ECONOMIC EVALUATION
OF THE
AGROFORESTRY OUTREACH PROJECT

by

Gerold Grosenick

WORKING PAPER SERIES

Working Paper No. 6

The author is an economist for the University of Maine Agroforestry Outreach Project. The work reported here was sponsored under USAID Project No 521-0122.

April 1986

1986

ATTACHMENT II

EVALUATION OF TECHNICAL PERFORMANCE

AGROFORESTRY OUTREACH PROJECT (521-0122)

John E. Palmer
Latin America Coordinator
Forestry Support Program
(USDA RSSA BST-5519-R-AG-2188)

US Department of Agriculture
- Office of International Cooperation and Development
- Forest Service

US Agency for International Development
- Science & Technology/Forestry, Environment and Natural Resources

AGROFORESTRY OUTREACH PROJECT (521-0122)

Evaluation

1. Executive Summary

2. Method of Evaluation and Scope of Work

3. Summary of Project and Accomplishments
   - 3.1 Overview
   - 3.2 Operation Double Harvest (ODH)
   - 3.3 CARE
   - 3.4 Pan American Development Foundation (PADF)
   - 3.5 University of Maine (UMO)

4 Critical Assessment of Project and Accomplishments
   - 4.1 Overview
   - 4.2 ODH
   - 4.3 CARE
   - 4.4 PADF
   - 4.5 UMO

5. Findings and Recommendations
   - 5.1 Overview
   - 5.2 Fruit Trees
   - 5.3 Income Generation verses Soil Conservation
   - 5.4 Targeted Watershed Management Project (TWM)
   - 5.5 Recurrent Costs and Sustainability
   - 5.6 Economics
   - 5.7 Base Counts
   - 5.8 Research
   - 5.9 Survival Rates
   - 5.10 Species/Site Relationships
   - 5.11 Treed Seed
   - 5.12 Nursery Operations
   - 5.13 ODH
   - 5.14 CARE
   - 5.15 PADF
   - 5.16 Harvesting
   - 5.17 Extension

1. Executive Summary

The Agroforestry Outreach Project (AOP) is the principal USAID/Haiti effort in forestry, energy and natural resources management and conservation. The AOP was authorized on September 32, 1981 for $ 8 million and on December 14, 1984 it was extended to March 31, 1987 with $3.5 million added to continue the original purpose.

The goal of the Project is to reduce, and ultimately reverse, the ongoin degradation of Haiti's natural resources, and thereby maximize the productive potential of its land. The primary purpose of the Project is to motivate Haitian peasants to plant and maintain trees and to achieve the planting and maintenance of a substantial number of trees. A secondary purpose is to obtain reliable information on the technical, economic, and social variables of forestation in Haiti. The Project Paper (PP) also states that trees planted will normally be planted for one or more of the following objectives (subpurposes); 1)Soil conservation; 2)Increased supply of fuelwood; and 3)Income generation.

It is doubtful the Project designers envisaged that the Project, on its own and within four years, would halt and reverse the degradation which has been going on in Haiti for over a 100 years. Instead the Project was designed as an experiment to test various approaches, through non-governmental organizations, for motivating farmers to plant and maintain trees. This has been accomplished.

Farmers have been motivated to plant and maintain trees in hopes of financial gains from personal use and selling of tree products. The side benefits have been a reduction in accelerated soil erosion, increase supply of fuelwood, income generation, and a large trained group of agronomists, animateurs, and moniteurs.

The Project has also been successful, through the efforts of CARE and PADF, in establishing technically sound systems for production and delivery of seedlings. These systems are extremely valuable and could be used for delivering a variety of technologies to farmers including planting and maintaining fruit trees and marketing agricultural products.

An important part of these systems is the nursery network. The number of nurseries and their geographical locations seem adequate to meet Project needs for many years to come. Seedling quality is good in all nurseries visited.

It is apparent that the Haitians running the AOP nurseries have received very good training and could, without outside technical assistance, continue to operate the nurseries. Technical assistance would be needed in the nursery if the present routine were to be changed by introduction of a tree improvement program, new species, or new technologies.

The major problems remaining with the nurseries are a lack of uniform record keeping and control of seed collection. Record keeping is important for duplicating successful planting, determining causes for failure, and testing new species or programs.

The implementation of the Project through four diverse organizations has had good results. During the early stages of the Project, CARE and PADF were able to rely on ODH to produce tree seedlings, while they concentrated their efforts on training and farmer motivation. Experience in other countries has shown that sound nurseries and quality seedlings do not guarantee outplanting, thus this approach proved very sound.

The geographical dipersion of the Project, that is, not being concentrated in selected watersheds, has had benefits in reaching more farmers and exposing more communities to the feasibility of cropping trees for income and other uses. The technologies learned are being spread to a much wider audience. The impact of this could be very positive in a long-term effort.

The Project need not be changed to continue its accomplishments. It is not to say that improvements could not be made, but that what is being done is successfully meeting USAID/Haiti's goals. The author feels that some changes leading to improvement are warranted. The author also strongly cautions the designers of any follow on project not to destroy what are the primary reasons for the project's success, that is, its flexibility of design and simplicity of objectives. Any changes that increase its complexity will equally increase its chances of failure. The most obvious areas needing improvement are research, record keeping, documentation, and analysis of data.

Additional items the Evaluation Team was asked to consider are: (1) the fruit tree improvement projects and whether they should be combined with AOP or kept separate; (2) whether the AOP should concentrate on income generation or soil conservation; (3) what effect the Targeted Watershed Management project will have on AOP; and (4) what steps must be taken to address recurrent costs and make nursery operations and tree planting sustainable.

Recommendations

1.1 Continue growing and distributing a limited number of fruit trees with the AOP

1.2 Continue planting trees emphasizing income generation.

1.3 Continue to support Project activities for another 10 or 15 years.

1.4 Complete the economic analysis as soon as possible as the results could influence the design of any follow on project.

1.5 Study the effect of DRI's tailored packages on time and resources, tree planting and maintenance, and 12-month survival counts. During the seven percent checks, examine and make seedling counts on the farmers' other parcels.

1.6 Develop an agroforestry resource center, which should be run as a separate project component by a research group.

129X

1.7 Place Haitians in charge of tree production and planting activities.

1.8 Determine the exact causes of tree mortality.

1.9 Document existing information on species/site relationships, note gaps in knowledge, and fill those gaps, as necessary, in the follow on project.

1.10 Develop and implement a program for selection of quality tree seed and tree improvement.

1.11 Continue nursery training and monitoring until uniform records are kept.

1.12 Develop a new grant with ODH to: (1) expand testing and distribution of its prototype nursery container; (2) assist in production and marketing of Haitian mix; (3) continue data gathering and monitoring of species trials and tree farms; and (4) collaborate with the research group in product development and seed selection and tree improvement.

1.13 Develop a new grant with CARE that would continue the activities it conducts now, except CARE would only collaborate on research, not be responsible for it.

1.14 Develop a new grant with PADF that would continue its same activities, except it would only collaborate on research, not be responsible for it. PADF should work more directly with the subgrantees' central staff rather than through the moniteurs.

1.15 Stump heights should be no less than 35 centimeters from the ground, until further testing dictates otherwise.

1.16 Determine manageable extension levels for the animateurs and adhere to them.

2. Method of Evaluation and Scope of Work

The AOP evaluation team consisted of Ira Lowenthal (Team Coordinator), Jim Talbot, and John Palmer. To facilitate the Project evaluation special studies were requested from a)Mike Benge in seed selection and tree improvement, b)Fred Conway on institutional arrangements, c)Roger Webb on potential collaboration with USAID fruit tree improvement projects, and d)University of Maine for a cost/benefit analysis of Project activities.

The evaluation follows the scope of work (Annex A), the amended and original evaluation plans (Annex B), and the latest guidance for preparing evaluations (Annex C).

Relevant Project documents were reviewed which include the Project Paper (PP) and extension, the Mid-Term Evaluation, the Audit-Evaluation, the USAID/Haiti 1985/86 Action Plan and latest CDSS, and Grantee reports submitted to AID.

During the 18-day TDY, 12 days were spent visiting foresters and their field sites and six days were spent in Port-au-Prince visiting central office personnel of PADF, UMO, ODH, and USAID/Haiti. Due to some in-country complications it was not possible to visit the central CARE office or the chief technical expert of ODH. The TDY was completed February 6, 1986.

There was a special opportunity to join an annual technical meeting of all Project foresters and some of their assistants. During this meeting we were asked to consider a number of other items during the evaluaton. These are listed in Annex D.

This evaluation report only contains the findings and recommendations of John Palmer. As an evaluator many aspects of the Project were reviewed but the principle focus was on the author's specific scope of work, which was to review:

a) the technical performance of the Project grantees in the field, in terms of:
- number of trees planted under Project auspices
- survival rates obtained
- growth and yield rates achieved and expected
- species types and quality of germplasm made available with respect to (1)site-specific conditions and requirements; (2)farmers' objectives; and (3)maximization of economic returns
- technical assistance and technological packages extended, and

b) the nursery network established to support Project outreach activities, in terms of:
- number and geographical distribution
- seed and plant material provenances
- quantity, quality and timely delivery of planting stock
- seedling production systems, potential improvement program and alternatives, including seed and germplasm improvement programs, direct seeding, and vegetative propagation techniques
- nurseryman training programs
- role and potential self-sufficiency (sustainability) of regional and decentralized nurseries

3. Summary of Project and Accomplishments

3.1 Overview

The Agroforestry Outreach Project (AOP) is the principal USAID/Haiti effort in forestry, energy and natural resources management and conservation. The AOP was authorized on September 32, 1981 for $ 8 million and on December 14, 1984 it was extended to March 31, 1987 with $3.5 million added to continue the original purpose.

The goal of the Project is to reduce, and ultimately reverse, the ongoing degradation of Haiti's natural resources, and thereby maximize the productive potential of its land. The primary purpose of the Project is to motivate Haitian peasants to plant and maintain trees and to achieve the planting and maintenance of a substantial number of trees. A secondary purpose is to obtain reliable information on the technical,

131 X

economic, and social variables of reforestation in Haiti. The Project Paper (PP) also states that trees planted will normally be planted for one or more of the following objectives (subpurposes); 1)Soil conservation; 2)Increased supply of fuelwood; and 3)Income generation.

Project implementation is done under the framework of private voluntary and non-government organizations (PVOs) as an experimental alternative to working with the Government of Haiti. Grants were provided to Operation Double Harvest (ODH), CARE, and Pan American Development Foundation (PADF). The University of Maine (UMO) was contracted March 1, 1985, adding an agroforestry research component to the Project. The Project also includes a Coordination and Technical Support Unit housed in the USAID Mission to facilitate coordination efforts and provide senior level technical assistance. This latter unit is not evaluated in this report.

Evaluation of any project is not an easy task. This particular Project offers additional challenges because of its wide geographical dispersion--it covers the entire country-- and because it is implemented through four separate and diverse organizations. During the evaluation it was quickly apparent that comparison of activities and accomplishments between CARE and PADF, and even between the five regions of PADF, was neither fair nor desirable . This is because of the highly variable geographic characteristics and distinct socioeconomic communities in which each works.

The Project has successfully met or exceeded outplanting goals, including number of participating farmers, tree seedlings planted, and survival rates. Other task accomplishments have been variable especially in relation to research and reporting. Some of the specifics are outlined below by implementing organization.

Seedling production has become routine. The successful rootrainers technology of the AOP has been adopted by others in the development of their nurseries. UNICORS nursery was funded by Canada and built with rootrainers technology. They plan to build four other nurseries with the same technology. DCCH built one nursery with credit from PADF and built a second with funding from a German PVO and rootrainer technology. Save the Children and CODEPLA also built nurseries using rootrainer technology. Helvetas has five nurseries using this technology.

3.2 Operation Double Harvest (ODH)

The purpose of the $850,000 Grant to ODH is to provide support to expand and implement its reforestation program in Haiti. The AID Grant was designed to support an expanded ODH program of (1) tree nursery experimentation and demonstration, (2) select seed production and storage, and (3) hardwood forest experimentation and demonstration ("tree farms"). The Grant was extended through December 1986 and $350,000 in additional funds were added. The purpose of the Grant was not changed.

3.2.1 Nursery Experimentation and Demonstration

ODH had already begun, prior to the Project, experimenting with: (a) the appropriate compost mix for seedling development;(b)the relative

advantages and disadvantages of different types of seedling containers;(c)seedling propagation in various nursery conditions, and (d)resistance and optimal transplant age of various tree varieties. ODH was to continue these activities under the Grant.

Compost Mix: ODH has put a great deal of effort into developing a "Haitian" mix from local materials. The best Haitian mix developed so far still contains up to 20 percent of the imported peat mix.

Seedling Containers: There was no evidence of any experimentation in this area.

Seedling Propagation: There was no evidence of research in this area.

Optimal transplant age: There was no evidence of research in this area.

3.2.1.1 Species Experimentation and Selection

ODH was to carry out a variety of tests with a number of tree species in a variety of ecological settings. The species were to include: *Azadirachta indica*, *Cassia siamea*, *Casaurina* spp, and others, as appropriate. Over 40 species were tested. Appropriate nursery techniques were developed for germinating and growing seedlings. Field testing was only completed in one ecological setting, the Cul-de-Sac area, at the time of the visit.

3.2.1.2 Development of a Tree Seedling Plug System

The AID Grant was to be used to develop a prototype plug system. ODH developed, and is presently using for all of its nursery operations, the "winstrip" plug system.

3.2.2 Select Seed Production and Storage

ODH was to continue selecting seed from *Leucaena* and other promising species with superior qualities and construct and equip a modern, high-quality, seed storage facility. There was little to no evidence of any seed selection process leading to improved seed quality and trees. We were told that a seed storage facility had just been constructed but was not operational yet. Time did not permit a visit.

3.2.3 Hardwood Forest Experimentation and Demonstration

This was to be the most significant activity to be carried out by ODH through the AID Grant. The tree farms had two principal purposes: (1)to act as testing ground for research on a variety of technical variables including species selection, rainfall and fertilizer requirements, land preparation techniques, elevation and slope constraints, etc, and (2)to act as demonstration centers to illustrate to land holders (small and large), in the region, that such land can be productively and profitably used for the cropping of hardwood trees for charcoal and other wood products.

The original PP called for the establishment of five tree farms with 250,000 tree in each. ODH established nine tree farms. The Project extension called for an additional 450,000 trees and establishment of a minimum of 14 tree farms under two different arrangements (Private landowner/share cropping and State land lease/Peasant farmers). The

extension also called for a number of other changes, including testing native versus exotic tree species. At the time of the evaluation not all the additional tree farms had been established. The original nine tree farms did test different exotic species and some preliminary harvesting was done.

Economic data was gathered on profitability of making and selling charcoal and other wood products. Few other technical variables were tested. Very few reports or other data have been forthcoming concerning the tree farms.

3.3 CARE

The Northwest Agroforestry Project of the AOP was designed to develop agroforestry models which preserve the productive capacity of land in northwest Haiti and provide local farmers with a reliable source of income. Over a four-year period, CARE was to involve an estimated 3,500 farmers in planting 4 million trees on private, government, or community-owned land. The three schemes to be used were (1)planting on individually-owned property, (2)planting on state leased land by HACHO, and (3)planting on rented or share-cropped land. The Project extension allowed for an increase from $2,350,000 to $2,450,000 of Grant funds.

The regional development organization in the northwest, HACHO, which CARE was to work with, was dissolved November 1983 and replaced by ODNO, a new regional development organization in the northwest under the Ministry of Planning. CARE's relationship with ODNO has remained limited.

Due to the limited time and other disturbances , CARE's latest accomplishment figures were unavailable. CARE has involved, as of spring 1985, approximately 12,812 farmers in planting 3,781,330 tree seedlings. CARE will far exceed its original Project objectives.

CARE operates its own regional nurseries. There are 3 such nurseries. This may not necessarily be preferred, but due to a lack of PVOs in the northwest region it is their only choice. CARE started a program and has developed 18 local (community) nurseries. These local nurseries use the more common plastic bag technology with materials which are readily available and provide a potential for sustaining seedling production after the Project is completed. These nurseries are too new to evaluate. Presently, CARE supplies materials and buys the seedlings produced at eight cents each. Their hope is to supply materials on credit and receive seedlings as payment. Of the 20 species trials established by CARE in the northwest, data still is being gathered on 15.

The best results in comparing the three different arrangements tested was achieved on individually-owned property with the owners' direct participation.

Both CARE and PADF are conducting survival counts using a 3 percent sample at 6 and 12 months, with a 7 percent sample check.

3.4 Pan American Development Foundation (PADF)

The purpose of the $3.9 million Grant was to protect the productive potential of Haiti's land and generate income in rural areas by promoting and replicating tree-growing and other economically productive and ecologically sound land uses by small farmers. The results were expected to reduce soil erosion and increase the fuelwood supply. The specific objectives were to: (1)establish an agroforestry resource center in Haiti,(2)establish at least three regional agroforestry outreach teams, (3)assist in the planning and implementation of at least 80 high impact agroforestry subprojects and plant 3 million tree seedlings,(4)initiate improved agroforestry practices and techniques through the establishment of agroforestry demonstration areas and the training of Haitians, and (5)gather data and information on forestation efforts in rural Haiti, regularly analyze the PADF agroforestry extension program to continually improve technical and motivational efforts, and prepare reports, manuals and other publications to reflect the analyses and provide effective training materials.

The Project extension authorizes a total Grant amount not to exceed $5.59 million and continues the purpose and objectives with minor refinements and additions. It also states that outplanting rates will be maintained at the same levels, which are estimated to reach 17.5 million seedlings in total by December 1986.

3.4.1 Agroforestry Resource Center

PADF has established a collection of technical materials in its central office which is available for use by everyone. The quality and usefulness of the materials was not reviewed.

3.4.2 Regional Agroforestry Outreach Teams

The goal of three teams has been exceeded. Five teams have been established and, in accordance, the area of influence has been divided into five regions. One of the regional teams is headed by a Haitian.

3.4.3 Agroforestry Subprojects

PADF has worked with 173 subgrantees over the life of the Project. Of these 81 were "occasional" grants which were used to test capabilities and interest. Some of these and others, for a total of 110 subgrantees, have had full extension projects. In 1985, PADF had 77 active extension projects. There are 28 subgrantees with nurseries for a total of 32 nurseries having a combined production capacity of 4.6 million seedlings per season.

Nurseries are constructed and run by subgrantees with technical assistance, training, and credit from PADF. The subgrantees provide the land and the water. The seedlings produced by the subgrantees are purchased by PADF at 7.5 cents each. At this price the credit extended is paid off in one or two seasons and then the nurseries operate at a profit. Most the nurseries use fiberglass rod huts and need technical assistance and special tools to make repairs. Some nurseries are now being constructed using local materials for easy maintenance and repair.

135

3.4.4 Demonstration Areas and Training

Nearly every participating farmer's field could serve as a demonstration area and many have, especially by indirectly motivating other farmers. A great deal of training has been accomplished. Jim Talbot is evaluating the training component so it will not be covered here.

3.4.5 Data collection and Reports

Through regular reporting by the regional teams a tremendous amount of information is available. Nursery training materials have been compiled for their annual nursery training meetings. All the training materials observed were in Creole. Time did not permit gathering a list of all reports and training materials produced. One item being produced is a nursery manual in Creole.

3.5 University of Maine (UMO)

The agroforestry research contract with UMO runs from March 1, 1985 to September 30, 1986, for a total of $808,524. At the time of the evaluation an extension thru December 31, 1986 was being considered. The purpose of the contract is to expand and strengthen the AOP research activities to produce a reliable and useful data base on the technical and socioeconomic parameters of reforestation in Haiti. The five particular areas of work are: (1)traditional Haitian agroforestry systems, (2)silvicultural studies, (3)nursery and outplanting techniques, (4)species trials, and (5)cost/benefit of agroforestry systems.
At the time of the evaluation none of the five areas of study had been completed, but work in all was well along. Jim Talbot will be evaluating research activities under the Project.

4. Critical Assessment of Project and Accomplishments

4.1 Overview

The Project has been very successful in accomplishing its goal and objectives. Farmers have been motivated to plant and maintain trees in hopes of financial gains with personal use and selling of products from the trees. The side benefits have been a reduction in accelerated soil erosion, increase supply of fuelwood, income generation, and a large trained group of agronomists, animateurs, and moniteurs.

The Project has also been successful, through the efforts of CARE and PADF, in establishing technically sound systems for production and delivery of seedlings. These systems are extremely valuable and could be used for delivering a variety of technologies to farmers including planting and maintaining fruit trees and marketing agricultural products.

An important part of these systems is the nursery network. The number of nurseries and their geographical locations seem adequate to meet Project needs for many years to come. Seedling quality is good in all nurseries visited. Sporadic rains have made timing for growing and delivery difficult, but basically a good job is being done.

It is apparent that the Haitians running the AOP nurseries have received very good training and could, without outside technical assistance, continue to operate the nurseries. Technical assistance would be needed in the nursery if the present routine were to be changed by the introduction of a tree improvement program, new species, or new technologies.

Presently the rootrainers, potting mix and other nursery materials are imported. If the Project were to close down these materials would be unavailable or prohibitively expensive to purchase in Haiti. Steps are being taken to test and use local materials.

The major problems remaining with the nurseries are a lack of uniform record keeping and control of seed collection. Record keeping is important for duplicating successful planting, determining causes for failure, and testing new species or programs.

The implementation of the Project through four diverse organizations has had good results. During the early stages of the Project, CARE and PADF were able to rely on ODH to produce tree seedlings, while they concentrated their efforts on training and farmer motivation. Experience in other countries has shown that sound nurseries and quality seedlings do not guarantee outplanting, thus this approach proved very sound.

The geographical dipersion of the Project, that is, not being concentrated in selected watersheds, has had benefits in reaching more farmers and exposing more communities to the feasibility of cropping trees for income and other uses. The technologies learned are being spread to a much wider audience. The impact of this could be very positive in a long-term effort.

Some additional items that are generally the same throughout the Project, though differing somewhat with every forester, are covered below. These are seed quality, pruning, growth and yield rates, species/site requirements, farmers' objectives, reports, and technology packages.

Seed Quality: There are a number of papers on the quality of seed being used by the Project. Basically the quality of seed being used by AOP is unknown and both high and low quality trees are seen throughout Haiti. Overall the quality of seed being used seems adequate enough to make tree planting profitable. To maintain or improve seed quality, a seed selection and tree improvement program is needed.

Pruning: Pruning of lower branches is not being done correctly on all farms. When pruning is done incorrectly it damages the tree and lowers the quality and/or quantity of the product. More extension and training is needed to instruct farmers on how to properly prune branches.

Growth and Yield Rates: Growth and yield rates are only being kept for some species trials. Growth and yield data are needed from the farms to determine profitability of growing trees, and the best species/site relationships. UMO has developed a biomass volume table which could be helpful in determining yield.

137x

Species/Site Requirements: The latest knowledge on species/site requirements is known by the foresters and their assistants, but very little is written. This makes it difficult for others to learn or to systematically seek to fill gaps in knowledge.

Farmers' Objectives: The farmers' objectives are becoming known only now that Project trees are reaching harvestable size. The farmers' expectations and uses reach beyond the charcoal and fuelwood markets into other wood and tree products. The farmer wants the most he can get from his trees. This is a very healthy attitude, important for achieving Project objectives. The Project is well adopted to this attitude. Also the farmers' objectives for harvesting, what the products or money will be used for, are very diverse. The Project is just beginning to study the latter and what effect it will have on extension, training, and species mix.

Reports: Reports, recording data, and analysis of information has, in general, not been kept at a desirable level. The Project has generated files of information. Unfortunately it is not summarized into a useful form or analyzed as to trends or new knowledge. This is not to say that useful information has not been utilized or exchanged between foresters, because it has. When a problem existed new information was sought, exchanged, and used. The problem is that much of this information does not exist in a useful or written form to be learned, utilized and improved by others.

Technology Packages: Many of the foresters felt the Project should be offering a complete agricultural package rather than just trees and different schemes for planting them on a farm. Unfortunately, technology packages that would have wide spread application do not exist. The Project is learning and has the capability of learning more, especally with UMO's study of traditional agroforestry systems. Only through observations, research, recording and analysis of data, and reporting will useful technology packages be developed. The Project technologies being delivered today to the farmers are sound, proven systems. Preliminary findings by UMO from visiting over 100 farms show at least 82 unique species associations, of which, 58 may have economic importance and that the AOP is presently reaching 26 of these.

4.2 ODH

There was no opportunity to speak to the chief technical expert, Peter Welle, during the three-week TDY. The USAID Mission is urged to discuss these finding with ODH as there may be some large gaps in the information that was available to the evaluator. Overall ODH has not demonstrated a strong capability to conduct reliable, well-designed research.

4.2.1 Nursery Experimentation and Development

ODH has developed a central, show-place nursery which was critical in getting the Project started on the right foot. This is not to say that problems were not experienced or, even today, that new nursery techniques are not being learned. This nursery has served its purpose in the outreach program to small farmers.

The development of a prototype container for seedling production will not have been worthwhile if it is not more widely tested and eventually competively produced and distributed. The prototype is sturdy, well designed, produces a quality seedling, and if it can be constructed locally in any country, could prove to be very valuable to reforestation efforts elsewhere.

Developing a local potting mix of high quality and low price could have value for other agricultural production activities besides producing tree seedlings. The Haitian mix produced to date still relies on imported materials. This need not be detrimental if the overall cost of production can be competitive. The need to develop a potting mix which is readily available and inexpensive is apparent. This is not an easy technology to develop nor can the regional nurseries be expected to learn and implement such a technology even if developed. It will always take a centralized effort. There was no evidence that ODH had contracted a specialist with knowledge in developing potting mixes.
Such assistance could prove useful.

ODH has not done all that it agreed to under its Grant. From the information available it appears that ODH has not 1)tested the relative advantages and disadvantages of different types of seedling containers, 2)determined seedling propagation in various nursery conditions, 3)tested resistance and optimal transplant age of various tree varieties, and 4)conducted a variety of tests with different species in a variety of ecological settings. Now that the Project has four years of field experience general research, as above, is no longer needed. Rather, specific research on promising species is needed.

4.2.2 Select Seed Production and Storage

Very little to nothing has been done to develop a program of seed selection, production, storage, and distribution as a permanent source of high quality tree seeds. The reason ODH has done so little are not known to the evaluator. The actual seed storage facility has only recently been constructed, but was not in operation at the time of the evaluation. ODH does not appear capable of developing such a program on its own.

4.2.3 Hardwood Forest Experimentation and Demonstration

ODH had achieved the establishment of nine demonstration tree farms under different arrangements during the original project period. Little of the desired research has been designed into these tree farms. Different species have been tested. Little or no testing has been done on 1)rainfall and fertilizer requirements, 2)land preparation techniques, 3)elevation and slope constraints, 4)different exposures, 5)different ecological zones, 6)spacing patterns, and 7)insecticide applications.

It was expected that a very significant body of information would be produced on what works technically and what the economics of tree production are in a variety of locations throughout Haiti. Very few reports on results of research and expermentation have been forthcoming.

139x

4.3 CARE

CARE has or will meet or exceed its goal and specific objectives in a technically sound and professional manner. During the visit, there was not an opportunity to talk with Rich Scott, Project Manager, about the cumulative accomplishments or overall reporting on the particular indicators they were to regularly monitor. Due to circumstances beyond CARE's control, all its files and information on the Project in Gonaive were lost.

The outplanting system, which is managed directly by CARE foresters, is very effective. The technical training given to the forester's staff is adequate. The farmers understood the planting and caring of trees. Some harvesting had taken place and stump sprouts were being properly managed.

As found everywhere the nurseries were operated well. The condition of the roads, or lack thereof, made farm visits and seedling deliveries difficult. Regardless of this, a good job is being done.

4.4. PADF

Relationships with subgrantees and nursery production and outplanting systems have been effectively developed by PADF. Many of the subgrantees are distinct in purpose and structure. This has had a varied effect on the Project. In some instances the subgrantees' best agronomists or animateurs are not provided for AOP activities. The animateurs are paid piecemeal which means they continually have other responsibilities. The cumulative effect has caused PADF to work more directly with the animateurs rather than through the subgrantees. This then takes more of the PADF forester's limited time and does not leave the subgrantee as well trained and operational in tree planting as may be desired.

PADF has excelled in and exceeded its planting and agroforestry subproject goals. Nurseries are run well by competent, well trained Haitians. The delivery systems developed are effective.

The agroforestry resources center had more potential benefits than were ever developed by PADF. This may be due to a lack of available time and funds to dedicate to this effort. In any case, the specific role of the Center was never well defined by AID.

4.5 UMO

It is difficult to critically evaluate UMO's accomplishments as none of its work was finalized at the time of the visit. There were, though, some interim tasks completed, which are documented in working papers. What can be commented on is the thrust of the research. The five basic research areas are of direct value to the Project. The tasks outlined in each area are logical and should provide useful data. The integration of the information generated into the Project field operations has not been well thought out. The information will only be useful if it is used to improve field operations or sustainability of Project activities.

5 Findings and Recommendations

5.1. Overview

The goal of the Project is to reduce and ultimately reverse the ongoing degradation of Haiti's natural resources, and thereby maximize the productive potential of its land. It is doubtful the Project designers envisaged that the Project, on its own and within four years, would halt and reverse the degradation which has been going on in Haiti for over a 100 years. Instead the Project was designed as an experiment to test various approaches, through non-governmental organizations, for motivating farmers to plant and maintain trees. This has been accomplished.

Due to a lack of data it is not possible at this time to evaluate the exact environmental or socioeconmomic impacts of Project accomplishments nor the potential magnitude of the successful approaches on reducing and ultimately reversing degradation to Haiti's natural resources. Information is being gathered on the socioeconomic impacts, but little is being gathered on the environmental effects. Observations on field trips show that tree planting has (1) slowed accelerated soil erosion (depending on site conditions and tree planting patterns), (2) provided fuelwood, and (3) generated income for peasant farmers.

The Project need not be changed to continue these accomplishments. It is not to say that improvements could not be made, but that what is being done is successfully meeting USAID/Haiti's goals. The author feels that some changes leading to improvement are warranted. The author also strongly cautions the designers of any follow on project not to destroy what are the primary reasons for the projects success, that is, its flexibility of design and simplicity of objectives. Any changes that increase its complexity will equally increase its chances of failure. The most obvious areas needing improvement are research, record keeping, documentation, and analysis of data.

Also covered in this section are the areas of concern Vince Cuzamano, ADO, asked the Evaluation Team to consider. These are: (1) the fruit tree improvement projects and whether they should be combined with AOP or kept separate; (2) whether the AOP should concentrate on income generation or soil conservation; (3) what effect the Targeted Watershed Management project will have on AOP; and (4) what steps must be taken to address recurrent costs and make nursery operations and tree planting sustainable.

5.2 Fruit Trees

Finding: The AOP is producing and distributing some fruit trees. Some of these are grafted citrus and grown in large bags. Other types of fruit trees are grown in root trainers. These latter ones are easier to distribute than grafted trees in large bags. PADF contracted a PVO to produce 24,000 grafted fruit trees at a cost of $31,000. These trees are given free to subgrantees, such as DRI and DCCH, for distribution. DRI and DCCH charge the farmers two Gourds per tree to cover handling and delivery costs.

1912

The evaluation team visited Sean Finnigan's fruit tree nursery in Ley Cayes and the Sheepa nursery in Hinche. Finnigan's nursery was very impressive and professionally run. Fruit trees from the nursery were distributed to small farmers and a grafting team visited farmers to graft the older, established trees on the farms. No one was at the Sheepa nursery to explain its operations. Observations showed that the grafted trees left in the nursery were overgrown and root-bound.

Farmers questioned as to their interest in receiving fruit trees responded positively. Some questioned how well grafted trees would do and wanted to see results before planting more than a few.

Recommendaion: Continue growing and distributing a limited number of fruit trees with AOP. The emphasis for PADF and CARE should be on fruit trees that can be grown in rootrainers. The production of grafted trees should be kept in well run nurseries like Sean Finnigan's. PADF and CARE could assist in distributing grafted fruit trees through their distribution systems.

There is some indication that farmers might be willing to pay for grafted fruit trees. This would help cover some of the costs of production and should be explored by PVOs distributing the trees.

Adding the fruit tree nurseries to the AOP will have a positive impact, but will increase the costs and coordination needs.

5.3 Income Generation vs Soil Conservation

Finding: The emphasis of the Project has been on income generation, but this has not been accomplished without a positive impact on soil conservation. Observations show that the trees planted have helped reduce accelerated soil erosion. Some farmers visited observed that crop production was increasing after interplanting with leucaena. No measurements have been taken on pre- or post-production levels to support these observations.

Recommendation: Continue planting trees emphasizing income generation. The farmers appear to respond best to this premise, and the premise appears to be holding true. The Project should also continue planting and testing hedgerows to develop a proven technique for yielding a balance of benefits. It is not a matter of which is more important, income generation or soil conservation, but rather what is the best approach to achieve everyone's objectives.

5.4 Targeted Watershed Management Project (TWM):

Finding: The purpose of TWM is in keeping with the AOP's purpose. There are good possibilities for coordinating activities of both projects.

Recommendation: The TWM should purchase all its fruit and other trees from the AOP and improved fruit tree projects. There are many other opportunities for the projects to work together. All possibilities should be explored in full during the design of TWM.

5.5 Recurrent Costs and Sustainability:

Finding: If AID support were stopped, seedling production would be

severely cut and some nurseries would close. Farmers would continue to manage the trees they have planted. It may take an additional 10 to 15 years of outside financial support for the lessons learned to become a part of peasant life and thus sustainable.

Recommendation: AID should continue supporting Project activities for another 10 to 15 years. The cost of support could possibly decrease with time. A process of phasing in costs that the market should support should be developed and followed to achieve sustainability. After a farmer knows how a tree species will perform and what his returns may be he might pay 7.5 cents per tree, the current price making nursery operations profitable. The price per tree a farmer is willing to pay today is not known, but should be determined. The economics of growing trees is not known and also should be determined.

5.6 Economics:

Findings: The basic premise for motivating farmers to plant trees is income generation. It is not certain whether planting and maintaining trees under the different planting schemes, or on all sites and conditions, is profitable. The UMO is now gathering data to analyze the economic viability of planting trees for income. Sufficient detailed information needs to be gathered to determine which sites, techniques, or species are profitable and which are not. None of the farmers interviewed, who are growing trees or who have harvested products for personal use and to sell, are displeased with the outcomes. To the contrary, all were confident in what they saw, and those who harvested were pleased with the results.

Recommendation: The economic analysis should be completed as soon as possible because the results could greatly influence the design of any follow on-project. It is assumed that some planting schemes on certain sites and under certain conditions will not be profitable. If this becomes the case, more experimentation will be needed to find viable options for these areas to meet the Project goal, or these areas should be avoided until conditions become more favorable.

5.7 Base Counts:

Findings: The Project started by giving 500 trees to each farmer. It soon became apparent that, for various reasons, the farmers were unable to handle that quantity of trees. Base counts of actual trees planted indicated 50 percent of the trees, in some cases, were not being planted by the participating farmer. The Project shifted to giving out a maximum of 250 seedlings per farmer, and in many instances, only 150 seedlings are given. This has resulted in an estimated 50 percent increase in the number of trees being planted by the participating farmer. One of the subgrantees, DRI in the Southwest, has recently begun tailoring their tree packages to the farmers' needs and desires. The impact this will have on tree planting, maintenance and survival is not known.

It was noted that base counts are determined by counting the seedlings on the parcel where the most seedlings were planted. The farmer could have planted seedlings on his other parcels. Under the method used these other parcels are not checked and seedlings are not counted. Box counts

have shown up to a 15 percent discrepency between the actual number of seedlings and the assumed number.

Recommendation: The effect of DRI's tailored packages on their time and resources, tree planting and maintenance, and on 12-month survival rates should be studied. If the results are promising, then, to the extent possible, the number and types of trees given to the farmers should be tailored to their needs and desires in any follow on project.

It would be worthwhile to inspect the farmers' other parcels to get a more accurate accounting of what happens to the seedlings. This information could influence the number of seedlings given and provide a baseline for judging the results of tailored packages. During the seven percent check counts other pacels could be examined and seedlings counted

5.8 Research, Record Keeping, Data Analysis, and Documentation:

Finding: Tree planting activities, from production to outplanting and followup, have absorbed most of the time of PADF's and CARE's personnel. This has forced them to neglect other activities, most notable, are research, record keeping, data analysis, and documentation. Without having the necessary time to devote to these activities it will be difficult to determine (1) what is working and what is not, (2) what impact the Project is having, and (3) what type of improvements can be made. There is a great deal of interest in developing an agroforestry resource center, which could help accomplish the neglected activities.

Recommendation: Develop an agroforestry resource center to be run, as a separate project component, by a research group. The center would be responsible for all research, analyzing data, documenting results, gathering and disseminating technical information from outside Haiti, providing technical backstopping, and procuring quality tree seed for the Project. This would include monitoring species trials, growth and yield, and environmental, social, and economic effects of the Project and continuing case studies, silvicultural research, market and product development, and analyzing reasons for seedling mortality and testing solutions.These services could be extended to the Targeted Watershed Management project too. The center should be run by an outside research group. This group would have to work in close collaboration with PADF and CARE and especially ODH on seed selection and tree improvement. The center should provide a better technical accounting of project activities. It must be carefully designed in line with project needs and objectives as not to become an objective unto itself. It should be designed last. Its greatest roles will be in centralizing research, data collection and analyses, dissemination of findings, and providing technical backstopping.

As soon as possible, place Haitians in charge of tree planting activities. To accomplish this, where necessary, each PADF and CARE forester will need to hire and train a Haitian. PADF could also free up their foresters' time by reducing the number of subgrantees to the more promising ones, and/or trying to develop some of the subgrantees into umbrella PVOs. The overall effect will be more time for the foresters to refine activities and improve the neglected ones.

5.9 Survival rates:

Finding: There is confusion and concern on the role of survival rates. All grantees have met the expected survival rates given in the PP. Very little work has been done to determine the exact causes of tree mortality nor did the PP call for it. The reasons given for mortality are poor seedling quality, species not matched to site, poor planting, lack of care after planting, tree cut during weeding, theft, uncertainty as to ownership, animal and human damage, drought (unpredictable rains) , soil depth, harshness of site, planting wrong site, weeding not done, and farmer eliminated the tree because it was not doing well. In general, tree survival has increased from the first planting season to the lastest one. This can be attributed to several factors including: better seedling quality, more and better training materials and sessions, greater understanding of tree potentials by project personnel and farmers, and better matching of species to site.

Recommendation: Determine the exact causes of tree mortality. Until the actual reasons for tree mortality are determined, little can be done to improve tree survival or know if it can be improved. To accomplish this, a more intensive pattern of field visits to a selected number of farmers will be needed. This could include but should not be limited to more visits during the first 2 months and counts before and after weeding. Survival rates need to be separated by Haitian "animateur", species, and site. This will yield a clear picture of what is or is not causing tree mortality. Once the causes are known, do what is possible to eliminate them.

5.10 Species-Site Relationships:

Finding: During the Project, 37 species trials were developed. Information yielded has been used to determined which species should be planted on which site. Also observations of previous out plantings have provided useful insights. Species-site relationships have not been systematically developed and much of the knowledge on the subject is with the individual field foresters and not written.

Recommendation: Present information on species-site relationships should be documented and gaps in knowledge noted. The follow on project should attempt to fill these gaps where necessary.

5.11 Tree Seed

Finding: There have been a variety of difficulties encountered in acquiring tree seed for seedling production and species trials. The quality of native and exotic tree germplasm being collected in Haiti for seedling production is unknown. Fortunately, in spite of this, good tree form and growth can be observed for most species in various parts of the country. Equally visible is poor tree form and growth in the same areas.

Recommendation: In the follow-on project develop a program for tree seed selection and tree improvement. This should include bringing seed in from other countries, for the tree species presently being used, to

145X

broaden the genetic base. The goal of tree improvement is to furnish commercial quantities of well adapted and genetically improved material for reforestation programs. Mike Benge will be developing a tree improvement program which should insure the use of quality seed. It is important that whatever program is developed that it be kept simple. The Project nor Haiti has the resources or need to implement a complicated tree improvement/genetics program at this time. As mentioned earlier this would function best if run by the research group in collaboration with ODH, using ODH's facilities.

5.12 Nursery Operations:

Findings: PADF is developing a nursery manual to guide operations and train others. Presently nurseries are not keeping uniform records.

Recommendation: Training and monitoring needs to continue until uniform records are kept on nursery operations. The nursery manual being developed should include record keeping standards and procedures.

5.13 ODH

Findings: ODH is well located and has good facilities. It has developed a practical prototype container for seedling production and a Haitian potting mix using mostly local materials. It has established species trials and tree farms which could yield useful information.

Recommendation: Develop a new grant with ODH under the follow-on project to: (1) expand testing and distribution of its prototype nursery container; (2) assist in production and marketing of Haitian mix; (3) continue data gathering and monitoring of species trials and tree farms; and (4) collaborate with a research group in product development and seed selection and tree improvement.

5.14 CARE

Findings: The work CARE is doing is well received and needed in the communities they work.

Recommendation: In the follow-on project CARE's activities should remain the same, except it should only collaborate on research, not be responsible for it.

5.15 PADF

Findings: PADF activities are also well received and needed. The foresters often work directly with the animateurs bypassing the subgrantee's central staff.

Recommendation: In the follow-on project PADF's activities should remain the same, except it should only collaborate on research, not be responsible for it. PADF should attempt to work more directly with subgrantee's central staff to upgrade their capabilities.

5.16 Harvesting

Finding: Coppicing trees were harvested leaving anywhere from 20 centimeter to 60 centimeter stumps. Physical damage to the stumps was minimal, but termites and disease were entering approximately 30 percent of the stumps.

Recommendation: Stumps for coppicing species should not be cut less tha 35 centimeters from the ground. The best height for growth and controlling insects and disease should be tested.

5.17 Extension

Finding: Every participating farmer needs visits from preplanting through harvesting and management of coppicing. Each planting season the animateur or moniteur adds 10 to 35 farmers. Some of these are repete farmers, which, by approximation, varied between 25 and 80 percent. The number of farmers needing extension is growing to unmanageable proportions. PADF has about 601 animateurs to attend to these needs. Salaries do not always fit the work loads and capabilities of the foresters' assistants and agronomists.

Recommendation: Determine manageable extension levels for the animateurs and adhere to them. Farmer extension needs must be determined and scheduled over the life of the project. The number of repete farmers needs to be determined to give a more accurate appraisal of the manageable number of farmers per extension agent. Salaries should be adjusted in line with work loads and capabilities.

147

Additional Evaluation Thoughts

During the AOP Technical Retreat, January 16-18, representatives from the four institutions involved in Project implementation were given an opportunity to express their thoughts on other items the Evaluation Team should look into. The Team was asked to consider:

1. Ways of integrating trees into peasant farm systems;
2. Doing a characterization of subgrantees;
3. Upgrading subgrantee capabilities;
4. The impact of PVO's on AID;
5. GOH involvement and interest in view of sustaining activities beyond the Project;
6. Institutionalization of Project activities;
7. Strengthening the agricultural component and its priorities;
8. Specialized groups for implementation as opposed to general major PVOs;
9. Project staffing patterns;
10. Improving income generation;
11. Developing demonstrations of agroforestry systems and mechanisms for delivery;
12. Increasing impact of living terraces;
13. Other forms of soil conservation;
14. More concentration of activities in upland areas;
15. Testing agroforestry systems in addition to species trials;
16. Maximizing productive potential of terraced land;
17. Project's impact on soil conservation and watershed management;
18. Improving availability of technical materials and assistance;
19. Research that is appropriate to field activities and flexible enough to respond to new needs;
20. Focusing the Project on specific areas;
21. The economics of subgrantee working in a particular area (Is it economical?);
22. Investigating food and other valuable crops that grow in shade;
23. What is needed to increase seedling production;
24. Project priorities if an increase or decrease in funding were to occur;
25. Working with large farmers;
26. Ability of farmers to grow seedlings on their own;
27. The hard objectives that would be set in any follow on activity;
28. Producing more educational materials and short courses;
29. Developing a monitoring program to follow-up on activities through the life of the project; and
30. Available time the agronomist will have for followup work with more planting of new areas and harvesting of older areas.

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	i
LIST OF TABLES	iii
INTRODUCTION	1
CHAPTER 1 DETERMINATION OF THE NET PRESENT VALUE OF INDIVIDUAL AGROFORESTRY PLANTINGS	4
The AOP plantations	4
The costs of AOP plantings	11
The benefits of AOP plantings	15
Net present value of AOP plantings	18
Additional note	23
CHAPTER 2 ANALYSIS OF INDUSTRIAL PLANTATIONS	26
The ODH plantations	28
Analysis of Class I - the Madsen farm.	30
The benefits	30
The costs	35
Analysis of Class 2 - the Roy farm.	37
The benefits	37
Conclusion	44
Marketing	44
Increasing productivity	45
CHAPTER 3 ANALYSIS OF THE AOP SMALL FARMER PROGRAM	46
CHAPTER 4 ADDITIONAL CONSIDERATIONS	54
Ecological benefits	54
Crop diversification	54
Savings	54
Fruit trees	55

149 x

Rural labor 55

Hedgerows 55

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS 56

Operation Double Harvest 56

PADF and CARE 57

REFERENCES CITED 60

LIST OF TABLES

I-1 Number of seedlings planted and number of farmers participating in the Agroforestry Outreach Project, by season and by region.

I-2 Crop associations used in the evaluation of the Agroforestry Outreach Project and their frequency of occurence in a random sample of project farms, by region.

I-3 Standardized labor requirements for various agricultural tasks.

I-4 Seed requirements for various crops.

I-5 Prices of inputs and outputs, by region. In dollars per unit.

I-6 Net incomes of different crop associations, by region. In dollars per hectare.

I-7 Example of determining net benefits from an AOP plantation.

I-8 Net incomes of different crop associations, by region. In dollars per AOP plot.

I-9 Assumptions about AOP plantations.

I-10 Dollar value of wood harvests, by region.

I-11 Determination of the value of wood harvests, an example.

I-12 Summary of the net costs and benefits incurred by AOP participants, by crop association and by region.

I-13 Cumulative changes in NPV.

II-1 Double Harvest plantations, their size and establishment dates.

II-2 Estimation of mean annual volume growth for the Madsen plantation.

II-3 Projected harvests from the Madsen plantation.

151x

II-4 Projected wholesale prices for wood products in Port Au Prince. Double Harvests's projected net unit revenues. 1982 to 1996.

II-5 Projected net revenues of the Madsen plantation. 1982 to 1996.

II-6 Total Double Harvest expenditures for the Agroforestry Outreach Project, by line item and by quarter. (In dollars)

II-7 Double Harvest costs of establishing and maintaining plantations. In dollars.

II-8 Adjusted ODH plantation establishment costs.

II-9 Comparison of annual costs and revenues of the Madsen farm.

II-10 Comparison of the net present value of expenditures and revenues for the Madsen farm at varying discount rates. In dollars.

III-1 Summary of net costs and benefits by region and by season.

III-2 Net present value and internal rate of return for the PADF component of the AOP.

III-3 Net present value and internal rate of return for the CARE component of the AOP.

III-4 Net present value and internal rate of return for the combined CARE and PADF components of the AOP.

V-1 Predicted and actual unit costs of seedlings produced and of surviving trees, for CARE and PADF.

LIST OF FIGURES

II-1 Map: location of plantations established by ODH.

II-2 Schematic representation of the harvest schedule for class I plantations.

II-3 Schematic representation of the harvest schedule for class II plantations.

II-4 Schematic representation of the harvest schedule for class III plantations.

INTRODUCTION

The AOP is based on many assumptions. The most important of these are those found in the Logical Framework, Annex C of the Project Paper. This paper examines the third of the three 'assumptions for achieving goal target'. This assumptions is stated as follows: Peasant agroforestry is an economically and technically viable enterprise.

The Project Paper calls the introduction of fast-growing trees as a cash crop the conceptual cornerstone of the project. (AID, 1981: 86-87) This assumption justifies our encouraging farmers to plant trees. How can we go wrong if we encourage farmers to make more money that hey are now? Conversely, however, if it happened that it were not possible to plant trees profitably, we would be doing the farmer a disservice and eventually the farmers would recognize this and stop planting.

We are now at a point at which we have enough experience and information to test this critical assumption. We are to determine whether agroforestry attractive to Haitian farmers? Before beginning, I believe the question should be re-phrased to better fit the situation. The question "Can the Haitian peasant cash-crop trees?" is rather limiting and needs to be modified to best serve the project. First of all, this question asks for a yes or no answer. Intuitively, a yes or no answer is inappropriate. The question should be re-phrased "In what circumstances can the Haitian peasant cash-crop trees?" We now have the pointed implication that tree farming can be profitable in some cases and not in others. This prompts us to look for variations which make some situations profitable and others not.

Secondly, the idea of cash-cropping limits us. It is true that the Haitian peasant is involved in cash markets, perhaps more so than one would think. However, tree farming can be advantageous to the farmer even if the trees are not considered a cash-crop.

Example: Hedgerows or living fences which provide green manure or windbreaks can significantly increase crop production. Trees are not a cash-crop but they can increase cash earnings.

Example: A farmer harvests his trees and uses poles for a new house and the remainder for firewood. Trees were not cash-cropped but prevented cash outlays and freed up labor for investment elsewhere on the farm, thereby increasing production.

There are many other reasons for planting trees. Improving fallow; providing shade for animals, crops, and people; producing green manure and forage; reducing the rate of soil erosion. All of the benefits of planting trees increase the welfare of the farmer, even if they do not increase the farmer's cash flow. Murray

153x

(1984) overemphasized the need to increase the farmer's cash flow by planting trees. Not that these cash flows don't need to be increased. This arguement, however detracts from the many other nonmonetary benefits of tree cropping.

Murray's philosophy is very evident in the Project Paper. "Emphasis will be placed ... on the planting of ... trees ... to harvest wood as a cash crop ..." (Page 33) "The Project places a major emphasis on the generation of income through cash-cropping of trees." (Page 34) "... in ways which maximize agricultural production and short-term returns ..." (Page 51) ".*.. this project with its conceptual cornerstone: the introduction of the fast-growing tree as a cash crop." (Page 86-87).

Only in the opening pages of the Project Paper does one find a broader view of the benefits of trees planting. "This focus on the potential for cash-cropping of trees should be viewed as the opening gambit of the Project, not its sum and substance."

Thus, the question we would like to answer is, "In which cases can a Haitian peasant plant trees to his advantage?" Now, having listed many of the non-cash advantages of tree planting (risk reduction, savings or investment, labor redistribution, provision of goods and services for which there is no market or a very limited market) we will consider only the cash income possibilities open to the planter of AOP trees. Doing this will demonstrate that tree farming can be profitable. However, one should remember the many other advantages of tree farming and not be surprised when a farmer makes decisions which are seemingly counter to his best interests.

This paper is being written as part of the evaluation of the Agroforestry Outreach Project. The model developed herein will be used for more than just an evaluation. It will be used at a later date to develop an economic analysis for a proposal to extend the project for several more years. Because of this, the model has been made so that many of its components can be altered. This allows the planner to see the effects of various modifications on the overall performance of the project. Research planners can see the effects of various factors on the overall project. With the help of this model, researchers can plan research programs around those factors which will have the greatest impact on the project. Finally, this paper is an interim report of the University of Maine research team. It is a preview of the final Cost - Benefit Study report which will be forthcoming in August, 1986.

There are many steps through which one must go to build a model. Each step will be discussed separately. For each component, we will try to explain how it relates to each of the other components. As we go through the model , piece by piece, the reader will begin to see the great number of assumptions which have been made. These assumptions are of two kinds. The first kind is the simplifying assumption. This type of assumption makes the world seem somewhat less complex than it really is. If we were to try to analyze the AOP without generalizing, we would have to analyze tens of thousands of small tree plantations. The second type of assumption is a technical

154

assumption. It is used when we do not have technical information necessary for the model. A good example is growth rates of tree during coppice rotations. Since we don't have this type of information, we have had to make a technical assumption.

This paper is divided into four parts. Chapter 1 considers agroforestry and the small farmer. These small farmers are the rural poor, the people at whom AID has aimed this project.. We will discuss whether the orderly introduction of tree components into the farm management system is profitable for the small farmer in Haiti.

The second Chapter will look at the possibilities of large scale tree farms. This will specifically look at the performance of ODH, whose objective it was to demonstrate the profitability of large scale tree farming in Haiti.

Chapter 3 brings together the tens of thousands of individual farmers. It looks at the cumulative benefits of all the millions of trees planted and financial and economic feasibility of the Agroforestry Outreach Project.

Chapter 4 briefly discusses some benefits not previously considered.

Finally, the fifth Chapter gives several conclusions and recommendations.

155x

CHAPTER 1

DETERMINATION OF THE NET PRESENT VALUE OF INDIVIDUAL AGROFORESTRY PLANTINGS

Our ultimate goal is to compare the costs of an AOP planting with its benefits. To do this we will go through four steps. First, we will present a general description of AOP plantations and the associntions which we will be analyzing. Second, we will determine the net revenues the farmer would have received had he not planted any AOP seedlings. These net revenues will be considered the opportunity costs of the AOP system. That is, the costs of the planting are equivalent to the foregone revenues. Next, we will determine the net revenues of the AOP system, including the tree and the crop components. These net revenues will be considered the benefits of the AOP planting. The final step in this comparison is to bring all the benefits and all the costs into a similar time frame. This is done by determining the net present value of the costs and the benefits.

We have chosen to evaluate the AOP agroforestry plantings over a sixteen-year period. We chose sixteen years because a) it falls within the usual length of economic evaluations: fifteen to twenty years, and b) the harvest schedule we have chosen, four rotations, each four years in length, fits this sixteen-year cycle.

The AOP plantations

CARE and PADF report that more than seventy-three thousand farmers have planted project trees since the Spring of 1982, when the AOP began. See Table I-1. It is neither possible nor necessary to analyze each of these 73,000 plantings in order to determine whether agroforestry is financially feasible in Haiti. Instead, we have divided these 73,000 farmers into a manageable number of representative situations. By analyzing these representative or typical situations we will be able to apply the inferences drawn from them to the entire 73,000 farmers.

The group of representative or typical farms to be analyzed was determined by studying and aggregating a sample of AOP planters. In late 1984 and early 1985, CARE and PADF prepared a survey form to be used to monitor project activities. (PADF, 1984a and PADF, 1984b) They used this form to gather information from a randomly selected one-percent sample of planters in each region. This information, gathered in the Spring of 1985, is used to guide this analysis. For example, the completed survey forms have information which allows us to describe typical crop associations found on participants' fields. (Henceforth, this survey and the survey form itself are referred to as the Case Study) Page 1 of the Case Study gives a list of the crops found on the field planted with AOP seedlings and the crop calendar for the two years preceding the planting date. Crop associations

156

Table 1-1. Number of seedlings planted and number of farmers participatings in the Agroforestry Outreach Project, by season and by region.

	Region										
	South	Southeast	North	Upper Plateau	Lower Plateau	Other	PADF Sub Total	Region I	Region II	CARE Sub Total	Total
	NUMBER OF SEEDLINGS PLANTED										
Spring, 1982	170928	107505	73534	71731	84835	0	508933	109000	0	109000	617933
Fall, 1982	466564	298920	375881	87500	20500	152500	1401865	106000	188000	294000	1695865
Spring, 1983	506125	324771	319970	282850	37500	2000	1473216	264748	349250	613998	2087214
Fall, 1983	565786	457910	433410	142250	100000	232250	1931606	305363	390847	696210	2627816
Spring, 1984	733605	495030	531550	340000	132005	56650	2288840	448200	319750	767950	3056790
Fall, 1984	709160	599185	545500	268023	165300	72450	2359618	325725	232181	557906	2917524
Spring, 1985	718975	449600	617546	412750	284500	51100	2534471	431379	307492	738871	3273342
Fall, 1985	644650	572095	714249	479073	348100	75000	2833167	453369	323168	776537	3609704
	4515793	3305016	3612040	2084177	1172740	641950	15331716	2443784	2110688	4554472	19886188
	NUMBER OF FARMERS										
Spring, 1982	400	252	173	168	199	0	1191	208	0	208	1399
Fall, 1982	752	482	606	141	33	246	2260	158	533	691	2951
Spring, 1983	1360	1349	730	591	0	78	4108	886	1105	1991	6099
Fall, 1983	1650	1952	962	450	0	495	5509	890	1234	2124	7633
Spring, 1984	1452	2400	1182	811	454	228	6527	1427	1097	2524	9051
Fall, 1984	2785	2086	2335	855	674	288	9023	1512	1162	2674	11697
Spring, 1985	2657	3520	2590	2752	1920	1251	14690	1470	1130	2600	17290
Fall, 1985	2370	2840	3783	3175	2250	750	15168	1407	1081	2488	17656
	13426	14880	12361	8943	5530	3336	58476	7958	7342	15300	73776

Sources: CARE Quarterly Report for III-85.
CARE Quarterly Report for III-84.
CARE Annual Report for 1983.
CARE, personal communication.
PADF, personal communication

157X

Table 1-2. Crop associations used in the evaluation of the Agroforestry Outreach Project and their frequency of occurence in a random sample of project farms, by region.

Crop Association	Region							
	South	Southeast	North	Upper Plateau	Lower Plateau	Region I	Region II	Total
Maize, sorghum, pois congo	3	5	0	10	4	1	1	24
Maize, manioc, beans	3	0	5	2	0	1	4	15
Maize, sorghum, manioc	2	2	1	7	2	0	0	14
Maize, beans	1	1	3	1	2	1	0	9
Maize, sorghum	1	0	0	1	6	0	0	8
Maize, sorghum, manioc, patate	2	0	0	1	1	3	1	8
Maize, manioc, patate	4	0	2	0	0	1	0	7
Fallow	2	0	0	0	2	1	0	5
Maize, patate	2	1	1	0	0	0	0	4
Maize, sorghum, pois congo, patate	0	2	2	0	0	0	0	4
Manioc, peanuts	1	0	1	0	0	0	1	3
Maize, sorghum, patate	1	0	0	0	1	0	1	3
Maize, sorghum, peanuts	0	0	1	1	0	0	0	2
Manioc, beans	1	0	1	0	0	0	0	2
Yam, patate	2	0	0	0	0	0	0	2
Manioc	1	0	1	0	0	0	0	2
Maize, potatoes	0	1	0	0	0	0	0	1
Pois congo, patate	0	0	0	0	0	1	0	1
Manioc, patate	0	0	0	0	0	1	0	1
Peanuts	0	1	0	0	0	0	0	1
Sorghum, patate, yam	1	0	0	0	0	0	0	1
Total	27	13	18	23	18	10	8	117

Source: Agroforestry Outreach Project. Case studies, Spring 1985.

found in the Case Studies were grouped into twenty typical associations. These twenty associations and "fallow" are shown in Table I-2. The typical associations have been tabulated by region. This was done to enable us to include regional differences in the prices of inputs and outputs in our analysis.

We would have liked to include the variation in crop yield for different areas. Unfortunately, since this type of information is not yet available, we will use crop budgets standardized for the country.

The standardized crop budgets mentioned above were created using published research data whenever available. The prices of the inputs and outputs may be varied by region. Tables I-3, I-4, and I-5 show the labor inputs, seed inputs, and prices of the inputs and outputs, respectively, used in the crop budgets. All the crop budgets and Tables I-3, I-4, and I-5 are on a computer spreadsheet. The tables can be altered easily and any alteration is automatically incorporated in the entire system. The net income of each crop association automatically adjusts to reflect the new set of inputs and outputs. Thus, as more and better information becomes available it can be incorporated into the model easily and quickly.

Table I-3. Standardized labor requirements for various agricultural tasks.

Task	labor requirement
Soil preparation	33.0 days/ha
Planting - cereals & legumes	10.0 "
patate	6.0 "
manioc	1.0 "
Weeding	8.0 "
Harvest - maize	8.3 days/tonne
sorghum	12.0 "
beans	75.0 "
pois	75.0 "
peanuts	8.3 "
manioc	2.0 "
patate	1.2 "
yam	2.0 "
Post harvest -	
maize	11.0 days/tonne
sorghum	11.0 "
beans	11.0 "
pois	11.0 "
peanuts	11.0 "
manioc	11.0 "
patate	11.0 "
yam	11.0 "

Source : Taylor, 1982.

159x

Table I-4. Seed requirements for various crops.

Crop	kg/ha
Maize	35.71
Beans	16.67
Pois	2.08
Sorghum	12.5
Peanuts	50

Source : Taylor

These net incomes are displayed in Table I-6. This table shows the net income derived from one hectare of each of the different crop associations in each region of the country. These are the net cash incomes derived if all labor is paid at the rates shown in Table I-5. Net cash income can be greater than the amounts shown to the extent that the farmer uses family labor or any other type of labor which is not paid for with cash. (Grazing is not yet included in any of the crop budgets. Nor is any benefit derived from fruit or other trees present before the project.)

The interactions between the tree component and the crop component are varied and complex. The two components may show supplementarity, complementarity, or competition. (Raintree, 1983; Harou, 1985) If the association shows supplementarity, the addition of a certain number of trees to the crop system has no effect on the crop output. If the association shows complementarity, the addition of a certain number of trees will increase the crop output. There are numerous examples of these positive interactions. The trees may protect the crops from wind damage. The tree may increase relative humidity, decrease wind velocity, reduce evapotranspiration, and thereby increase production. Trees may bring nutrients from deep in the soil to the surface. The trees may provide shade for crops such as coffee or cocoa which need shade. Finally, if the association shows competition, one or more of the species present suffers from lack of light, water, or nutrients due to the presence of the other. The nature of the effect of the trees on the crop will depend on the density of the trees, as well. It is possible that the association would pass through the different stages from supplementary, to complementary, to competitive, as densities increase.

It is difficult to estimate the net effects of the interactions between the components, given our present knowledge. We have, therefore, simplified the interactions between the components to be analyzed.

For the purposes of the analysis given here, competition will be minimal for the first two years of each four year rotation. Farmers can continue to raise their crops with no reduction in yield. (Supplementarity) This assumption is valid if we consider that, on

Table I-5. Prices of inputs and outputs, by region
(in $ per unit)

Item	unit	Region						
		South	Southeast	North	Upper Plateau	Lower Plateau	Region I	Region II
Beans	kg	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Maize	kg	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Manioc	kg	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Patate	kg	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Peanuts	kg	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Pois congo	kg	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Potatoes	kg	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Sorghum	kg	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Yam	kg	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Labor	day	0.95	0.80	1.10	0.70	1.50	1.00	1.00
Charcoal	sack	2.40	3.60	2.20	1.60	2.00	1.60	1.60
Poles	each	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lumber	10 BdFt	4.00	5.00	3.50	3.00	2.00	3.00	3.00

Sources: Taylor.
Capital Consult.
McGowan.

161 x

Table I-6. Net income of different crop associations, by region. In dollars per hectare.

Crop association	Region						
	South	Southeast	North	Upper Plateau	Lower Plateau	Region I	Region II
Maize, sorghum, pois congo	231.47	243.17	n.a.	250.97	188.58	227.57	227.57
Maize, manioc, beans	199.94	n.a.	187.46	220.75	n.a.	195.78	195.78
Maize, sorghum, manioc	339.01	350.34	327.68	357.89	297.48	n.a.	n.a.
Maize, beans	119.01	132.43	105.59	141.38	69.81	114.54	n.a.
Maize, sorghum	258.02	n.a.	n.a.	276.11	218.23	n.a.	n.a.
Maize, sorghum, manioc, patate	390.47	n.a.	n.a.	414.97	343.42	386.20	386.20
Maize, manioc, patate	230.21	n.a.	217.77	n.a.	n.a.	226.06	n.a.
Maize, patate	41.00	51.40	30.59	n.a.	n.a.	n.a.	n.a.
Maize, sorghum, pois congo, patate	n.a.	291.24	264.98	n.a.	n.a.	n.a.	n.a.
Manioc, peanuts	376.88	n.a.	365.65	n.a.	n.a.	n.a.	373.14
Maize, sorghum, patate	262.78	n.a.	n.a.	n.a.	219.38	n.a.	258.84
Maize, sorghum, peanuts	n.a.	n.a.	287.37	316.24	n.a.	n.a.	n.a.
Manioc, beans	122.48	n.a.	112.03	n.a.	n.a.	n.a.	n.a.
Yam ,patate	151.23	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Manioc	110.19	n.a.	113.69	n.a.	n.a.	n.a.	n.a.
Maize, potatoes	n.a.	1191.80	n.a.	n.a.	n.a.	n.a.	n.a.
Pois congo, patate	n.a.	n.a.	n.a.	n.a.	n.a.	-3.58	n.a.
Manioc, patate	n.a.	n.a.	n.a.	n.a.	n.a.	194.85	n.a.
Peanuts	n.a.	261.83	n.a.	n.a.	n.a.	n.a.	n.a.
Sorghum, patate, yam	374.56	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Sources: Tables I-3, I-4, I-5.

n.a. - this crop association not observed in this region.

average, trees have 4.8 m2 of growing space at planting and that these trees have a survival rate of approximately thirty-three percent after one year. Thus, the average tree will have 14.4 m2 of growing space. With the customary pruning done by the farmers, these trees should not have significant negative effects on the agricultural component during the early years of the association. Beginning in the third year, competition for light, water, and nutrients is so great that crops can no longer be grown under the trees. (Competition) The trees will eventually be harvested, say for poles and fuelwood. At this point, the stumps will sprout and a four-year coppice rotation begins. As in the first rotation, crops may be grown under the trees for the first two years of the rotation. Succeeding rotations are identical to the first.

The costs of AOP plantings

In this section we determine the costs of planting AOP seedlings. Before doing so, it seems appropriate to discuss exactly what should be compared when doing a cost - benefit analysis. One should compare the net benefits of the new investment, in this case trees and crops, with the net benefits which would have been received had the investment not been made. This is the "with versus without" approach. Unfortunately, it is, at times, difficult to determine what a Haitian farmer would have done if he hadn't planted trees. It is not necessarily true that he would continue to do what he has done in the past.

For instance, we will assume that erosion in unprotected fields causes a 2% reduction in yield each year. The farmer's "without" income is based on the reduced yields he would have received had he not planted. Table I-7 shows an example. The first row of the table shows the net revenues a farmer in the South will receive if he continues to raise maize, sorghum, and pois congo for sixteen years. Notice that the yields steadily decline at a rate of two percent each year.

It is important also to consider changes that the farmer would have made even if he hadn't decided to plant AOP seedlings. A farmer who plants AOP trees in a maize and bean field is not necessarily giving up maize and beans as the trees grow and dominate the field. As Conway says "The informants of Savanne Mole planted their seedlings with the idea of integrating them into their fallow system rather than establishing a system of permanent intercropping." (Conway, 1986, p. 17) This is an example of the classic taungya system of plantation establishment. In this case the "without" net revenues are those derived from an unimproved fallow which, for us, are zero, because we have not yet introduced grazing into our model.

During the sixteen-year agroforestry cycle described in the preceding section, crops are grown in years 1 and 2, 5 and 6, 9 and 10, and years 13 and 14. This is shown on the second line of Table I-7. If we compare this to the harvests the farmer would have had without AOP seedlings, we note that he has foregone crop harvests in half the years: years 3 and 4, 7 and 8, 11 and 12, and years 15 and 16. Note that we are assuming that in the "without" situation, the

163x

Table I-7. Example of determining net benefits from an AOP plantation.

South	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Maize, sorghum, pois congo																
Without = Costs																
foregone crop production	25.59	25.08	24.57	24.08	23.60	23.13	22.67	22.21	21.77	21.33	20.91	20.49	20.08	19.68	19.28	18.90
With = Benefits																
net revenues from crops	25.59	25.08			26.11	26.11			26.11	26.11			26.11	26.11		
planting costs	-2.85															
net revenues from wood				54.39				63.62				74.43				87.07
Net benefits	-2.85	0.00	-24.57	30.31	2.51	2.98	-22.67	41.41	4.34	4.78	-20.91	53.94	6.03	6.43	-19.28	68.17

Table I-8. Net income of different crop associations, by region. In dollars per AOP plot.

Crop association	Region						
	South	Southeast	North	Upper Plateau	Lower Plateau	Region I	Region II
Maize, sorghum, pois congo	26.11	20.78	n.a.	16.14	12.22	31.02	31.02
Maize, manioc, beans	22.55	n.a.	18.99	14.20	n.a.	26.69	26.69
Maize, sorghum, manioc	38.24	29.33	33.19	23.02	19.28	n.a.	n.a.
Maize, beans	13.42	11.31	10.69	9.09	4.52	15.61	n.a.
Maize, sorghum	29.10	n.a.	n.a.	17.76	14.14	n.a.	n.a.
Maize, sorghum, manioc, patate	44.05	n.a.	n.a.	26.69	22.25	52.65	52.65
Maize, manioc, patate	25.97	n.a.	22.06	n.a.	n.a.	30.82	n.a.
Maize, patate	4.62	4.39	3.10	n.a.	n.a.	n.a.	n.a.
Maize, sorghum, pois congo, pa	n.a.	24.88	26.84	n.a.	n.a.	n.a.	n.a.
Manioc, peanuts	42.51	n.a.	37.03	n.a.	n.a.	n.a.	50.87
Maize, sorghum, patate	29.64	n.a.	n.a.	n.a.	14.22	n.a.	35.29
Maize, sorghum, peanuts	n.a.	n.a.	29.10	20.34	n.a.	n.a.	n.a.
Manioc, beans	13.82	n.a.	11.35	n.a.	n.a.	n.a.	n.a.
Yam ,patate	17.06	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Manioc	12.43	n.a.	11.51	n.a.	n.a.	n.a.	n.a.
Maize, potatoes	n.a.	101.83	n.a.	n.a.	n.a.	n.a.	n.a.
Pois congo, patate	n.a.	n.a.	n.a.	n.a.	n.a.	-0.49	n.a.
Manioc, patate	n.a.	n.a.	n.a.	n.a.	n.a.	26.56	n.a.
Peanuts	n.a.	22.37	n.a.	n.a.	n.a.	n.a.	n.a.
Sorghum, patate, yam	42.25	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Sources: Tables I-6 and I-10.

n.a. - this crop association not observed in this region.

Table I-9. Assumptions about AOP plantations.

Region	Number of trees planted	Average survival	Pole price	Charcoal price
South	235	40%	1.00	2.40
Southeast	178	21	1.00	3.60
North	211	31	1.00	2.20
Upper Plateau	134	34	1.00	1.60
Lower Plateau	135	40	1.00	2.00
Region I	285	79	1.00	1.60
Region II	285	40	1.00	1.60

Other Assumptions

Avg original spacing --- 4.8 square meters per tree

Stems usable as poles -- 50%

Weight use as poles ---- 33%

Rate of real price increase - 4%

Growth rate ---------- dbh (cm) = 2 x age (years)

Volume equation --------

dry wt (kg) = 0.817 x BA (cm2) - 2.707 x dbh (cm)

Sources: Bannister, 1986.
McGowan, personal communication.
Grosenick, 1986, forthcoming.
Ehrlich, 1985.

farmer can harvest every year for sixteen years with a slight reduction in yield. Since this is clearly not the case, the actual costs of the AOP plantings are overstated.

The net incomes for the different crop associations listed in Table I-2 are shown in Table I-8. Remember that Table I-6 has the net incomes per hectare from each of the crop associations in each of the regions. The amounts shown on Table I-8 are the net incomes per AOP plot. The average size of an AOP parcel is the average number of trees found in the base count in each region times the average space occupied by a tree, 4.8 square meters. See Table I-9 for the assumptions used to describe the AOP plantings. For example, in the South region, the average number of trees planted by farmers in the Spring of 1985 was 235. These 235 trees, each occupying 4.8 m2, occupy a total of 1128 m2 or 0.1128 hectares. The net income from one

hectare of, say, maize and beans is $119.01 (See Table I-6). Multiplying this amount by 0.1128 gives $13.42, the net income derived from 1128 m2 of maize and beans in the South region. This is also the annual opportunity cost of not being able to plant this crop association along with the AOP trees. As is shown in Table I-7, this figure will decrease by 2% each year under the assumption of declining yields on unprotected fields.

We must also acknowledge that even though we are analyzing a plantation on a specific parcel of land, a farmer's decisions about a particular parcel affect the entire farm. The complete farm enterprise should be considered. If a farmer takes land out of crop production to plant trees in one field and puts a similar parcel into crop production on another field, then his overall fallow/production program has not changed. We know from the Case Study forms (question 17 of page 3) that 64% of all planters have fallow land. That is, they already have land on which they are not producing food crops. Although we know that fields are not strictly interchangeable, we will say that only in 36% of the cases is land actually being taken out of food production. The other farmers are merely transferring crop production to other plots. This figure is not unreasonably high. Smucker (1983: 239) says that 75% of the households units in L'Artichaut maintain some land in fallow.

The benefits of AOP plantings

The information in Table I-9 was used to determine the value of the wood harvested by AOP planters. These values are shown in Table I-10. We will now see how these figures were derived.

As was mentioned earlier, farmers are assumed to harvest their trees every four years. Trees distributed by the AOP grow, on average, at a rate described by the function

$$dbh = 2 \times age$$

where dbh is the diameter in centimeters of the tree at breast height (1.3 meters above the ground) and age is the age of the tree in years. Thus, farmers will always harvest trees which are eight centimeters in diameter.

The volume of these trees can be determined by using a volume equation developed by Ehrlich (1985).

$$dry\ weight = 0.817 \times BA - 2.707 \times dbh$$

where dry weight is the weight, in kilograms, of the usable portion of the tree if it were dried to 0% moisture; BA is the basal area, in cm2, of the tree (basal area is the surface area of the "stump" of the tree if it were felled at breast height); and dbh is the diameter at breast height, in cm.

167X

Table I-10. Dollar value of wood harvest, by region.

Region	value in each of four rotations			
	year 4	year 8	year 12	year 16
South	$54.39	$63.62	$74.43	$87.07
Southeast	24.03	28.11	32.89	38.47
North	37.14	43.45	50.83	59.47
Upper Plateau	24.41	28.55	33.44	39.08
Lower Plateau	30.09	35.20	41.17	48.17
Region I	120.61	141.10	165.07	193.10
Region II	61.07	71.44	83.58	97.77

Sources : PADF and CARE survival rate estimates.
UMO price estimates.
UMO volume equation.

Since all harvested trees are the same size, they will all weigh the same amount: 19.4 kilograms.

dry weight = 0.817 x 50.3 cm2 - 2.707 x 8 cm

This is the yield per tree, in kilograms, shown in the second column of Table I-11. Since farmers in the South region receive an average of 235 trees and these trees have survival rate of 40%, on average, a farmer in this region will harvest 1823 kilograms of usable wood every four years.

total weight = 235 trees x 40% survival x 19.4 kg/tree

This value is shown in the third column of Table I-11.

The next two columns give the average prices of poles and of charcoal in the South region, in dollars. In 1985, poles sold for $1.00 each and a sack of charcoal sold for $2.40. The price of charcoal and of firewood has been increasing much faster than the prices of other goods in Haiti over the last fifteen years. (See Grosenick, forthcoming) Columns four and five reflect this real price increase, set at 4% per year.

We can now calculate the value of the poles the farmer will have harvested. The farmer planted 235 trees. With a survival rate of 40%, he will harvest 94 trees. Of these 94 trees, fifty percent of them, or 47 trees, will have form adequate for use as poles. The other 50% can only be used for fuelwood. From column four we see that a pole will be worth $1.12 four years from now. Our farmer's 47 poles will be worth $52.64 when he harvests them in 1989. The value of these trees to him is the amount he will receive for them less the cost of felling them. This cost can be estimated by assuming that he

Table I-11. Determination of the value of wood harvests.

Year	yield kg/tree	total yield (kg)	pole price ($)	charcoal price ($)	value of poles ($)	value of charcoal ($)	total value ($)
1	—	—	1.00	2.40	—	—	—
2	—	—	1.04	2.50	—	—	—
3	—	—	1.08	2.60	—	—	—
4	19.4	1823	1.12	2.70	42.29	12.09	54.39
5	—	—	1.17	2.81	—	—	—
6	—	—	1.22	2.92	—	—	—
7	—	—	1.27	3.04	—	—	—
8	19.4	1823	1.32	3.16	49.48	14.14	63.62
9	—	—	1.37	3.28	—	—	—
10	—	—	1.42	3.42	—	—	—
11	—	—	1.48	3.55	—	—	—
12	19.4	1823	1.54	3.69	57.88	16.55	74.43
13	—	—	1.60	3.84	—	—	—
14	—	—	1.67	4.00	—	—	—
15	—	—	1.73	4.16	—	—	—
16	19.4	1823	1.80	4.32	67.72	19.36	87.07

will have the trees cut on a sharecropping basis. When ODH contracts to have trees felled, debranched, and the poles stacked, the workers receive 20% of the wholesale value of the poles. If we use this same assumption for our average AOP planter in the South region, his poles which have a sales value of $52.64 have a standing value of $42.11. This is the value shown in column six of Table I-11.

The seventh column shows the value of the charcoal the farmer is assumed to produce from these trees. We can see on Table I-9 that the poles already discussed above account for 33% of the total weight of all wood harvested. That means that 67% of the 1823 kg shown in column three, or 1215 kg, are available to make charcoal. The charcoaling process used in Haiti has a conversion rate of about 20%. (Timyan, 1984) That is, 1215 kg of wood will produce 243 kg of charcoal. This amount of charcoal will make 8.1 sacks of charcoal, each holding 30 kg. Since each of these sacks will be worth $2.70 in 1989, combined they are worth $21.87. To determine the value of the labor necessary to convert the wood into charcoal, we consider a typical sharecropping arrangement. The owner of the trees will receive only 55% of the retail value of the charcoal produced from his trees. Thus our AOP planter's wood is worth $12.03 if used for charcoal.

Finally, the sum of these two values, $42.29 and $12.03, or $54.32, is the total value or the net revenues received by the farmer in year four. Following similar procedure one can determine the net revenues of all harvests for all regions. These net revenues are shown on Table I-10.

One final note. To be complete, we include the cost of tree planting in the calculation of net benefits. In all cases, farmers are expected to take three days to plant their AOP seedlings. The cost of planting is therefore, three times the daily wage in the region. This cost is incurred in year one. There are also costs of weeding to be considered. However, since most of the AOP participants planted their seedlings in a field being cultivated at the time, we assume that the trees will be weeded at the same time the crops are weeded and at no extra cost.

Net present value of AOP plantings

Now that we have determined the costs and the benefits of planting AOP seedlings, we can combine them to calculate the net present value (NPV) of these plantings. Table I-12, column 22 shows the net present values of all the different agroforestry systems described earlier, for each region. For an example of the calculations explained below, see Table I-7.

We see that there is a stream of costs and benefits over the sixteen-year period being considered. In year 1 there is a labor expense for planting the AOP seedlings. We've assumed that all farmers spend three days planting at a cost of three times the average daily wage rate for that region. In the South the average daily wage is $0.95 so three days of labor are worth $2.85.

Table I-12. Summary of the net costs and benefits incurred by AOP participants, by crop association and by region.

South	(1)	(2)	(3)	(4)	(5)	(6) Year 1	(7) Year 2	(8) Year 3	(9) Year 4	(10) Year 5	(11) Year 6	(12) Year 7	(13) Year 8	(14) Year 9	(15) Year 10	(16) Year 11	(17) Year 12	(18) Year 13	(19) Year 14	(20) Year 15	(21) Year 16	(22)
Maize, sorghum, pois congo	3	295	106	271.47	26.11	-2.85		-24.57	30.31	2.51	2.90	-22.67	41.41	4.34	4.78	-20.91	53.94	6.03	6.43	-19.28	68.17	37.77
Maize, manioc, beans	3	295	106	199.94	22.55	-2.85		-21.23	33.59	2.17	2.57	-19.58	44.43	3.75	4.13	-18.06	56.73	5.21	5.56	-16.66	70.75	47.19
Maize, sorghum, manioc	2	197	71	339.01	38.24	-2.85		-35.99	19.12	3.67	4.37	-33.20	31.09	6.36	7.00	-30.62	44.42	8.83	9.42	-28.24	59.39	5.66
Maize, beans	1	98	35	119.01	13.42	-2.85		-12.63	42.01	1.29	1.53	-11.65	52.20	2.23	2.46	-10.75	63.90	3.10	3.31	-9.91	77.35	71.36
Maize, sorghum	1	98	35	258.02	29.10	-2.85		-27.39	27.54	2.80	3.32	-25.27	38.06	4.04	5.32	-23.31	51.59	6.72	7.17	-21.50	66.00	29.84
Maize, sorghum, manioc, patate	2	197	71	390.47	44.05	-2.85		-41.45	13.76	4.23	5.03	-38.24	26.15	7.32	8.06	-35.27	39.87	10.17	10.05	-32.53	55.19	-9.71
Maize, manioc, patate	4	394	142	230.21	25.97	-2.85		-24.44	30.44	2.49	2.96	-22.54	41.53	4.32	4.75	-20.79	54.05	6.00	6.40	-19.18	68.27	38.15
Maize, patate	2	197	71	41.00	4.62	-2.85		-4.35	50.12	0.44	0.53	-4.01	59.69	0.77	0.85	-3.70	70.00	1.07	1.14	-3.42	83.72	94.66
Manioc, peanuts	1	98	35	376.88	42.51	-2.85		-40.01	15.18	4.08	4.85	-36.91	27.45	7.07	7.78	-34.04	41.07	9.02	10.47	-31.40	56.30	-5.65
Maize, sorghum, patate	1	98	35	262.78	29.64	-2.85		-27.90	27.05	2.85	3.30	-25.73	38.40	4.93	5.42	-23.73	51.17	6.85	7.30	-21.89	65.62	28.42
Manioc, beans	1	98	35	122.48	13.82	-2.85		-13.00	41.65	1.33	1.58	-11.99	51.87	2.30	2.53	-11.06	63.59	3.19	3.40	-10.20	77.07	70.32
Yam, patate	2	197	71	151.23	17.06	-2.85		-16.06	38.66	1.64	1.95	-14.81	49.11	2.84	3.12	-13.66	61.04	3.94	4.20	-12.60	74.72	61.74
Manioc	1	98	35	113.69	12.82	-2.85		-12.07	42.56	1.23	1.46	-11.13	52.71	2.13	2.35	-10.27	64.37	2.96	3.16	-9.47	77.79	72.95
Sorghum, patate, yam	1	98	35	374.56	42.25	-2.85		-39.77	15.42	4.06	4.82	-36.68	27.67	7.02	7.73	-33.85	41.28	9.76	10.41	-31.20	56.49	-4.96
Fallow	2	197	1771	0.00	0.00	-2.85		0.00	54.39	0.00	0.00	0.00	63.62	0.00	0.00	0.00	74.43	0.00	0.00	0.00	87.07	106.90
Totals	27	2657	2657			-7572	0	-21385	123557	2183	2594	-19725	149708	3778	4156	-18194	179930	5248	5598	-16781	214899	

Southeast	(1)	(2)	(3)	(4)	(5)	(6) Year 1	(7) Year 2	(8) Year 3	(9) Year 4	(10) Year 5	(11) Year 6	(12) Year 7	(13) Year 8	(14) Year 9	(15) Year 10	(16) Year 11	(17) Year 12	(18) Year 13	(19) Year 14	(20) Year 15	(21) Year 16	(22)
Maize, sorghum, pois congo	5	1354	487	243.17	20.78	-2.40		-19.55	4.87	2.00	2.37	-18.04	10.43	3.45	3.00	-16.64	16.59	4.80	5.12	-15.34	23.43	-8.81
Maize, sorghum, manioc	2	542	195	350.34	29.93	-2.40		-28.17	-3.58	2.08	3.42	-25.99	2.64	4.98	5.48	-23.97	9.40	6.91	7.37	-22.11	16.80	-33.05
Maize, beans	1	271	97	132.43	11.31	-2.40		-10.65	13.59	1.09	1.29	-9.82	18.48	1.88	2.07	-9.06	24.01	2.61	2.79	-8.36	30.28	16.24
Maize, patate	1	271	97	51.40	4.39	-2.40		-4.13	19.98	0.42	0.50	-3.81	24.37	0.73	0.80	-3.52	29.44	1.01	1.08	-3.24	35.29	34.57
Maize, sorghum, pois congo, pa	2	542	195	291.24	24.88	-2.40		-23.42	1.08	2.39	2.84	-21.60	6.94	4.14	4.55	-19.93	13.36	5.75	6.13	-18.38	20.46	-19.69
Maize, potatoes	1	271	97	1191.80	101.83	-2.40		-95.84	-69.89	9.78	11.62	-88.40	-58.52	16.93	18.63	-81.54	-47.02	23.52	25.09	-75.21	-35.23	-223.40
Peanuts	1	271	97	261.83	22.37	-2.40		-21.06	3.40	2.15	2.55	-19.42	9.08	3.72	4.09	-17.91	15.34	5.17	5.51	-16.52	22.28	-13.03
Fallow	0	0	2253	0.00	0.00	-2.40		0.00	24.03	0.00	0.00	0.00	28.11	0.00	0.00	0.00	32.89	0.00	0.00	0.00	38.47	46.20
Totals	13	3520	3520			-8448	0	-32424	52810	3310	3933	-29907	69638	5727	6302	-27505	80739	7957	8487	-25444	110479	

Table I-12, page 2. Summary of the net costs and benefits incurred by AOP participants, by crop association and by region.

North	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
						Year																
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Maize, manioc, beans	5	719	259	187.46	18.99	-3.30		-17.87	19.63	1.82	2.17	-16.48	27.30	3.16	3.[illegible]	-15.20	35.93	4.39	4.68	-14.02	45.73	21.51
Maize, sorghum, manioc	1	144	52	327.68	33.19	-3.30		-31.24	6.53	3.19	3.79	-28.81	15.22	5.52	6.07	-26.57	24.79	7.67	8.18	-24.51	35.45	-16.09
Maize, beans	3	432	155	105.59	10.69	-3.30		-10.07	27.28	1.03	1.22	-9.28	34.35	1.78	1.96	-8.56	42.44	2.47	2.63	-7.90	51.73	43.46
Maize, sorghum, pois congo, pa	2	208	104	264.98	26.84	-3.30		-25.26	12.39	2.58	3.06	-23.30	20.62	4.46	4.91	-21.49	29.77	6.20	6.61	-19.82	40.05	0.72
Maize, manioc, patate	2	208	104	217.77	22.06	-3.30		-20.76	16.00	2.12	2.52	-19.15	24.69	3.67	4.03	-17.66	33.52	5.09	5.43	-16.29	43.51	13.38
Maize, patate	1	144	52	30.59	3.10	-3.30		-2.92	34.28	0.30	0.35	-2.69	40.81	0.52	0.57	-2.48	48.40	0.72	0.76	-2.29	57.23	63.57
Manioc, peanuts	1	144	52	365.65	37.03	-3.30		-34.86	2.98	3.56	4.23	-32.15	11.94	6.16	6.77	-29.65	21.77	8.55	9.12	-27.35	32.67	-26.27
Maize, sorghum, peanuts	1	144	52	287.37	29.10	-3.30		-27.39	10.29	2.80	3.32	-25.27	18.69	4.84	5.32	-23.31	27.99	6.72	7.17	-21.50	38.40	-5.28
Manioc, beans	1	144	52	112.03	11.35	-3.30		-10.68	26.67	1.09	1.30	-9.85	33.80	1.89	2.08	-9.09	41.93	2.62	2.80	-8.38	51.26	41.73
Manioc	1	144	52	113.69	11.51	-3.30		-10.64	26.52	1.11	1.31	-10.00	33.65	1.91	2.11	-9.22	41.79	2.66	2.84	-8.50	51.14	41.29
Fallow	0	0	1658	0.00	0.00	-3.30		0.00	37.14	0.00	0.00	0.00	43.45	0.00	0.00	0.00	50.83	0.00	0.00	0.00	59.47	71.78
Totals	18	2590	2590			-8547	0	-17068	79466	1742	2070	-15743	97108	3015	3317	-14521	117419	4189	4468	-13393	140902	

Upper Plateau	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
						Year																
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Maize, sorghum, pois congo	10	1197	431	250.97	16.14	-2.10		-15.19	9.52	1.55	1.84	-14.01	14.02	2.[illegible]	2.95	-12.93	20.77	3.73	3.98	-11.92	27.40	4.50
Maize, manioc, beans	2	239	86	220.75	14.20	-2.10		-13.36	11.31	1.36	1.62	-12.33	16.47	2.36	2.60	-11.37	22.30	3.28	3.50	-10.49	28.60	9.65
Maize, sorghum, manioc	7	838	302	357.89	23.02	-2.10		-21.67	3.18	2.21	2.63	-19.98	8.97	3.83	4.21	-18.43	15.38	5.32	5.67	-17.00	22.42	-13.70
Maize, beans	1	120	43	141.38	9.09	-2.10		-8.56	16.02	0.87	1.04	-7.89	20.01	1.51	1.66	-7.20	26.30	2.10	2.24	-6.72	32.50	23.17
Maize, sorghum	1	120	43	276.11	17.76	-2.10		-16.72	8.03	1.71	2.03	-15.42	13.44	2.95	3.25	-14.22	19.50	4.10	4.38	-13.12	26.23	0.22
Maize, sorghum, manioc, patate	1	120	43	414.97	26.69	-2.10		-25.12	-0.21	2.56	3.05	-23.17	5.84	4.44	4.88	-21.37	12.50	6.16	6.58	-19.71	19.76	-23.42
Maize, sorghum, peanuts	1	120	43	316.24	20.34	-2.10		-19.14	5.65	1.95	2.32	-17.66	11.25	3.38	3.72	-16.29	17.48	4.70	5.01	-15.02	24.36	-6.61
Fallow	0	0	1761	0.00	0.00	-2.10		0.00	24.41	0.00	0.00	0.00	28.55	0.00	0.00	0.00	33.44	0.00	0.00	0.00	39.08	47.24
Totals	23	2752	2752			-5779	0	-17224	50297	1758	2009	-15087	63001	3042	3340	-14653	77667	4227	4508	-13516	94303	

Lower Plateau	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
						Year																
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Maize, sorghum, pois congo	4	427	154	188.58	12.22	-4.50		-11.50	18.80	1.17	1.40	-10.61	24.80	2.03	2.24	-9.70	31.58	2.82	3.01	-9.03	39.33	24.12
Maize, sorghum, manioc	2	213	77	297.48	19.28	-4.50		-18.14	12.29	1.05	2.20	-16.73	18.00	3.20	3.53	-15.44	26.04	4.45	4.75	-14.24	34.22	5.43
Maize, beans	2	213	77	69.81	4.52	-4.50		-4.26	25.90	0.43	0.52	-3.93	31.35	0.75	0.83	-3.62	37.62	1.04	1.11	-3.34	44.90	44.49
Maize, sorghum	6	640	230	218.23	14.14	-4.50		-13.31	17.03	1.36	1.61	-12.28	23.17	2.35	2.59	-11.32	30.07	3.27	3.40	-10.44	37.93	19.03
Maize, sorghum, manioc, patate	1	107	38	343.42	22.25	-4.50		-20.94	9.54	2.14	2.54	-19.32	16.27	3.70	4.07	-17.82	23.71	5.14	5.48	-16.44	32.06	-2.45
Maize, sorghum, patate	1	107	38	219.38	14.22	-4.50		-13.38	16.96	1.37	1.62	-12.34	23.11	2.36	2.60	-11.38	30.01	3.28	3.50	-10.50	37.88	18.83
Fallow	2	213	1306	0.00	0.00	-4.50		0.00	30.07	0.00	0.00	0.00	35.20	0.00	0.00	0.00	41.17	0.00	0.00	0.00	48.17	56.47
Totals	18	1920	1920			-8640	0	-7872	50020	804	955	-7261	60469	1390	1530	-6697	72483	1932	2060	-6177	86433	

Table I-12, page 3. Summary of the net costs and benefits incurred by AOP participants, by crop association and by region.

Region I - Bombardopolis	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
						Year																
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Maize, sorghum, pois congo	1	147	53	227.57	27.31	-3.00		-25.70	95.42	2.62	3.12	-23.71	117.87	4.54	5.00	-21.87	143.64	6.31	6.73	-20.17	173.33	167.79
Maize, manioc, beans	1	147	53	195.78	23.49	-3.00		-22.11	98.94	2.26	2.68	-20.40	121.11	3.91	4.30	-18.81	146.63	5.43	5.79	-17.35	176.10	177.89
Maize, beans	1	147	53	114.54	13.74	-3.00		-12.94	107.93	1.32	1.57	-11.93	129.41	2.29	2.51	-11.01	154.28	3.17	3.39	-10.15	183.15	203.71
Maize, sorghum, manioc, patate	3	441	159	386.2	46.34	-3.00		-43.62	77.86	4.45	5.29	-40.23	101.67	7.70	8.48	-37.11	128.70	10.70	11.42	-34.23	159.56	117.40
Maize, manioc, patate	1	147	53	226.06	27.13	-3.00		-25.53	95.59	2.61	3.10	-23.55	118.02	4.51	4.96	-21.72	143.70	6.27	6.68	-20.04	173.47	168.27
Pois congo, patate	1	147	53	-3.58	-0.43	-3.00		0.40	121.01	-0.04	-0.05	0.37	141.47	-0.07	-0.08	0.34	165.41	-0.10	-0.11	0.32	193.41	241.23
Manioc, patate	1	147	53	194.85	23.38	-3.00		-22.01	99.04	2.25	2.67	-20.30	121.21	3.89	4.28	-18.72	146.72	5.40	5.76	-17.27	176.18	178.19
Fallow	1	147	994	0.00	0.00	-3.00		0.00	120.61	0.00	0.00	0.00	141.10	0.00	0.00	0.00	165.07	0.00	0.00	0.00	193.10	240.10
Totals	10	1470	1470			-4410	0	-12634	164915	1290	1532	-11653	195997	2232	2456	-10749	232119	3101	3307	-9914	274141	

Region II - Jean Rabel	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
						Year																
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Maize, sorghum, pois congo	1	141	51	227.57	27.31	-3.00		-25.70	35.08	2.62	3.12	-23.71	48.21	4.54	5.00	-21.87	62.15	6.31	6.73	-20.17	78.00	47.92
Maize, manioc, beans	4	565	203	195.78	23.49	-3.00		-22.11	39.40	2.[illegible]	2.68	-20.40	51.45	3.91	4.30	-18.81	65.14	5.43	5.79	-17.35	80.77	58.02
Maize, sorghum, manioc, patate	1	141	51	386.2	46.34	-3.00		-43.62	18.32	4.45	5.29	-40.23	32.01	7.70	8.48	-37.11	47.21	10.70	11.42	-34.23	64.23	-2.48
Manioc, peanuts	1	141	51	373.14	44.78	-3.00		-42.14	19.77	4.30	5.11	-38.87	33.35	7.44	8.19	-35.85	48.44	10.34	11.03	-33.07	65.36	1.67
Maize, sorghum, patate	1	141	51	258.84	31.06	-3.00		-29.23	32.42	2.98	3.55	-26.96	45.01	5.16	5.68	-24.87	59.21	7.17	7.65	-22.94	75.29	37.98
Fallow	0	0	723	0.00	0.00	-3.00		0.00	61.07	0.00	0.00	0.00	71.44	0.00	0.00	0.00	83.58	0.00	0.00	0.00	97.77	120.22
Totals	8	1130	1130			-3390	0	-11652	57590	1189	1413	-10748	70195	2058	2265	-9913	84730	2860	3050	-9144	101519	

Table I-13. Cumulative changes in NPV.

net income ($)	Number and percent of farmers whose NPV from tree farming is below the amount in column 1	
	number	percent
-60	94	0.01
-40	937	0.06
-20	2097	0.12
0	2576	0.15
20	3909	0.23
40	4818	0.29
60	8914	0.53
80	11643	0.69
100	11764	0.70
120	14802	0.88
140	15475	0.92
160	15721	0.93
180	15644	0.93
200	15774	0.94
220	15812	0.94
240	15812	0.94
260	16821	1.00

Source: Table I-10.

In the third and fourth year of each four year rotation, there are no revenues from crop production because, as explained earlier, the farmer will not be able to plant his crops due to excessive shading. Column four shows the net income from the first tree harvest in the South region from Table I-10: $54.39. Succeeding four year rotations are similar. The small differences in net revenues from wood are due to the increase in the price of wood products over time. Note that the net revenues from crops do not decrease over time when planted only two years in every four on land protected from excessive erosion by trees.

Calculations similar to those shown in Table I-7 are made for each of the crop associations considered. These are summarized in Table I-12. In the last column of Table I-12 we see the net present value of each of the associations. Some of these values are positive and some are negative. That is, it is profitable to replace some crops with trees but not profitable for other crops. Column 3 of Table I-12 shows the number of farmers estimated to have replaced each of the listed crop associations with trees. If we list all the AOP participants by the amount they will have gained or lost, we obtain the Table I-13. We can see from this table that 15% of all AOP associations have net present values less than zero.

This does not mean that 85% of all these farmers are better off while 15% are worse off than they would have been without the project. This will be discussed more in the next section. We will for the moment continue to use the financial losses shown in Table I-12.

Additional note

It would seem from Table I-13 that 15% of all AOP participants are worse off for having participated in the project. This is not necessarily so. It is only true if we have correctly assumed the farmers "without project" actions. That is, what he would have done had he not participated in the AOP.

Our assumption has been that the farmer will continue to raise the crops on his field for sixteen years. Because they planted AOP seedlings, they must give up some income they would have earned from crop production. This is the opportunity cost of the plantation. The 2576 farmers who seemingly lost money by planting AOP trees (See Table I-13) did so because of these opportunity costs. However, if those farmers have labor or other constraints which would prevent them from farming this land, then it follows that they would not have had the same opportunity costs and therefore would not have had net losses. It may be, for example, that a farmer's sons have grown up and moved away and he no longer has the family labor necessary to cultivate all his land. He then decides to plant trees which require very little labor for establishment and maintenance.

We are not saying that the losses incurred by these farmers should be ignored. They are included in this analysis as a cost of the project. What we hope to do in this section is to give some possible explanations as to why some farmers choose to plant trees when, according to our analysis they should not be doing so. It may be that the 15% of all AOP farmers who are "losing money" may feel that this is one of the best investments they have.

The farmer is faced with a production situation in which he must allocate a number of inputs (land, labor, capital, cash) to several outputs (types of agricultural crops and trees). He will maximize his profit by allocating these inputs to the various outputs in such a way that the marginal value product of each input is equal for all outputs. (Harou, 1983; Raintree, 1983) This allocation process is such that the farmer must consider all inputs and outputs at once. Decisions should not be based on one field only. There is evidence that the Haitian farmer does consider the entire farm enterprise.

The decisions made by the farmer are influenced by the availability of resources. As the resources available to the farmer change during his life, the basis of his decisions change. For instance, family wealth in the form of land holdings normally increases as the head of the family ages. Labor available for agricultural activities normally increases as children grow and then decreases as they leave home. The possibility for education and urban employment also affects the availability of labor over time.

175x

Some farmers are limited by the amount of land they have available. Others are limited by the lack of family labor and the lack of cash to purchase labor. Others are limited not by the amount of labor they have but its seasonal availability in relation to the seasonal demands of the crops. Others have what might be called a labor surplus. They are willing to work but have nothing to do.

Murray supports this view when he says that the farmer's "success in life entails not only the acquisition of land, but the systematic mobilization of the energies ot other individuals as well ... Much of his behavior will not be understood, however, unless his radical dependence on the labor of others is clearly perceived ..." (Murray, 1975: 237)

The NPV criteria which we have been using assumes that the farmer will be reimbursed for his labor at the regional average daily wage rate. We know that he does not pay himself a wage, but he will devote his labor to other activities if he considers the returns to his labor from tree farming are too low.

Uncertainty is another reason for planting trees. Conway writes "Their (the farmers') reasoning was that with agriculture becoming increasingly uncertain, and with land available because of labor constraints, they preferred to cultivate trees which could be used as a reserve for cash at any time once the trees were mature." (Conway, 1986: 26) Some farmers may use the trees as a reserve for emergencies. The reason for doing this is that when an emergency occurs, the farmer may have to borrow cash at very high interest rates. It is important to mention uncertainty because we have thus far assumed it away. That is, we have given agricultural production the advantage by saying that the farmer can harvest sixteen successive crops. This makes that opportunity cost of tree farming higher that it should be.

There is another reason some farmers may be willing to participate in a program which is seemingly unprofitable. In this report we have seen that certain farmers are planting AOP seedlings under conditions which will make them financially worse off. Note that the investment we are talking about is planting AOP seedlings. Consider the farmer who has received his seedlings from an organization which sponsors many activities. Such organizations may distribute tree seedlings while providing health services, fertilizer, improved seed, pigs, and so on. Regular clients often receive preferential treatment. In some cases farmers accept trees for planting as a way of gaining or maintaining preferred client status. I such cases the farmer does not judge tree planting as a simple investment in and of itself. He judges the whole package of benefits he stands to receive from his local PVO. He will accept the package if the net result is positive even if some of the components are negative if he believes that by accepting the less profitable investments he has assured access to the very good ones.

Finally, normal economic investment decision criteria should be based on the most limiting factor of production. One problem we face is that we cannot classify our 73,000 farmers by their most limiting

factor and perform different analyses on each group. What we have done is used the most common basis, land, because it is the easiest basis on which to gather information and therefore more information is available for land that for any other factor.

It is clear that land is believed by most people to be the most limiting factor to Haitian farmers. The Project Paper says that "The project will develop small farm agroforestry demonstration models aimed at increasing productivity and incomes per unit land area ..." (AID, 1981: 69) Labor is a more limiting constraint than land for some farmers. Thus, the project should also consider developing models aimed at increasing labor productivity.

We might have added labor savings due to less time spent collecting firewood. If we had done this, then we would have had to reduce the benefits from selling charcoal. Since it is relatively easier to calculate the value of the charcoal value, we've used it rather than the value of auto-consumption of firewood. In this case, the income from charcoal is the least the farmer could receive. It may be that by using the wood for firewood, he would benefit more that we have shown.

177x

CHAPTER 2

ANALYSIS OF INDUSTRIAL PLANTATIONS.

The role Operation Double Harvest (ODH) plays in the AOP complements that of CARE and PADF. CARE and PADF work with small farmers. In general, they do not distribute more than five hundred trees to one individual. In the recent past, many farmers have received only 250 or even 150 trees. Double Harvest, on the other hand, deals exclusively with large landowners. The plantations range in size from sixteen hectares to seventy-six hectares, with an average of forty hectares. See Table II-1 and Figure I-1.

Table II-1. Double Harvest plantations, their size and establishment dates.

Plantation	Size in Hectares	Establishment Date
Madsen	51	May, 1981
Heraux	40	July, 1981
Fonds Parisien	47	April, 1982
Ashton	20	July, 1982
Gardere	32	July, 1982
Roy	90	July, 1983
Liautaud	24	July, 1983
Roude	63	Jan, 1984
Durocher	43	July, 1984
Nadal	76	July, 1985

Source: ODH Quarterly Reports.

While CARE and PADF work to develop a body of knowledge which will help small farmers raise trees profitably, Double Harvest is doing the same for large landowners who wish to establish industrial plantations.

There is another basic difference between the method used by CARE and PADF and that used by Double Harvest. CARE and PADF provide only seedlings and technical assistance (training and advice). The participating farmers do all the work themselves or arrange to have it done. ODH, on the other hand, enters into an agreement with the landowner. Under this agreement, ODH executes and pays for all the plantation operations, from establishment through maintenance to harvest. The share of profits accruing to each partner is specified in the contract as well. This process is explained in more detail elsewhere. For the purposes of this financial analysis, ODH and

Perodin
Bois Rouge
L' ARTIBONITE
Savane à Roches
Desarmes
Petite Montagne
Thomonde
Bois Jolis
Boucan Carré
La Chapelle
Dufailly
Paredon
Barrage de Peligre
Mirebalais
Saut d' Eau ou Ville Bonheur
Cazales
Savane Mme. Michel
Marché Canard
Trianon
Poste Rouge
Duvalierville
Ciment d'Haïti
Boucassin
Source Matelas
Ibo Beach
Minoterie d' Haïti
Savanelle
Bon Repos
Trou Caïman
Pont Beudet
Croix des Missions
Drouillard
Crx. des Bouquets
Mariani
Thor
Delmas
Frères
Duval
Ganthier
Pétionville
Diquini
Grenier
Bois Pin
Jacques
Fort Alexandre
Kenscoff
Clemenceau
Fond Ferrier
Robin
Furcy
Fond Parisien
Azuey
Fond Verr
DE L'OUEST
Me. Cabaio
La Visite
Mare Rouge
Cap
Senain

179 x

the landowner are considered together. Expenditures made by either are used in the analysis, as are incomes earned by either.

As in Chapter 1 , we will begin by summarizing the benefits which will accrue to the plantations.

The ODH plantations.

In consultation with ODH personnel, we agreed to divide the ten ODH plantations into four productivity classes. Instead of analyzing each of the ten plantations, we will consider four plantations, one from each class. This will give an idea of the range of production possibilities and the profitability over a range of sites. The variability is due to many factors but mainly to differences in soil and, to a lesser extent, rainfall. For further information on site diversity, see the technical portion of the project evaluation. Each class will have a different harvest schedule. These are described below. They are not based on any determination of optimum rotation and are not even recommendations. They are reasonable schedules based on limited information.

Figure I-2. Harvest Schedule for Class I plantations.

```
                    Age of plantation in years

  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15
 ---------------------------------------------------------------
  !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !

             [P]---------[P]---------[P]---------[P]---------[P]
              !
             / \
Plant-------! S !
             \ /
              !
              !------------------[L]-------------------------[L]

[P] - Harvest poles
[L] - Harvest lumber
!S! - Select lumber trees
```

Class I contains only the Madsen plantation because no other plantation has the potential that Madsen has. The harvest schedule for class I is described below and is shown schematically in Figure 2.

> Year 3: 20% of all stems would be selected for lumber production. These trees would be harvested in year nine. The remaining 80% would be harvested for poles and fuelwood. Year 6: another 20% of all stems would be selected for lumber production

from among those harvested in year three These lumber trees are scheduled to be harvested in year twelve. The remaining 60% would be harvested for poles and fuelwood again. Year 9: a third 20% would be reserved for lumber production from among the 60% which had been twice harvested for poles and fuelwood. These trees would be harvested in year fifteen. The other 40% would be harvested for poles and fuelwood. Finally the first lumber harvest would be made. Year 12: the second lumber harvest would be made along with a 60% harvest for poles and fuelwood. Year 15: a third lumber harvest is made along with an 80% poles and fuelwood harvest.

Class II is comprised of the Roy, Gardere, and Liautaud plantations. They are estimated to have productivity below that of the Madsen farm but greater than the remaining farms. The harvest schedule for Class II is much simpler than that for Class I. See Figure 3.

Figure I-3. Harvest Schedule for Class II plantations.

```
                    Age of plantation in years

  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15
 ---------------------------------------------------------------
  !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !

                      [P]-----------------[P]-----------------[P]
                       !
                      / \
Plant---------------! S !
                      \ /
                       !
                       !-------------------------------------[L]

[P] - Harvest poles
[L] - Harvest lumber
!S! - Select lumber trees
```

Year 5: 20% of all stems are designated as lumber trees, to be harvested in year fifteen. The remaining eighty percent of all stems will be harvested for poles and fuelwood. Year 10: the trees harvested in year five will again be harvested for poles and fuelwood. Year 15: the trees harvested in year ten will again be harvested for poles and fuelwood. The lumber trees selected in year five will be harvested.

181X

Class III contains the Fonds Parisien, Roude, Durocher, Ashton, and Nadal plantations. The harvest schedule is quite simple, there will be no lumber production. See Figure 4.

Figure I-4. Harvest Schedule for Class III plantations.

Age of plantation in years

```
 0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15
 ---------------------------------------------------------------
 !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !

Plant-------------------------[P]-------------------------[P]

[P] - Harvest poles
 ---------------------------------------------------------------
```

Year 8: poles and fuelwood are harvested. Year 15: all trees are again harvested for poles and fuelwood.

Class IV was created for the Heraux plantation. This plantation is thought to be unproductive. ODH is no longer committing any resources to the Hereaux plantation. Any harvest from this plantation would be of little importance.

Analysis of Class I - the Madsen farm.

The benefits

A good deal of research has been done on the Madsen farm. We have estimates of yields in years two and three. We will use these estimates to project yields for other ages. As mentioned earlier, any projections beyond four years are educated guesses. However, we feel that what follows are reasonable estimates.

1) In 1983 Timyan (Timyan, 1983) estimated the fuelwood yield for the Madsen plantation based on measurements taken by Bihun (Bihun, 1983). The plantation was divided into ten parcels of differing productivity. See Figure V. Ten permanent sample plots were established, one to represent each of the site classes. Annual volume growth was determined for each parcel and extrapolated to the area represented by that parcel. The results of this study are shown in Table II-2. The average yield of these ten plots was estimated to be 6.6 cubic meters per hectare per year.

To determine the average yield for all of the Madsen farm we would include the area not included in the yield study described above. These areas of 'no growth' comprise seventeen of the fifty-one hectares. Thus the the average yield for all of Madsen is 4.4 cubic meters per hectare per year. (All fifty-one hectares were planted in 1982)

182

Table II-2. Estimation of mean annual volume growth for the Madsen plantation.

Parcel Number	Area of Parcel	Mean Annual Volume Growth (m3/hectare)
1	2.7	8.0
2	2.0	5.1
3	11.8	3.1
4	0.6	13.8
5	7.5	2.5
6	3.6	20.5
7	1.6	17.8
8	1.0	4.6
9	2.1	9.1
10	1.1	2.0
Area surveyed	34.0	6.6 (wtd avg)
Other areas	17.0	0.0
Total area	51.0	4.4 (wtd avg)

Source: Timyan (1983) Table VII.

2) In June of 1984, Timyan established an experimental plot containing three hundred leucaena. (Timyan, 1984) These trees were clearcut to determine the yield at thirty-seven months. Timyan found that the leucaena on this site produced at the rate of 10 metric tons of merchantable wood per hectare per year or 16.4 cubic meters per hectare per year. In additions, there were five tons of non-merchantable wood. In this study, any branch or stem having a diameter exceeding 1.5 cm was considered merchantable.

ODH was conducting an 80% thinning of the Madsen plantation at the time and wanted to have an idea of the standing volume after the thinning. The second objective of Timyan's 1984 study was to determine this volume. After having felled all three-hundred trees, he selected the largest and best 20% of all trees. These trees yielded 45.6% of merchantable and 43.5% of nonmerchantable biomass.

3) Timyan determined that approximately 50% of all trees harvested (one-hundred-sixty out of three-hundred) were suitable for poles.

4) Of the total volume of wood used for poles and charcoal, thirty-six percent of the volume was in the poles and 64% was usable only for fuelwood.

5) Timyan converted 2.07 tons of dry wood into 0.42 tons of merchantable charcoal. This represents a 20% dry weight conversion rate.

183

Table II-3. Projected harvests forom the Madsen plantation.

Year	harvest in cubic meters: Pole and fuelwood	harvest in cubic meters: lumber	harvest in commercial units: Number of poles	harvest in commercial units: Kg of charcoal	harvest in commercial units: Bdft of lumber
1					
2					
3	370.3		1125	29772	
4					
5					
6	370.3		1125	29772	
7					
8		807.8			169646
9	370.3		1125	29772	
10					
11					
12	370.3		1125	29772	
13					
14					
15	370.3	706.9	1125	29772	148440
Total	1851.5	1614.7	5625	148860	318086

Pole and fuelwood harvest = 6.6 m3/he/yr x 3 yr x 34 he x 0.55
Lumber harvest = 6.6 m3/he/yr x 8 yr x 34 he x 0.45

Poles harvest = 2500 trees/he x 0.90 (survival) x 0.50
Kg of charcoal produced = 370.3 m3 x 600 kg/m3 x 0.64 x 0.20 (conversion)
BdFt of lumber produced = 807.9 m3 x 35 ft3/m3 x 12 bdft/ft3 x 0.50 (conversion)

Table II 4. Projected wholesale prices for wood products in Port Au Prince. Double Harvest's projected net unit revenues. 1982 to 1996.

Year	Projected wholesale price			Projected net unit revenue		
	20 kg sack charcoal	one dozen avg poles	board foot of lumber	20 kg sack charcoal	one dozen avg poles	board foot of lumber
1982	***	***	***	***	***	***
1983	***	***	***	***	***	***
1984	3.00	5.50	0.50	1.65	4.40	0.20
1985	3.00	5.50	0.50	1.65	4.40	0.20
1986	3.09	5.67	0.52	1.70	4.53	0.21
1987	3.18	5.83	0.53	1.75	4.67	0.21
1988	3.28	6.01	0.55	1.80	4.81	0.22
1989	3.38	6.19	0.56	1.86	4.95	0.23
1990	3.48	6.38	0.58	1.91	5.10	0.23
1991	3.58	6.57	0.60	1.97	5.25	0.24
1992	3.69	6.76	0.61	2.03	5.41	0.25
1993	3.80	6.97	0.63	2.09	5.57	0.25
1994	3.91	7.18	0.65	2.15	5.74	0.26
1995	4.03	7.39	0.67	2.22	5.91	0.27
1996	4.15	7.61	0.69	2.28	6.09	0.28

Table II-5. Projected net revenues of the Madsen plantation. 1982 to 1996.

Year	Net revenue in dollars			
	Poles	Charcoal	Lumber	Total
1982				
1983				
1984	412.50	2456.19		2868.69
1985				
1986				
1987	437.81	2605.05		3042.86
1988				
1989			39018.58	39018.58
1990	478.13	2843.23		3321.35
1991				
1992				
1993	522.19	3111.17		3633.36
1994				
1995				
1996	570.94	3394.01	41563.20	45528.15
	573.63	3414.10	11772.15	15759.88

Source: Tables II-3 and I -4.

1860

These five pieces of information and the harvest schedule for a Class I plantation, discussed above, allow us to determine the harvest volumes over the entire rotation.

Table II-3 shows the projected harvests for the Madsen farm during the fifteen-year rotation. Table II-4 shows the projected wholesale prices of these for these products and ODH's projected net income per unit. The prices in this table reflect a four-percent annual real price increase. That is, we are assuming that the price of all wood products will rise at a rate three-percent greater than the general cost-of-living.

Note that ODH does not employ wage labor for harvest or product transformation. All labor is compensated on the traditional Haitian system of sharecropping. Workers who contract to harvest poles are paid 20% of the wholesale price in Port Au Prince for all the poles they cut and stack. Since poles of different sizes have different values, the workers stack their poles by size and are paid accordingly. Those who harvest fuelwood are paid $2.50 per stere cut and stacked. Charcoal makers are paid 45% of the wholesale value of charcoal for all the charcoal they produce. These charcoal makers fell the trees, transport the wood, and make and bag the charcoal. ODH has not yet produced any lumber but we will assume the following labor shares: The person sawing timber into boards receives fifty-percent of the lumber in payment for sawing and those who fell the trees receive 20% of the wholesale value of the logs. This means that if lumber were selling at, say, $0.50 per board foot, the sawyer would receive $0.25, the feller would receive $0.05 and ODH would retain $0.20.

ODH has a band saw with which it will saw lumber from logs comings from their plantations. The type of saw ODH has is identical to the one used by OMS in Cap Haitian. The best estimate of ODH's as yet unknown sawing costs is the price OMS charges for sawing. This price is 50% of the value of the lumber.

By applying the net unit revenues in Table II-4 to the harvests in Table II-3 we obtain the projected plantation revenues shown in Table II-5.

<u>The costs</u>.

Now that we have estimated the revenues which will be generated by the Madsen farm, we will develop a summary of the costs of plantation establishment and estimates of maintenance costs based on the maintenance costs experienced during the first four years of the project.

According to AID records, ODH spent approximately $1,067,891.90 on the agroforestry project through October of 1985. $965,141.22 in the first grant period, beginning in 1981 and going through the first quarter of 1985 and $102,750.68 during the grant extension beginning in the second quarter of 1985 and going through October, 1985. See Table II-6. According to ODH financial reports to AID, expenditures totaled $967,054.98. However, additional expenditures were made but

187

not reported to AID. During the last quarter of 1984 and the first quarter of 1985, ODH reported expenditures in only one category, Management and Administration. Expenses were not reported for other categories because ODH had already exceeded the grant budget for those line items and so did not list expenditures from its own funds in the other categories. Listing further expenses would not have led to further reimbursements by AID, although it would have been useful for purposes of cost accounting.

(This may be a gross underestimate of the amount spent by ODH. According to the original grant agreement $850,000 would be supplied by AID and $1,114,000 by ODH. As stated above ODH reported only $965,000 worth of expenditures to AID. We have no idea of the nature of expeditures made with ODH contributed funds, or even if additional funds were contributed by ODH. Thus, to the extent that ODH contributed funds according to the grant agreement, the costs of the agroforestry project are underestimated.)

Rather than go over six months' records to determine additional ODH expenses not reported to AID, I have used average quarterly expenditures over the previous year as proxy for actual expenditures. That is, expenditures in each of IV-84 and I-85 are taken as being equal to one quarter of the expenditure from IV-83 through III-84. The estimated amounts, $10,432.32 for nursery; $18.114.60 for plantations; and $754.54 for the contingency fund, were added to the amount reported to AID for each of the two quarters. Page 3 of Table II-6 has a slightly different format than do the first two pages. This is because ODH obtained a Grant Extension which began in the second quarter of 1985. The Grant Extension has a budget whose has format is not strictly comparable to the budget for the original grant. Table II-6 shows all ODH expenditures on the agroforestry project, by quarter. The expenditures are broken down into five categories.

Since we are determining the feasibility of tree farming from the point of view of the landowner we are not concerned with all project costs at this time. Only two categories concern us for the moment: category C, Hardwood forest experimentation and demonstration and category D, Management and administration costs. We are not considering nursery costs, for example, because the plantations have been charged for the purchase of seedlings at the rate of $0.075 per seedling.

Let us first consider the direct costs of plantation establishment and maintenance. Table II-6 shows this total to be $456.096.94. ($386,738.39 + $69,358.55) Table II-7 is a summary of plantation and maintenance costs for each plantation. This table was prepared by ODH in early 1985. Only labor costs for the period January through September 1985 have been added. This table shows total expenditures to be $246,841.75 or only 54% of the expenditures for categories C and D shown in Table II-6. The expenditures in Table II-7 should be increased by 85% to include these unspecified costs. (1 / 0.54 = 1.85) Table II-8 shows the estimated establishment and maintenance costs for each plantation when increased to compensate for this difference.

The total cost of establishing and maintaining the ten ODH plantations is the sum of the costs in category C plus a portion of the management and administration costs in category D. For example, during the initial grant, expenditures on the plantations ($386,738.39) were 53% of all non-management expenditures ($729,502.14). So, 53% of all management expenditures (0.53 x $235,639.08 = $124,888.71) should be allocated to establishment and maintenance of plantations. The expenditures in Table II-7 should be increased by this amount to account for these administrative costs.

From Table II-8 we see that establishment and maintenance expenditures for the Madsen plantation were $62,206.57. Table II-9 shows these expenditures grouped into annual totals and compared with the annual revenues determined in preceding section.

Table II-10 shows the net present value of these series of expenditures and revenues. The net present value of the costs of the Madsen plantation is greater than that of the revenues at all discount rates.

Analysis of Class 2 - the Roy farm.

The Roy plantation is used as an example for the analysis of class II plantations.

The benefits

There have been no detailed studies of productivity on any of the ODH plantations other than Madsen. However, in December and January, ODH did a simple inventory of the other plantations in order to have production estimates for this analysis. Several transects were laid out on each plantation. Circular plots one-hundred square meters in size were established every fifty meters along each transect. The dbh of every tree found on the plot was recorded, by species. The transects were not laid out according to any particular sampling scheme. They were merely established to show variability in growth by crossing any environmental gradients.

Dry wood weights per plot were determined using equations developed by Timyan for leucaena on the Madsen plantation and by Ehrlich for neem and prosopis. Weights per plot were expanded to weights and volumes per hectare. The average yield of the Roy plantation is 1.2 cubic meters per hectare per year. As Pelleck (1986: 4) says, "In general the performance of leucaena, neem, and cassia at Wa (Roy) are inferior to the native bayahonde, Prosopis sp., at least from the standpoint of biomass production."

The difference in yields between the Madsen plantation and the Roy plantation is not due entirely to differences in growth rates. Part of the difference is due to differing survival rates. Timyan (1983) reports that the survival rate on the Madsen farm was 90% (verify this). According to the ODH inventory sheets, the survival rate on the Roy plantation is 48%.

189x

Table II-6, Page 1. Total Double Harvest expenditures for the Agroforestry Outreach Project, by line item and by quarter. (In dollars)

Line Item	QUARTER I - 81	II - 81	III - 81	IV - 81	I 82	II - 82	III - 82	IV - 82	Cumulative Expenditures
A. Nursery experimentation and demonstration	3446.82	2369	13930.86	603.47	41253.9	38516.47	8390.5	7024.98	115536.00
B. Select seedraising, grading and storage	13573.58	3679.97	13920.95	13570.01	1003.05	4600.69	259.19	1243.49	51850.93
C. Hardwood forest experimentation and demonstration	6386.32	9349.40	30632.60	119576.39	9135.67	17029.12	3430.40	-29553.29	225193.19
E. Contingency fund, 5%.								1085.17	1085.17
SUBTOTAL	23405.72	15398.37	58484.41	133749.87	51392.62	60146.28	12080.09	39006.93	393665.29
D. Management, administration, technical supervision and research	1500.00	2499.99	22175.00	9000.00	10427.87	8257.41	9993.44	16104.76	79958.47
TOTAL	24906.72	17898.36	80659.41	142749.87	61820.49	68403.69	22073.53	55111.69	473623.76
Admin expense allocated to plantations	409.26	1517.91	11614.68	8046.27	1853.68	2337.91	2837.85	12242.93	40860.50
Total expenses for plantations	6795.58	10867.31	42247.28	127622.66	10989.35	19367.03	6268.25	41896.22	266053.69

Source: ODH financial reports to AID plus estimates as indicated in text.

Table II-6, Page 2. Total Double Harvest expenditures for the Agroforestry Outreach Project, by line item and by quarter. (In dollars)

Line Item	QUARTER I - 83	II - 83	III - 83	IV - 83	I - 84	II - 84	III - 84	IV - 84	I - 85	Cumulative Expenditures
A. Nursery experimentation and demonstration	13392.37	52600.41	25444.66	12138.70	9958.40	12792.60	6839.60	10432.32	10432.33	269567.39
B. Select seedraising, grading and storage	0.00	0.00	937.00	0.00	0.00	0.00	0.00	0.00	0.00	52787.93
C. Hardwood forest experimentation and demonstration	6604.60	10880.00	35373.00	21539.61	14543.40	25528.40	10846.99	18114.60	18114.60	386738.39
E. Contingency fund, 5%.	14850.00						2982.18	745.54	745.54	20408.43
SUBTOTAL	34846.97	63480.41	61754.66	33678.31	24501.80	38321.00	20668.77	29292.46	29292.47	729502.14
D. Management, administration, technical supervision and research	18115.12	14596.89	23690.70	14855.47	20223.81	13851.81	20223.81	14151.00	15672.00	235639.08
TOTAL	52962.09	78077.30	85445.36	48533.78	44725.61	52172.81	40892.58	43743.46	44964.47	965141.22
Admin expense allocated to plantations	3433.39	2501.78	13570.01	9501.10	12004.14	9227.70	10613.47	8936.57	9691.64	120340.29
Total expenses for plantations	10037.99	13381.78	48943.01	31040.71	26547.54	34756.10	21460.46	27051.17	27806.24	507078.68

Source: ODH financial reports to AID plus estimates as indicated in text.

194/61

Table II-6, Page 3. Total Double Harvest expenditures for the Agroforestry Outreach Project, by line item and by quarter. (In dollars)

Line Item	QUARTER II - 85	III - 85	IV - 85	Cumulative Expenditures
Hardwood Forest Experimentation	10763.37	44629.83	13965.35	69358.55
Machine shop and woodworking equipment	0.00	1128.50	835.22	1963.72
Research	4610.49	2303.40	245.00	7158.89
Nursery	5674.29	5758.47	2892.74	14325.50
SUBTOTAL	21048.15	53820.20	17938.31	92806.66
Administrative costs	4071.49	3890.50	1982.03	9944.02
TOTAL	25119.64	57710.7	19920.34	102750.68
Plantation share of admin costs	2082.03	3226.16	1543.05	6851.24
Total plantation costs	12845.40	47855.99	15508.40	76209.79

Source: ODH financial reports to AID plus estimates as indicated in text.

Table II-7. Double Harvest costs of establishing and maintaining plantations. In dollars.

Period	Plantation and size in hectares										TOTAL
	Madsen	Heraux	Fonds Parisiens	Ashton	Gardere	Roy	Linutaud	Roude	Durocher	Nadal	
	51	40	47	20	32	90	24	63	43	76	
May - Jun, 1981	521.50										521.50
Jul - Sep, 1981	2617.00	18.20									2635.20
Oct - Dec, 1981	2111.90	1655.70									3767.60
Jan - Mar, 1982	1669.20	163.40									1832.60
Apr - Jun, 1982	1970.20	120.80	1119.60								3210.60
Jul - Sep, 1982	1549.80	202.40	954.40	103.20	33.80						2843.60
Oct - Dec, 1982	1498.05	181.40	832.80	1201.40	933.60						4647.25
Jan - Mar, 1983	918.20	239.60	581.00	167.20	993.20						2899.20
Apr - Jun, 1983	757.00	100.00	1248.40	453.80	658.20						3217.40
Jul - Sep, 1983	642.60	175.80	1336.00	357.40	1099.60	446.80	283.40				4341.60
Oct - Dec, 1983	598.40	96.00	902.40	660.00	2702.20	3223.40	961.20				9233.60
Jan - Mar, 1984	540.80	75.60	1909.40	1356.20	628.30	2861.30	756.40	235.40			8343.40
Apr - Jun, 1984	1169.60	12.60	799.80	992.60	559.80	2573.80	525.20	2307.20			8940.60
Jul - Sep, 1984	1001.80	0.00	889.00	791.00	399.40	2132.20	588.20	1580.[illegible]0	13.80		7395.60
Oct - Dec, 1984	547.20	0.00	787.00	892.00	705.80	1534.80	548.80	1668.00	1145.60		7829.20
Jan - Mar, 1985	336.00	0.00	830.00	493.00	252.60	1080.20	491.40	690.00	1865.60	0.00	6038.80
Apr - Jun, 1985	297.80	0.00	718.20	295.00	256.40	1142.00	251.00	1097.20	685.60	0.00	4743.20
Jul - Sep, 1985	558.60	0.00	???	1095.00	738.80	171.40	1060.40	3435.80	892.00	3039.20	10991.20
Total maintenance wages	19305.65	3041.50	12908.00	8837.80	10051.70	15165.90	5466.00	11013.80	4602.60	3039.20	93432.15
Wages for trees planted	1070.90	580.50	2702.60	1618.60	1397.20	2642.40	1078.00	3097.20	422.40	0.00	14809.80
Purchase of seedlings	9675.00	8325.00	15350.00	3967.50	6532.50	13635.00	4440.00	10237.50	-----	0.00	72162.50
Vehicle depreciation and fuel	840.00	1680.00	1680.00	448.00	1250.00	1050.00	266.00	500.00	-----	0.00	7714.00
Fencing materials	-----	1150.00	-----	-----	1170.60	3165.10	2517.60	2533.00	-----	0.00	10536.30
Land preparation	6480.00	8453.00	4736.00	2048.00	3264.00	8960.00	2432.00	8064.00	3750.00	0.00	48187.00
Total expenditures	37371.55	23230.00	37376.60	17119.90	23666.00	44618.40	16199.60	35445.50	8775.00	3039.20	246841.75
Expenditures per hectare	732.78	580.75	795.25	856.00	739.56	495.76	674.98	562.63	204.07	39.99	

Source: ODH report plus payroll records

Note: The costs per hectare shown in the last line of the table are not strictly comparable. The costs for Madsen, for instance, are for a period of four-and one-half years whereas tose for the Roude plantation cover a period of only one-and three-quarters years.

193x

Table II-8. Adjusted ODH plantation establishment costs.

Plantation	total unadjusted expenditures	unadjusted expenditures per hectare	total adjusted expenditures	adjusted expenditures per hectare
Madsen	37371.55	732.78	69206.57	1357.00
Heraux	23230.00	580.75	43018.52	1075.46
Fonds Parisiens	37376.60	795.25	69215.93	1472.69
Ashton	17119.90	856.00	31703.52	1585.19
Gardere	23666.00	739.56	43825.93	1369.56
Roy	44618.40	495.76	82626.67	918.07
Liautaud	16199.60	674.98	29999.26	1249.96
Roude	35445.50	562.63	65639.81	1041.91
Durocher	8775.00	204.07	16250.00	377.91
Nadal	3039.20	39.99	5628.15	74.06
	246841.75		457114.35	

Source: Table I-7.

Table II-9. Comparison of annual costs and revenues of the Madsen farm.

Year	Annual expenditures	Annual Revenues
1982	45128.07	0.00
1983	11408.17	0.00
1984	5116.43	2868.69
1985	5967.93	0.00
1986	1585.97	0.00
1987	***	3042.86
1988	***	0.00
1989	***	39018.58
1990	***	3321.35
1991	***	0.00
1992	***	0.00
1993	***	3633.36
1994	***	0.00
1995	***	0.00
1996	***	45528.15
Total	69206.57	97412.99

Source: Tables II-5 and II-7.
Note: Maintenance costs are assumed to be zero starting in 1987.

Table II-10. Comparison of the net present value of expenditures and revenues for the Madsen farm at varying discount rates. In dollars.

Discount rate (%)	NPV of expenditures	NPV of revenues
5	63898.90	57222.00
10	59358.75	35540.71
15	55432.84	23175.36
20	52005.38	15759.88
25	48987.45	11110.01
30	46309.81	8078.03

Source: Table II-9.

195x

The analysis of the Roy plantation stops here. $44618.40 have been spent to establish and maintain this plantation during its first two years. The annual production of this plantation is approximately 1.2 m3/ha x 90 ha = 108 m3. The Madsen plantation yields of approximately 4.4 m3/ha x 51 ha = 224.4 m3 annually after initial establishment costs of only $37.371.55. It clearly cost more to produce wood on the Roy plantation than on the Madsen plantation.

Conclusion

The net present value of costs exceed the net present value of revenues for the ODH Madsen plantation at all discount rates. The cost of producing wood on other ODH plantations is even greater. It is not financially feasible for private landowners to produce wood on forest plantations using the methods tested by Operation Double Harvest.

This is not to say that industrial forest plantations would never be financially feasible in Haiti. With the information which is currently available and with the experience gained by ODH, it is possible to make industrial forestry more feasible than this analysis shows. In the process of testing suitable practices, some costly mistakes were made. Correcting these and making other policy changes will surely have a positive effect on the financial feasibility of this type of plantation.

This type of corrective analysis will not be performed as part of the project evaluation but could be incorporated into the project redesign. However, a brief discussion of the types of possible corrective actions is given below.

Marketing

Double Harvest has successfully marketed limited quantities of charcoal and poles. These wood products have relatively large markets. These products are used frequently by the general public so large quantities are sold at relatively uniform prices. However, it has been difficult for ODH to break into the fuelwood market. Fuelwood is generally used by businesses and therefore the number of individuals involved in the market is much smaller. Many businesses have regular suppliers. Prices are less standardized. Quantity measures are less precise. All of these factors have hindered ODH from selling as much fuelwood as they would have liked. According to preliminary estimates made by ODH, selling fuelwood from the Madsen farm would be much more profitable than converting that same wood to charcoal.

Double Harvest is also considering creating new markets. Ron Smith, a former ODH employee is currently experimenting with the use of exotic wood for tool and implement handles. He is also working on developing efficient production systems. One other possibility being considered by ODH is that of turning poles (on a lathe) for furniture production.

Increasing productivity

There are many ways of increasing the productivity of ODH farms. Some of them have been discussed at length in other sections of this evaluation. These include using innocula in nursery production and using properly selected seed. In addition to these we might add better systems of animal control and of water harvest (individual water catchments, for example).

However, the most one of the most effective ways of guaranteeing higher productivity on industrial forest plantations is also one of the easiest: evaluate the site. Double Harvest signed leases for land which is definitely not suited for industrial forest plantations. Proper soil tests would have indicated that a large percentage of ODH's land should never have been planted. The objective of this component of the project was to see if trees could be grown under the difficult conditions found in Haiti, but not under the <u>most difficult</u> conditions found in Haiti.

Discussions with local residents would have brought to light disputes over land use. ODH should not sign a lease for any piece of land over which the lessor does not have adequate control.

197x

CHAPTER 3

ANALYSIS OF THE AOP SMALL FARMER PROGRAM

In Chapter 1 we developed the basis for evaluating the Agroforestry Outreach Project's small farmer program. We determined the net benefits to small farmers who, as project participants, plant trees in their fields. In this section of the paper we will sum these benefits of all the farmers who have participated in the project to date and compare these benefits to the costs of the project.

Table I-12 summarizes the costs and benefits of the AOP project to those who planted AOP trees in the Spring of 1985. In each region and for each year, the total of net benefits is equal to the sum of the net benefits cost incurred by each crop association multiplied by the number of farmers having that association. For example, in the North region in year 4 (1989), 259 farmers who had maize, manioc, and beans each had net benefits of $19.63 for a total of $5084.17. Fifty-two farmers who had maize, sorghum and manioc each had net benefits of $6.53 for a total of $339.56. The total net benefits in 1989 for all 2590 farmers who planted in Spring of 1985 is $79466.

These net benefits for the Spring 1985 season are now taken as the basis for estimating the net benefits for trees planted in all other seasons. Table III-1 summarizes the benefits and costs for the eight planting seasons from Spring 1982 through Fall 1985. The benefits and costs for the Spring 1985 season are the totals shown on Table I-12. To determine the benefits and costs for another season, the Spring 1985 figure was divided by the number of seedlings planted in Spring 1985 and the result multiplied by the by the number of seedlings planted during the season in question.

Note that a line for 'Other' plantings has been added to Table III-1 to account for the 'Other' PADF plantings shown in Table I-1. The benefits accruing to these other trees was calculated by determining the per tree net benefits for the average PADF seedling in Spring 1985. This figure was then used to estimate benefits in other seasons as described above.

In addition to the 'other' trees listed in Table I-1, another group of trees has been added to the 'other' line in Table III-1: those trees planted because of PADF's institution building efforts. One often hears or reads that PADF has planted so many trees or that PADF nurseries have produced so many seedlings. PADF itself reports the number of trees Proje Pyebwa has planted and many people do not distinguish between PADF and Proje Pyebwa.

In fact, PADF plants very few trees. The great majority of trees is planted by the PVO's with whom PADF works. One of PADF's prime responsibilities is to aid these PVO's to establish tree planting programs, train nursery workers and extension agents, subsidize

Table III-1. Summary of net costs and benefits by region and by season.

Spring 1982

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-1800	0	-5084	29374	519	617	-4689	35591	898	988	-4325	42776	1248	1331	-3990	51090
Southeast	-2020	0	-7753	12627	791	940	-7151	16651	1370	1507	6596	21219	1903	2029	-6084	26417
North	-1023	0	-2043	9514	209	248	-1885	11626	361	397	-1738	14058	501	535	-1603	16869
Upper Plateau	-1004	0	-2993	8741	306	363	-2761	10949	529	582	-2547	13498	735	783	-2349	16389
Lower Plateau	-2576	0	-2347	14916	240	285	-2165	18031	415	456	-1997	21614	576	614	-1842	25773
Other PADF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Region I	-1114	0	-3192	41670	326	387	-2945	49524	3091	620	-2716	58651	783	836	-2505	69269
Region II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fall 1982

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-4914	0	-13878	80179	1417	1683	-12830	97150	2451	2697	-11807	116762	3406	3632	-10890	139454
Southeast	-5817	0	-21558	35111	2201	2615	-19884	46299	3808	4190	18340	58999	5290	5643	-16917	73453
North	-5202	0	-10389	48369	1061	1260	-9582	59106	1835	2019	-8838	71470	2519	2719	-8152	85763
Upper Plateau	-1225	0	-3651	10663	373	443	-3368	13356	645	710	-3106	16465	896	956	-2865	19991
Lower Plateau	-623	0	-567	3604	58	69	-523	4357	100	110	-483	5223	139	148	-445	6228
Other PADF	-2394	0	-5894	21871	602	715	-5436	27015	1041	1145	-5014	32930	1416	1543	-4625	39732
Region I	-1084	0	-3105	40524	317	377	-2864	48161	3006	603	-2641	57037	762	813	-2436	67363
Region II	-2073	0	-7124	35210	727	864	-6571	42917	1258	1305	-6[illegible]1	51804	1749	1865	-5590	62069

Spring 1983

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-5331	0	-15054	86978	1537	1826	-13806	105387	2659	2926	-12808	126663	3694	3940	-11813	151279
Southeast	-6102	0	-[illegible]422	38147	2391	2841	-21604	50304	4137	4552	19926	64101	5748	6131	-18380	79805
North	-4428	0	-8845	41174	903	1073	-8157	50314	1562	1719	-7524	60839	2170	2315	-6940	73006
Upper Plateau	-3960	0	-11803	34468	1205	1432	-10867	43173	2085	2294	-10042	53223	2897	3089	-9262	64624
Lower Plateau	-1139	0	-1038	6593	106	126	-957	7970	183	202	-883	9554	255	272	-814	11393
Other PADF	-31	0	-77	287	8	9	-71	354	14	15	-66	432	19	20	-61	521
Region I	-2707	0	-7754	101213	792	940	-7152	120280	7507	1507	-6597	142457	1903	2030	-6085	160247
Region II	-3850	0	-13234	65411	1351	1605	-12207	79727	2338	2572	-11259	96237	3248	3464	-10305	115306

Fall 1983

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-5959	0	-16829	97231	1718	2041	-15522	117010	2973	3271	-14317	141593	4130	4405	-13206	169111
Southeast	-8604	0	-33024	53786	3371	4005	-30460	70925	5833	6418	20095	90379	8104	8644	-25914	112521
North	-5999	0	-11979	55771	1223	1453	-11049	68153	2116	2328	-10191	82408	2940	3135	-9400	98889
Upper Plateau	-1992	0	-5936	17334	606	720	-5475	21713	1049	1154	-5050	26767	1457	1554	-4658	32500
Lower Plateau	-3037	0	-2767	17582	282	336	-2552	21254	489	538	-2354	25477	679	724	-2171	30301
Other PADF	-3646	0	-8976	33300	916	1089	-8279	41142	1585	1744	-7636	50150	2203	2349	-7043	60510
Region I	-3122	0	-8943	116740	913	1085	-8249	138741	8659	1738	-7[illegible]	164312	2195	2341	-7018	194058
Region II	-4309	0	-14811	73202	1512	1796	-13661	89223	2616	2879	-12600	107699	3635	3877	-11622	129039

1974

Table III-2. Net present value and internal rate of return for the PADF component of the ADP.

PADF PROJECT COSTS

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Season		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spring	2164053.38	335585	472294	561370	802866	802866															
Fall	2590697.43	375055	486689	569863	1088528	1088528															
	4754750.81																				

PADF PROJECT BENEFITS

Planting Season	NPV of benefits	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spring 1982	126707.72	-8424	0	-20221	75172	2064	2453	-18651	92848	3572	3930	-17203	113164	4962	5293	-15868	136538				
Fall 1982	579046.85	-35670	0	-94573	343175	9654	11471	-87231	424387	16705	18381	-80459	517727	23209	24754	-74213	625097				
Spring 1983	319584.00		-21198	0	-60744	209527	6201	7368	-56029	259876	10730	11806	-51679	317643	14907	15900	-47667	384044			
Fall 1983	753452.22		-53139	0	-138351	493371	14123	16781	-127611	610718	24438	26890	-117705	745549	33953	36214	-108567	900604			
Spring 1984	526067.34			-39874	0	-106595	378643	10981	12929	-98319	468792	18829	20717	-90687	572401	26159	27901	-83647	691500		
Fall 1984	556489.80			-43644	0	-116296	402675	11872	14106	-107267	499266	20542	22603	-98940	610210	28540	30441	-91259	737744		
Spring 1985	521747.61				-45048	0	-110894	411522	11320	13450	-102285	508319	19588	21553	-94345	619610	27215	29027	-87021	747610	
Fall 1985	1052606.73				-93338	0	-229517	833749	23429	27838	-211699	1031046	40542	44608	-195265	1257815	56326	60076	-180106	1518556	
Spring 1986	474316.01					-45048	0	-110894	411522	11320	13450	-102285	508319	19588	21553	-94345	619610	27215	29027	-87021	747610
Fall 1986	956915.21					-93338	0	-229517	833749	23429	27838	-211699	1031046	40542	44608	-195265	1257815	56326	60076	-180106	1518556
Total NPV	5866933.50																				
Adjusted NPV	6746973.52																				
IRR	0.126	-754734	-1033320	-1329545	-1810528	-1536055	475155	845880	1640650	761272	752841	1205786	2104322	1028027	1038069	1604547	2624709	1282386	1251220	1999039	2266166
Adjusted IRR	0.144	-761348	-1044471	-1359292	-1798398	-1485054	546428	972762	1886748	875463	865767	1386654	2419970	1182231	1193779	1845229	3018415	1474744	1438903	2298895	2606091

200

production of seedlings, and eventually aid these PVO's in finding alternate funding. There are several PVO's which are now planting seedlings and distributing them without direct financial support from PADF. Exactly as was foreseen in the Project Paper. These trees are due to PADF's efforts and are therefore a benefit of AID's AOP. The net benefits of these trees should be included in the evaluation of the AOP. We have included 375,000 in the 'other' totals for each season, beginning with the Spring, 1985 season.

The costs incurred by these now independent PVO's should also be included as a cost of the project. The Menonite Central Committee budgets $0.1015 per seedling for 1986, including costs of their extension staff. The Methodist Center at Vialet spends approximately $0.10 per seedling are spent producing and distributing the seedlings. Included in this amount is the cost of training extension agents. Based on these two cost estimates, we use a cost of ten cents per seedling produced. Thus the costs incurred by PADF as shown in TAble III-2 include an additional $37,500 for each season in 1985 and 1986.

Table III-2 shows the calculations for the analysis of the PADF component of the AOP. The top portion of the table shows the project expenditures for each of the eight planting seasons through Fall 1985 plus estimates for the two 1986 seasons. Expenditures in 1986 are assumed to be equal to those in 1985. The net present value of these expenditures is $4,754,750.81 when discounted at 10%.

The middle portion of the table shows the benefits of the PADF component of the AOP. Each line in this portion of the table lists the benefits and costs of the seedlings planted in one season. These numbers are the sums of the appropriate lines in Table III-1. Again, the benefits for the two 1986 planting seasons are assumed to be identical to those of the two 1985 seasons. The net present value of the benefits is $6,746,975.43, also discounted at 10%. The ratio of benefits to costs is then 1.42 to 1. That is, when we use a discount rate of 10%, society realizes $1.42 worth of benefits for every $1.00 spent by PADF

Note that there are two totals for the NPV. The first is the actual sum of the seasonal NPV's. The second, which is 15% greater, is the total we have used. We have increased the total by 15% to account for the approximately 15% of all project trees which are given by project participants to friends, neighbors, and relatives. This can be done because the PADF and CARE benefits calculated above use base counts which do not include trees given away. Although these trees are not official trees, they are beneficial to the farmers and have added to the total cost of the project.

The next portion of the table shows the internal rate of return of the PADF component. The adjusted IRR, which includes the additional 15%, is 14.4%.

The CARE portion of the AOP is shown on Table III-3. The ratio of costs to benefits is 1.57 to 1 when a 10% discount rate is used. The internal rate of return is 19.1%.

201x

Finally, Table III-4 shows the benefits and costs of the CARE and PADF components combined. The B/C ratio is 1.54 when discounted at 10% and the IRR is 15.6%.

Table III-1, page 2. Summary of net costs and benefits by region and by season.

Spring 1984

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-7727	0	-21821	126071	2228	2647	-20127	152754	3854	4241	-18564	183592	5355	5712	-17123	219272
Southeast	-9302	0	-35701	58146	3644	4330	-32929	76675	6306	6939	30373	97706	8761	9345	-28015	121643
North	-7357	0	-14691	68400	1500	1782	-13551	83585	2595	2855	-12499	101068	3405	3845	-11528	121281
Upper Plateau	-4761	0	-14108	41432	1448	1721	-13087	51896	2506	2758	-12071	63977	3482	3714	-11134	77681
Lower Plateau	-4009	0	-3652	23209	373	443	-3369	28057	645	710	-3107	33632	896	956	-2866	40104
Other PADF	-889	0	-2189	8124	223	266	-2019	10035	387	426	-1863	12233	537	573	-1718	14760
Region I	-4582	0	-13127	171346	1340	1592	-12108	203639	12709	2551	-11168	241170	3221	3436	-10301	204831
Region II	-3525	0	-12117	59886	1237	1470	-11176	72993	2140	2355	-10308	88108	2974	3172	-9508	105566

Fall 1984

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-7469	0	-21093	121870	2153	2558	-19456	147664	3726	4100	-17946	177474	5177	5521	-16552	211965
Southeast	-11259	0	-43212	70300	4411	5241	-39358	92807	7633	8399	36763	118263	10605	11311	-33909	147237
North	-7550	0	-15077	70195	1539	1829	-13906	85778	2663	2930	-12827	103721	3700	3946	-11631	124463
Upper Plateau	-3753	0	-11184	32661	1142	1357	-10316	40910	1976	2174	-9515	50434	2745	2928	-8777	61236
Lower Plateau	-5020	0	-4574	29063	467	555	-4219	35133	808	889	-3891	42114	1122	1197	-3589	50219
Other PADF	-1137	0	-2800	10390	286	340	-2583	12334	495	544	-2382	15444	687	733	-2197	18876
Region I	-3330	0	-9540	124524	974	1157	-8799	147993	9236	1854	-8116	175268	2341	2497	-7486	206992
Region II	-2560	0	-8798	43485	898	1067	-8115	53003	1554	1710	-7485	63978	2159	2303	-6904	76655

Spring 1985

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-7572	0	-21385	123557	2183	2594	-19725	149708	3770	4156	-18194	179930	5248	5598	-16781	214899
Southeast	-8448	0	-32424	52810	3310	3933	-29907	69638	5727	6302	27585	88739	7957	8487	-25444	110479
North	-8547	0	-17068	79466	1742	2070	-15743	97108	3015	3317	-14521	117419	4189	4468	-13593	140902
Upper Plateau	-5779	0	-17224	50297	1758	2089	-15887	63001	3042	3348	-14653	77667	4727	4508	-13516	94363
Lower Plateau	-8640	0	-7872	50020	804	955	-7261	60469	1390	1530	-6697	72403	1931	2060	-6177	86433
Other PADF	-802	0	-1975	7328	202	240	-1822	9052	349	384	-1680	11034	485	517	-1550	13314
Region I	-4410	0	-12634	164915	1290	1532	-11653	195997	12232	2456	-10749	232119	3101	3307	-9914	274141
Region II	-3390	0	-11652	57590	1189	1413	-10743	70195	2058	2265	-9913	84730	2060	3050	-9144	101519

Fall 1985

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South	-6790	0	-19175	110704	1957	2326	-17686	134231	3307	3727	-16313	161330	4706	5019	-15047	192684
Southeast	-10750	0	-41258	67198	4212	5004	-38055	88611	7288	8019	35101	112916	10125	10799	-32376	140580
North	-9885	0	-19741	91910	2015	2394	-18208	112314	3487	3837	-16795	135806	4815	5167	-15491	162966
Upper Plateau	-6708	0	-19991	58379	2041	2425	-18439	73124	3531	3885	-17008	90146	4906	5233	-15608	109456
Lower Plateau	-10571	0	-9631	61202	983	1168	-8884	73986	1701	1872	-8194	88687	2363	2521	-7558	105755
Other PADF	-1177	0	-2898	10756	296	352	-2673	13286	512	563	-2466	16195	711	759	-2274	19540
Region I	-4635	0	-13278	173322	1355	1611	-12247	205908	12855	2581	-11297	243952	3259	3476	-10420	288116
Region II	-3563	0	-12246	60526	1250	1485	-11295	73773	2163	2380	-10419	89050	3005	3205	-9610	106695

203x

Table III-3. Net present value and internal rate of return for the CARE component of the AOP.

CARE PROJECT COSTS

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Season		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spring	794751.69	164351	164657	259908	240801	240801															
Fall	823239.60	251663	259908	185538	184256	184256															
	1617991.49																				

CARE PROJECT BENEFITS

Planting Season	NPV of benefits	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spring 1982	80199.71	-1114	0	-3192	41670	326	387	-2945	49524	564	620	-2716	58651	783	836	-2505	69269				
Fall 1982	141010.19	-3156	0	-10229	75734	1044	1241	-9435	91078	1807	1988	-8702	108041	2510	2677	-8027	129432				
Spring 1983	283513.90		-6557	0	-20988	166623	2143	2546	-19359	200015	3707	4079	-17056	230694	5151	5494	-16470	283553			
Fall 1983	323356.69		-7431	0	-23754	189941	2425	2881	-21910	227964	4196	4617	-20209	272011	5830	6218	-18640	323097			
Spring 1984	361122.42			-8107	0	-25243	231232	2577	3062	-23284	276632	4459	4906	-21476	329279	6195	6608	-19809	390397		
Fall 1984	262387.36			-5890	0	-18338	168009	1872	2224	-16914	200995	3239	3564	-15601	239246	4500	4800	-14390	283653		
Spring 1985	315906.55				-7800	0	-24286	222505	2479	2946	-22401	266191	4290	4720	-20662	316850	5960	6357	-19058	375660	
Fall 1985	332011.18				-8198	0	-25524	233848	2606	3096	-23543	279761	4509	4961	-21715	333002	6264	6681	-20029	394810	
Spring 1986	287187.77					-7800	0	-24286	222505	2479	2946	-22401	266191	4290	4720	-20662	316850	5960	6357	-19058	375660
Fall 1986	301828.34					-8198	0	-25524	233848	2606	3096	-23543	279761	4509	4961	-21715	333002	6264	6681	-20029	394810
Total NPV	2688524.12																				
Adjusted NPV	3091802.74																				
IRR	0.169	-420284	-438553	-472864	-368393	-126702	355627	404039	566057	401279	448236	504984	692648	495401	550323	619350	837075	597713	648001	731383	770470
Adjusted IRR	0.191	-420925	-440651	-476977	-359893	-81949	408971	464645	650966	461471	515471	580732	796545	569711	632871	712253	962636	687370	745201	841090	886041

Table III-4. Net present value and internal rate of return for the combined PADF and CARE components of the ADP.

COMBINED PADF AND CARE PROJECT COSTS

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Season		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spring	2958805.07	499936	636951	821278	1043667	1043667															
Fall	3413937.23	626718	746597	755401	1272784	1272784															
	6372742.30																				

COMBINED PADF AND CARE PROJECT BENEFITS

Planting Season	NPV of benefits	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spring 1982	206907.43	-9538	0	-23413	116842	2390	2840	-21596	142372	4136	4550	-19919	171815	5745	6129	-18373	205807				
Fall 1982	720057.04	-38826	0	-104802	418909	10698	12712	-96666	515465	18512	20369	-89161	626568	25719	27431	-82240	754529				
Spring 1983	603097.90		-27755	0	-81732	376150	8344	9914	-75308	459841	14437	15685	-69535	556337	20058	21394	-64137	667597			
Fall 1983	1076808.92		-60570	0	-162105	683312	16548	19662	-149521	838682	28634	31507	-137914	1017560	39783	42432	-127207	1223701			
Spring 1984	887189.76			-47981	0	-131038	609875	13458	15991	-121603	745424	23208	25623	-112163	901660	32354	34509	-103456	1081897		
Fall 1984	818877.16			-49534	0	-134634	570684	13744	16330	-124181	700261	23781	26167	-114541	849456	33040	35241	-105649	1021397		
Spring 1985	837654.16				-52848	0	-135180	634027	13799	16396	-124686	774510	23878	26273	-115007	936460	33175	35384	-106079	1123270	
Fall 1985	1384617.91				-101536	0	-255041	1067597	26035	30934	-235242	1310807	45051	49569	-216900	1590817	62590	66757	-200135	1913366	
Spring 1986	761503.78					-52848	0	-135180	634027	13799	16396	-124686	774510	23878	26273	-115007	936460	33175	35384	-106079	1123270
Fall 1986	1258743.55					-101536	0	-255041	1067597	26035	30934	-235242	1310807	45051	49569	-216980	1590817	62590	66757	-200135	1913366
Total NPV	8555457.62																				
Adjusted NPV	9838776.26																				

IRR	0.137	-1175018	-1471873	-1802409	-2178921	-1664757	830782	1249919	2206707	1162551	1201077	1710770	2796970	1523428	1588392	2223897	3461704	1880039	1899221	2730422	3036636
Adjusted IRR	0.156	-1182273	-1485122	-1834269	-2158292	-1567003	955399	1437407	2537713	1336934	1381239	1967386	3216516	1751942	1826651	2557482	3981[illegible]	2162114	2184104	3139985	3492131

CHAPTER 4

ADDITIONAL CONSIDERATIONS

Wood Production

In Chapter 1 we determined the amount of wood which will be produced on a typical farm in each region. By summing over all farms, we can determine the amount of wood which will be produced each year. These amounts are compared to projected consumption needs in Table IV-1. Trees distributed by the AOP will supply as much as 3.9 percent of the total wood needs of the country.

When one considers the efforts of other donors as well as those of AID, it becomes clear that reforestation can have a significant impact on the overall supply of wood products.

Table IV-1. Comparison of the estimated AOP wood production and the projected consumption needs of Haiti. 1982 to 2001.

Year	Production 1000 m3	Consumption 1000 m3	Percent Consumption Satisfied by Production
1982	0	4203	0.0
1983	0	4308	0.0
1984	0	4415	0.0
1985	47	4526	1.0
1986	86	4639	1.9
1987	97	4755	2.0
1988	148	4874	3.0
1989	195	4995	3.9
1990	86	5120	1.7
1991	97	5248	1.8
1992	148	5380	2.8
1993	195	5514	3.5
1994	86	5652	1.5
1995	97	5793	1.7
1996	148	5938	2.5
1997	195	6086	3.2
1998	86	6239	1.4
1999	97	6395	1.5
2000	148	6554	2.3
2001	148	6718	2.2

Monetary benefits

Table III-4 shows the net benefits of the AOP plantations to the farmers of Haiti and the costs of the AOP to USAID and other donors. The $8,719,780 invested by the United States, Canada, Switzerland, Texaco, and others will generate a total of $34,418,885 in net beneftis over the twenty-year period considered. That is, each dollar invested will produce $3.95 of net benefits to Haitian peasant farmers.

In addition to these net benefits, we can mention that there will be significant benefits in the form of labor income. A great deal of labor is necessary to harvest trees and transform the raw material into a usable product. The value of this labor is a cost to the AOP participant. However, the approximately $12,000,000 in labor costs incurred by the producer are $12,000,000 in labor income. This income is earned either by the same producer of by other, most likely poorer peasants.

Ecological benefits

There are certain ecological benefits of the project. During the five year life of the project, aapproximately 26,700,000 trees will have been planted. See Table I-1. Given an average initial spacing equivalent to 4.8 square meters per tree, These 26,700,000 trees will cover the equivalent of 12,800 hectares. This planting is being done at the rate of 3,300 hectares per year in 1985 and 1986. The benefits accruable to these trees are many but for the most part immeasurable.

The value of protecting and conserving 12,800 hectares of soil is very important in a country where livelihoods depend on agriculture. The value of the increased fertility of even the maintenance of fertility of land enhanced by trees is evident in a country in which agricultural yields are estimated to be fallng at the rate of 2% per year or more.

Crop diversification

In some cases, tree planters may rely on trees as an element of their risk management strategy. Farmers may wish to accept lower incomes in exchange for lower risk. They may feel they are better off planting trees to create a reserve for a bad year, thereby reducing the chance of having an year in which there is no income. In this cases AID might want to consider the reduced likelihood of needing to bring emergency food aid into a region as a benefit at the project level.

A second reason for diversifying crop production is to reduce labor demands during what are currently peak seasons and to provide opportunities for labor in what are currently slack seasons. Thus, even though the amount of labor necessary for the farm operations may not change, the timing changes so that labor is more reasily available.

207x

Savings

The average Haitian farmer has limited access to captial markets. He must rely on traditional methods of saving for emergency needs. The most well known example of traditional savings methods is the keeping of livestock. Trees have many of the same advantages as livestock and it seems that many farmers consider their trees as a type of reserve, to be harvested when a need for cash arises.

It may be that a young farmer is cash poor. His social and economic position may be such that he finds it very difficult to save money. If he cannot save money he will never be able to build himself a house, a requisite for marriage. He may opt to plant trees so that, in several years, he will have the materials he needs to build the house. He may do this even if it would have been more profitable for him to continue raising food crops. In a case like this, we can say that he is willing to pay a certain amount for the opportunity to save. That is, saving is so desirable to him, he is willing to pay for the right to be able to do it.

There is only a subtle difference between this idea of saving and the idea of risk management expressed in the preceding section. In both cases the trees are used as a form of capital accumulation. However, we distinguish between the idea of establishing a reserve for emergencies (usually done by older, more responsible people) and building a nestegg for future investment (usually done by younger people).

Fruit trees

Both CARE and PADF produce small quantities of fruit trees. CARE distributed approximately 5,200 fruit trees in the Fall of 1985. Farmers pay for some of these trees. (CARE, 1986) In 1986, more trees will be produced and the number of grafted trees will increase. These trees are not included in CARE's producrtion totals in Table I-1. PADF produced 35,166 fruit trees in 1985 and plans to produce more and better quality trees in 1986. These trees currently represent less than 1% of PADF's total production.

Rural labor

The design of the AOP did not specifically foresee the project as a way of providing rural employment. Nonetheless, CARE, PADF, and the PVO's financed by PADF employ many people. The PADF component alone employs over six hundred extension agents. The vast majority of all these people live and work in small rural communities. The incomes of these employees is naturally a stimulant to the local rural economies.

Hedgerows

One agroforestry systems which holds great promise for Haiti is the leucaena hedgerow. CARE and PADF have been experimenting with this technique for some time now. Since the hedgerows are established by direct seeding, there is no production of seedlings. Thus these

hedgerows have not been considered in the above analysis because they are not part of the production totals in Table I-1.

To date, CARE has extablished more than fifty-two kilometers of leucaena hedgerows in the Northwest. Half of this in the Fall of 1985 season. (CARE, 1986) PADF has established more that eight kilometers.

CARE began a "community bases nursery" project in late 1985. Each of twenty nurseies will produce about 5,000 seedlings which will be bought by CARE for $0.08 each. CARE hopes to trasfer payment to planters by the third season.

209X

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The Agroforestry Outreach Project has attempted to encourage tree planting in Haiti at two different levels. Responsibility for testing the feasibility of industrial forestry plantations was given to Operation Double Harvest. Responsibility for plantings on small farms was given to CARE and PADF.

Operation Double Harvest

The AID grant to Double Harvests includes nusery experimentation and demonstration; select seedraising, grading, and storage; hardwood forest experimentation and demonstration; and agroforestry research. Of these four areas of responsibility, only tree farming was evaluated, and then only a partial analysis was done. It was found that the internal rate of return for the Madsen farm was 3.7% After a brief discussion of the potential production of the other nine ODH plantations, it was considered that none would have and internal rate of return as high as the Madsen farm. Such low returns are due primarily to indiscriminate selection of land for plantation establishment. Even a minimum of site evaluation would have indicated that portions of each farm should not be converted to plantation and would have eliminated some farms from consideration altogether. It seems that selection of plantation sites was done at the administrative level rather than at the technical level. This could be said of a number of other decisions as well. Selection of technical personnel, assignment of responsibilities, etc.

Industrial scale forestry in Haiti should not be condemned, however. Although specific analyses were not performed, I believe that it is financially feasible to establish industrial forest plantations. These analyses could be performed as part of the upcoming project design.

It is necessary to discuss only briefly the reasons for not analyzing the other responsibilities given ODH under the grant agreement.

1) Nursery experimentation and demonstration. ODH has developed an efficient system of mass production of seedlings that only ODH itself uses. The seedling container system developed as part of the grant is used only by ODH.

2) Select seedraising, grading, storage, and distribution. It is admitted by most that the seed currently used in Haiti is 'genetic garbage'. This in itself says a lot about ODH's effort to improve access to high qualtiy seed. Only recently has ODH completed installation of a seed storage facility.

3) Research. A good number of experiments have been established by ODH personnel. However, very few results are available on which to base and evaluation.

Recommendation Based on the above discussion and on an apparent conflict of interest which seems to cloud ODH's decisions, I recommend that the ODH grant not be extended or renewed.

PADF and CARE

The present analysis has shown that both PADF and CARE have acceptable internal rates of return even when many nonmonetary benefits are not included. The economic analysis in the Project Paper predicted an IRR of 8.6% and 9.1% for CARE and PADF, respectively. This analysis shows CARE's component to have an IRR of 19.1% and PADF's component to have an IRR of 14.4%. Both components have done much better than had been expected.

One could also evaluate the performance of these two organizations on the basis of the cost per established seedling. The Project Paper states that CARE was to produce 1,940,000 seedlings. Considering the 62.5% survival rate predicted in their grant proposal, CARE would have extablished 1,212,500 trees for a total of $3,493,000. Thus, the unit cost of establishing and maintaining a seedling for one year was predicted to be $2.88. Similarly, PADF was to have produced 3,080,000 seedlings with a survival rate of 50% and at a cost of $5,370,000. PADF's unit cost was therefore predicted to be $3.49 per established tree.

Table V-1 below shows that both CARE and PADF have establishment costs significantly below those implied in the Project Paper.

Recommendation Both PADF and CARE have managed their individual components is a manner as to have higher than expected internal rates of return and lower than expected costs per seedling produced and cost per tree established. Considering the value of this project to Haiti, I recommend that this project to extended with significant additional funds. I further recommend that because this project has proven itself to be efficient and well managed, it be given priority consideration over new, as yet untested projects whose goals are the same.

Other Recommendations

Recommendation Planning for Phase II of the AOP should take advantage of the economic model prepared for this analysis. Many people involved in this project are discussing certain technical question such as improving survival rates or introducing better genetic material. Some have already proposed new nursery techniques which should be considered mandatory in Phase II of the AOP. One should not make such technical decisions without considering their costs or the relative impact they will have on the benefits of the project. To discuss whether current survival rates are 'good' is meaningless if one does not simultaneously consider the cost of increasing those rates and the increased benefits derived from increased survival.

211X

Recommendation Increased emphasis should be placed on non cash benefits of tree farming. Both CARE and PADF have begun working with erosion control techniques and fruit trees. Additional effort can be devoted to these aspects of the AOP without reducing the overall IRR of the project. Simultaneously, additional attention should be given to quantifying these non cash benefits so as to have a better idea of the impact a program can have.

Table V-1. Predicted and actual unit costs of seedlings produced and of surviving trees, for CARE and PADF.

	Predicted in Project Paper	
	CARE	PADF
Seedlings to be produced	1940000	3080000
Total cost, in dollars	$3493000	$5370000
Cost per seedling produced	$1.80	$1.74
Survival rate, in percent	62.5	50
Surviving trees	1212500	1540000
Cost per surviving tree	$2.88	$3.49

	Actual production	
	CARE	PADF
Seedlings produced	4554472	15343017
Total cost, in dollars	$1711082	$4625250
Cost per seedling produced	$0.38	$0.30
Survival rate, in percent	60	40
Surviving trees	2732683	6137207
Cost per surviving tree	$0.63	$0.75

Source: Project Paper
Tables I-1 and III-3 and III-4

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213X

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