same result.

E.7. The AOP should purchase and give to every PVO field rep and agronome a copy of "Nomenclature Polyglotte des Plantes Haitiennes et Tropicales," A.V. Pierre-Noel, Presses Nationales D'Haiti, 1971. Several of the reps and agronomes knew local names of plants and trees that they were interested in but cannot identify them scientifically.