HAITI PRODUCTIVE LAND USE SYSTEMS PROJECT

SOUTH-EAST CONSORTIUM FOR INTERNATIONAL DEVELOPMENT

AND

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IMPACT OF TREE PLANTING IN HAITI:
1982-1995

by

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ABBREVIATIONS USED IN THIS REPORT

AFII	Agroforestry II (a USAID project 1990-1992)
AOP	Agroforestry Outreach Project (a USAID project 1981-1989)
AU	Auburn University
CECI	Centre Canadien d'Etudes et de Coopération Internationale
CODEPLA	Comité pour le Développement et la Planification
CRWRC	Christian Reformed World Relief Committee
DCCH	Développement Communautaire Chrétien d'Haiti
IRG	International Resources Group
OAS	Organization of American States
ODH	Operation Double Harvest
ORE	Organization for the Rehabilitation of the Environment
PADF	Pan American Development Foundation
PLUS	Productive Land Use Systems (a USAID project 1992-present)
PVO	Private voluntary organization
SECID	South-East Consortium for International Development
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

This document reports the impact of tree planting activities implemented under the Agroforestry Outreach Project (AOP) and Agroforestry II (AFII). These projects were funded by the U.S. Agency for International Development (USAID) between 1981 and 1991. During this period, over 63 million trees were distributed to 253,000 small peasant farmers. This study is the first post project assessment of the effects of project tree planting on farmers and their environment. The consultancy team was comprised of a cultural anthropologist and a forester-ecologist with longstanding experience in Haiti. The study was conducted between January and March, 1995.

Methodology. The team visited nine regions representative of the CARE and PADF target areas under the AOP and AFII projects. The team interviewed 77 tree planters, and inventoried 43 tree planting sites. Trees inventoried were planted between 1982 and 1986. Tree planter interviews elicited cropping and tree planting history, plot selection, motivations, changing in land use patterns, harvest and tree utilization, tree regeneration management, farm strategies, agricultural calendars and fallow patterns.

Tree plot inventories included measurement of site environmental parameters; a tally of the harvested and standing trees planted between 1982-1986, harvested and standing coppice of the original trees, harvested and standing volunteers and harvested and standing coppice of the volunteers; stem diameter measurements of the standing trees and coppice, and stump diameter measurements of the harvested trees and coppice; and a determination of native species that had regenerated on site since time of planting. Data analyses were performed to estimate survival by site and species; wood volume of harvested and standing trees, reported harvest by product category, and the difference between reported harvest and inventory estimates; and gross value of reported harvests by product category and time since tree establishment.

Land Use Patterns. Farmers established trees in a range of configurations on all major garden types characteristic of peasant farm units: house gardens, adjacent gardens, field gardens, and mixed perennial gardens. Farmers favored sites with greater land security, but tree tenure was far more important than land tenure status.

Two-thirds of the farmers continued to cultivate annual food crops on sites where they planted trees. Tree planting enriched border land use on more intensively farmed sites, resulting in a diverse mix of exotic and native species without sacrificing cropland for food. About a third of the farmers shifted away from the cultivation of erosion intensive annual food crops to establishment of permanent woodlots. Significant numbers of farmers used project trees to establish enriched fallows, charcoal gardens, and mixed perennial gardens linking trees to perennial cultigens such as coffee, plantains and sugar cane.

Tree Inventories. The tree sites averaged 12.3 years old and achieved a survival of 35%. A third of the surviving project trees were still standing, dominated by *Senna siamea*, the most widely planted species, and other species such as *Casuarina equisetifolia* and *Catalpa longissima* valued for high value wood products. *Leucaena leucocephala* and *S. siamea* were the most heavily harvested trees and contributed over 80% of the wood volume. Considering all species, the original project trees have produced about 2.14 metric tons ha^{-1} yr^{-1} of wood. Coppice production, mostly from 4 species, contributed an additional 0.5 metric tons ha^{-1} yr^{-1}. A second generation of volunteer trees, mostly from 5 species, produced 0.25 metric tons ha^{-1} yr^{-1}. Farmers managed the regeneration of native species on half of the sites, dominated by species valued highly as sources of wood, including *Simarouba glauca, Calophyllum calaba, Swietenia mahagoni* and *Bumelia salicifolia*.

Harvests. Reported harvests represented a little more than half of the estimated wood yields, with significant amounts of wood subject to uncontrolled harvests, particularly theft and piecemeal use of firewood, stakes and small poles. The most important products were charcoal and construction wood for peasant houses. Charcoal, produced primarily for sale, comprised over 80% of the wood harvested and 31% of the monetary value. Construction wood, harvested primarily for use, made up 15% of the harvested wood volume and 60% of its monetary value. Overall, the monetary value of the reported harvest was split equally between sale and use categories. The most significant levels of wood harvest by value occurred between eight and eleven years after planting.

Services. The trees provided important services as well as products. Most tree planters attributed tremendous importance to project trees as a store of value, a specialized reserve in the peasant scheme for managing risk. The farmers made extensive uses of project trees to improve soil quality, increase land value, enhance aesthetics, break wind, provide shade for mixed perennial gardens and other important services.

Environmental Impacts. Project trees have positively benefited the environment by increasing habitat diversity and facilitating a shift toward soil conserving land use patterns. They are playing an important role as nurse trees that both attract seed dispersers and modify the microsite to favor regeneration. This in turn conserves natural pathways to tree regeneration which is the primary source of seedlings for the small farmer. Tree planting has increased the biomass production of degraded sites, and enriched habitats by improving the soil and site quality, increasing income potential, creating habitats with food and shelter for native fauna, and paving the way for succession by other species.

Project Objectives. Formal AOP objectives stated in the Project Paper have been attained. Peasant farmers have proved highly motivated to plant and maintain a substantial number of trees for a variety of reasons including soil conservation, fuelwood and income; however, hardwood production has not proved to be a cash crop on a par with agricultural production. It occupies special niches and plays a complementary role in risk management and storage of value. Farmers are inclined to invest land and labor in trees, but they are unlikely to invest scarce cash resources in tree cropping nor to sacrifice opportunities for more lucrative food cropping.

The basic purpose of the project was to help reverse environmental degradation. The AOP has had an important environmental impact; however, the farm forestry strategy has not restored the overall natural resource base. Green cover has been restored on thousands of widely dispersed microsites, but there are limits to this strategy due to the inherent fragmentation and dispersal of peasant farm plots with competing priorities. The project has enrolled about 25 percent of the Haitian peasantry in the tree extension program. This is an important achievement, but this alone cannot resolve the underlying problems of a peasant society in a chronic state of crisis, and a natural resource base stressed to the breaking point.

REZIME

Rapò sa-a bay rezilta yon etid sou enpak aktivite plante pyebwa ki te fèt sou Pwojè "Agroforestry Outreach Project" (AOP) ak Pwojè Agwoforestye (AFII). Pwojè sa yo te finanse pa "Agency for International Development (USAID)" pandan diz-an (1981-1991). Pandan tan sa-a, plis pase 63 milyon pye bwa te distribye bay 253.000 ti plantè. Etid sa-a se premye evalwasyon ki fèt apre pwojè sa yo fèmen, pou etidye rezilta plante pye bwa sou lavi plantè ak anviwonman yo. Nan ekip ki fè etid sa-a te genyen yon antwopològ ak yon forestye-ekolojis ki fè anpil esperyans an Ayiti. Etid sa-a te fèt nan epòk janvye-mas 1995.

Metodoloji

Ekip-la te vizite nèf (9) rejyon kote CARE ak PADF te travay pandan Pwojè AOP ak AFII. Ekip la te poze 77 moun ki plante pye bwa kesyon, e li te fè envantè 43 sit kote yo te plante pye bwa. Pyebwa sa yo te plante ant 1982 - 1986. Kesyon te poze sou istwa plantasyon pyebwa ak kilti yo, sou chwa tè yo, sou motivasyon plantè yo, sou chanjman ki fèt nan jan yo sèvi ak tè yo, sou rekòt ak itilizasyon pwodwi yo, sou fason yo jere pitit ak repous pye bwa yo, sou estrateji plantè yo chwazi, sou kalandriye agrikòl ak sou fason yo kite tè-a poze.

Pou chak tè ki te chwazi pou fè envantè-a, men sa ki te konte ak mezire: kantite pyebwa ki rekòlte ak kantite ki rete sou tè-a nan sa ki te plante ant 1982-1986, kantite tayi (repous pyebwa ki koupe) ki rekòlte ak kantite ki rete sou tè-a; kantite volontè (pyebwa ki pouse pou kont yo) ki rekòlte ak kantite ki rete sou tè-a; kantite tayi ki soti nan volontè yo ki rekòlte ak kantite ki rete sou tè-a; dyamèt tij pyebwa ak tayi ak dyamèt souch pyebwa ak tayi ki rekòlte; espès natif natal ki rejenere sou tè-a depi plantasyon yo fèt. Analiz chif ki ranmase yo pèmèt estime pousantaj pyebwa ki pran (siviv) nan chak sit ak pou chak espès; volim bwa ki rekòlte ak sa ki rete nan pyebwa sou tè-a, kantite chak kategori pwodwi plantè-a di li rekòlte sou tè-a, ak diferans ant sa plantè-a di ak estimasyon ki fèt nan envantè-a; anfen valè angwo (san retire depans) rekòt plantè-a di li fè pou chak kategori pwodwi ak tan depi plantasyon-an fèt.

Jan plantè yo sèvi ak tè yo

Plantè yo plante pyebwa sou tout kalite tè: jaden bò kay, jaden pre kay, jaden lwen kay, ak jaden miks ki genyen plant ki rete lontan nan tè-a. Plantè yo pito mete pyebwa sou tè yo santi yo genyen plis sekirite, men sekirite sou pyebwa-a pi enpòtan lontan pase sekirite sou tè-a.

De tyè (2/3) plantè yo kontinye fè lakilti sou tè yo plante pyebwa yo. Sou tè plantè yo travay anpil, yo plante pyebwa plis sou lantouray, sa ki fè gen yon melanj pyebwa etranje ak natif natal san yo pa diminye sou tè yo fè manje. Apeprè yon tyè (1/3) plantè chanje fason yo sèvi ak tè-a: yo pa travay fè manje sou tè erode yo ankò, yo fè plantasyon pye bwa pito. Yon bon kantite plantè plante pyebwa pwojè-a sou tè yo kite poze, oubyen pou fè jaden chabon, oubyen pou fè jaden ki genyen plant ki rete lontan nan tè-a tankou kafe, bannann ak kann.

Envantè pyebwa yo

Pou tout tè ki konsidere nan envantè-a, pyebwa yo genyen anmwayenn 12,3 lane, apeprè 35% pyebwa yo te pran (siviv). Yon tye (1/3) pyebwa pwojè-a ki siviv te kanpe sou tè-a toujou. Se plis *Senna siamea* ki te genyen sou tè yo, ak lòt espès tankou *Casuarina equisetifolia* ak *Catalpa longissima* ki bay bwa ki gen valè. Se *Leucaena leucocephala* ak *S.siamea* ki te plis rekòlte, yo bay 80% volim bwa ki kalkile. Lè yo konsidere tout espès yo, bwa pwojè-a bay 2,14 tòn metrik bwa/ekta/ane. Tayi yo, pou kat espès sitou, bay 0,5 tòn anplis bwa/ekta/an. Yon dezièm jenerasyon pyebwa volontè (pitit), pou senk espès sitou, bay 0,25 tòn bwa/ekta/an.. Plantè yo jere rejenerasyon espès natif natal yo sou mwatye tè yo, ki plis genyen espès ki gen valè tankou *Simaruba glauca, Calophyllum calaba, Swietenia mahogani* ak *Bumelia salicifolia.*

Rekòt

Rekòt plantè yo deklare reprezante yon ti kras plis pase mwatye volim bwa ki kalkile. Kidonk, gen yon bon kantite bwa rekòlte ki pa kontwole, tankou bwa yo vòlè, bwa pou fè dife, pikèt ak ti poto. Pwodwi ki pi enpòtan se chabon ak bwa pou fè kay peyizan. Bwa pou fè chabon, sitou pou vann, te bay plis pase 80% volim bwa ki rekòlte ak 31% nan lajan ki rantre. Bwa pou konstwi te fè 15% volim bwa ki rekòlte e te vo 60% lajan ki rantre. Angwo, kantite lajan bwa yo bay te separe ren pou ren ant sa ki vann ak sa ki sèvi moun yo dirèkteman. Pi gwo rekòt bwa fèt ant wit (8) - onz (11) lane apre plantasyon.

Sèvis pyebwa yo rann

Se pa bwa ki rekòlte sèlman ki enpòtan, pyebwa yo menm te rann sèvis tou. Majorite plantè konsidere pyebwa yo tankou yon bank, yon rezèv pou sitirasyon difisil. Plantè yo sèvi ak pyebwa pwojè-a pou amelyore tè-a, pou ogmante valè tè-a, pou bèbèl, pou kase van, pou bay lonbray nan jaden kafe ak kakawo, ak lòt sèvis ankò.

Enpak pyebwa yo sou anviwonman

Pyebwa pwojè-a gen yon enpak pozitif sou anviwonman-an. Yo ogmante divèsite abita yo (kote bagay ki vivan rete), e yo fasilite chanjman nan fason yo sèvi ak tè yo. Yo jwe yon wòl enpòtan ni nan atire bèt k-ap pote semans ni nan chanje kondisyon tè yo pou pèmèt rejenerasyon natirel fèt. Sa an menm tan pèmèt pyebwa leve pou plantè-a jwenn ti plantil. Plantasyon pyebwa ogmante pwodiksyon biyomas kote ki degrade yo, yo fè abita yo vinn pi rich, pase yo amelyore kalite sòl ak figi tè-a, yo ogmante posiblite pou plantè-a tire plis lajan nan tè-a, yo kreye kondisyon, manje ak kay, pou bèt vinn viv, yo prepare teren pou lòt plant vinn pran.

Objektif pwojè-a

Objektif ki sou papye ansyen pwojè AOP-a reyalize. Peyizan yo montre yo trè motive pou plante ak pran swen yon bon kantite pyebwa pou diferan rezon, tankou pou konsèvasyon sòl, pou fè chabon ak bwa dife ak pou fè lajan. Sèl bagay, pwodiksyon bwa pa montre li ka sèvi kòm danre konpare ak pwodiksyon agrikòl. Pyebwa yo te plante kèk kote sèlman, kote yo sèvi kòm konpleman, kòm bank, kòm rezèv, pou garanti kont sitirasyon difisil tankou sizoka plantè yo pa ta fè bon rekòt. Plantè yo dakò pou envesti nan plante ak pran swen pyebwa, men yo pa soti pou depanse ti lajan yo genyen nan pyebwa ni pou sakrifye okazyon pou fè lakilti ki rapòte plis lajan.

Bi prensipal pwojè-a se te pou ede konbat degradasyon anviwonman. AOP te genyen yon enpak enpòtan sou anviwonman-an, men estrateji ki te itilize pou fè plante pyebwa pa rive refè *tout* baz resous natirèl yo. Kouvèti vejetal la retounen sou milye ti sit ki lwen youn ak lòt, men gen limit nan estrateji sa-a akòz tè ki gen pyebwa yo gaye e nan konpetisyon ak lòt priyorite tankou fè lakilti. Pwogram plante pyebwa pwojè-a touche apeprè 25% peyizan ayisyen. Se yon reyalizasyon enpòtan, men sa sèlman pa kapab rezoud pwoblèm sosyete peyizan-an ki nan yon kriz nèt ale ni refè baz resous natirèl yo ki degrade nan yon eta k'ap difisil pou refèt.

CHAPTER 1
INTRODUCTION

Background of Study

The basic objective of this study is to assess long term environmental and socio-economic impacts of trees planted under the auspices of the Agroforestry Outreach Project (AOP), and the follow-on Agroforestry II Project (AFII). These projects were funded by the U.S. Agency for International Development (USAID) between 1981 and 1991. During this decade of continuous USAID funding, a total of more than 63 million trees were distributed to 253,000 small peasant farmers.

Tree planting under the AOP began with the spring rains of 1982, and continued without interruption for 19 successive spring and fall planting seasons. See **Table 1.1** below for a summary of CARE and PADF outreach between 1982 and 1991. AF II outreach ended in September 1991 when the project was suspended due to political turmoil and the overthrow of the Aristide government. In 1992 USAID redesigned the project, shifting its emphasis from tree extension to sustainable agricultural production under the Productive Land Use Systems Project (PLUS).

Table 1.1. Summary of CARE/PADF Outreach under AOP/AFII, 1982-1991.

PROJECT	NO. OF PVOs[1]	NO. OF FARMERS[2]	NO. OF TREES[3] (x 000)
CARE - AOP I		22,812	5,800
CARE - AOP II		22,800	7,700
CARE - AFII		3,847	1,374
SUBTOTAL		**49,459**	**14,874**
PADF - SW (I)	29		10,756
PADF - SE (II)	49		9,140
PADF - N (III)	76		15,838
PADF - UP (IV)	41		6,139
PADF - LP (V)	30		6,329
SUBTOTAL	**225**	**203,347**	**48,202**
TOTAL	**225**	**252,806**	**63,076**

[1] The column *PVO* refers to private voluntary organizations, both local and international, which collaborated with PADF. [2] Actual number of tree planters, estimated to be less than reported, to avoid double counting repeat planters. [3] Refers to trees *distributed* to farmers. In 1991, 80 species were produced in 40 regional nurseries, 30 community nurseries and 1,450 backyard nurseries. Forty percent of the trees distributed in 1991 were native species. The project had trained an extension network of about 1200 extanimators. PADF financing included some support from Swiss, Canadian, Belgian, Shell Oil and private US sources. SOURCES: *Info-PLUS* I (1-2), PADF and CARE staff.

Under the AOP (1981-1989), CARE International provided extension services to peasant farmers in the Northwest. The Pan American Development Foundation (PADF) operated in five other regions of Haiti under the name *Pwoje Pyebwa* (Tree Project). Operation Double Harvest (ODH) carried out nursery and plantation activities in the Cul-de-Sac plain. In 1985, the AOP established an applied research component operated by the University of Maine. In 1987 research support continued through the South-East Consortium for International Development (SECID) under Auburn University. Between 1990 and 1991, AF II retained outreach and research components operated by CARE, PADF and SECID. AF II continued the AOP tree planting strategy plus a wider range of interventions emphasizing soil and water conservation. Between 1987 and 1991, the project funded the Haiti Seed and Germplasm Improvement Program operated by the International Resources Group and then SECID. The germplasm program supported CARE and PADF agroforestry through conservation and genetic improvement of native and exotic tree species.

Project Assumptions

According to project documents, the primary purpose of AOP/AFII funding was to help reverse patterns of severe environmental degradation in rural Haiti. This held the promise of stemming the trend toward denuding Haiti's mountains, helping to restore Haiti's green cover, and improving the country's natural resource base.

The implementation strategy was to introduce large numbers of trees into rural Haiti through a farm forestry extension system. The Project Paper states primary objectives of the AOP as follows:

(1) *to motivate Haitian peasants to plant and maintain trees for soil conservation, production of fuelwood, and generation of income in rural areas,*

(2) *to achieve the planting and maintenance of a substantial number of trees over the life of the project,*

(3) *to obtain reliable information through applied research on the technical, economic and social variables of forestation in Haiti.*

The guiding premise for this effort was the following: *Peasant farmers can be motivated to plant large numbers of trees by undertaking the production of fast growing tropical hardwoods to be harvested as a cash crop.* This keystone principle was based on the following assumptions:

1. Peasant farmers are willing to try new crops if given the opportunity to do so without great risk.
2. Farmers are oriented to cash crops with a relatively quick return on investment.
3. Market incentives, especially for fuelwood and charcoal, are sufficient to motivate small farmers to plant hardwood trees on their own land.

4. Land tenure arrangements are adequate to promote investment of perennials on land which farmers hold securely. Despite the shortage of good cropland in rural Haiti, most peasant farms have tracts of agriculturally marginal land that could be planted in trees. Trees could also be intercropped with traditional food crops.

5. Planters own the trees they plant on their own land. They are able to exercise full control over site selection, management and harvest of trees planted.

6. Fast growing, leguminous fuelwood species with the ability to regenerate by coppice are readily adapted to the peasant farm context.

7. It is feasible to plant such fast growing hardwoods as a new and potentially lucrative cash crop. Initial harvest could take place within two or three years for fuelwood or wood charcoal production.

Objectives of Impact Study

Over three years have elapsed since AFII was suspended, and 13 years since the AOP first distributed trees in the spring planting season of 1982. No previous post-project impact evaluation has been undertaken. There is now sufficient time depth to review the impact of project trees on peasant farms.

Tree cropping is a long range proposition. Even fast growing tropical hardwoods may well require a decade or more to attain harvestable size, especially on degraded sites, and especially for higher value wood products. Furthermore, coppicing species require sufficient time depth to enable assessment of multiple rotations. In this perspective, the earliest plantings of project trees are only now in a position to demonstrate both short and long term returns on the farmer's investment. Only now, and for the first time, are we able to revisit the question of impact, and observe some of the effects that project trees have had on the farmers and their environment.

How are farmers managing and utilizing project trees? How has establishment of large numbers of project trees affected farmer decision making and land use patterns? The evaluators have been asked to estimate numbers of original trees still standing, rates of natural regeneration, reasons for harvest, age at harvest, coppice management, economic value of harvests, species preference, farmer perceptions of benefits, changes in attitudes and practice. In short, what has happened to the trees, peasant tree planters, and the sites where farmers planted trees? What do we know about the possible long term environmental and socioeconomic impacts of project trees?

Methodology

The evaluation team is composed of a forester-ecologist and a cultural anthropologist with longstanding experience in Haiti. The terms of reference instruct the team to undertake investigations of representative sites. The team is to interview project participants and key informants in the areas where CARE and PADF were active in tree planting. Site selection for field interviews and inventories is discussed in **Chapter 2**.

The team interviewed a total of 77 tree planters, and inventoried 43 tree planting sites on peasant farms. See **Table 1.2** below for a breakdown of interviewees by region, gender and inventory site. The team selected its sample of farmers and sites with a view to assuring a relatively broad range and variation in land use and tree management strategies. Given its mandate, the team was interested in harvest and utilization strategies - including inventory of sites with no reported harvest. Given the short time frame for a study of this magnitude - a total of 6 weeks for preparation, fieldwork in far widely dispersed locations, analysis and report preparation - it was simply impossible to carry out a statistically valid, project-wide random sample. In view of these limitations the team selected a sample deemed representative of project tree sites. The team feels that this sample generated a realistic sense of the range and variation in land use where the majority of project trees were planted on peasant farms. The team also interviewed other informants noted in **Appendix 1**. These interviewees included current and former agency personnel, farmers not enrolled in the program, and other members of local communities.

Table 1.2. Summary of tree planter interviews by site and gender.

	Interviewed			Inventoried (43 plots)		
SITE	MEN	WOMEN	TOTAL	MEN	WOMAN	TOTAL
Bombardopolis	8	2	10	7	1	8
Dos d'Ane	7	1	8	5	0	5
St. Michel de l'Attalaye	12	2	14	9	2	11
Bainet	10	1	11	10	0	10
Fond-des-Blancs	12	7	19	5	2	7
Ste. Hélène	8	3	11	3	0	3
Grenier	4	0	4	4	0	4
Total (Percent)	**61 (79)**	**16 (21)**	**77 (100)**	**43 (90)**	**5 (10)**	**48 (100)**

At sites where PADF village studies were undertaken in the mid 1980s, the team sought to visit planters and sites with a preexisting baseline of available information; however, some additional planters were interviewed even if they had not been queried in earlier village studies. In the Northwest, no previous questionnaires were available for comparative purposes. The vast majority of tree gardens were managed by men in keeping with the normal division of labor in rural Haiti; however, the team sought out woman planters to assure representation of both men and women planters in the study sample. Morne-Franck had a much higher rate of female planters due to the high rate of male outmigration to French Guiana. Where tree site inventories were undertaken, women comprised 10 percent of planter interviewees. Women made up 21 percent of all tree planters interviewed including farmers whose tree gardens were not inventoried. Planter interviews were supplemented by additional interviews with market women selling wood products.

The team visited a number of tree sites which they did not formally inventory. They also visited tree sites from virtually all stages of project implementation including AOP/AFII trees planted in PLUS areas; however, the team sought to stratify the sample by selecting tree inventory sites with greater time depth in order to maximize available information on land use changes, varied harvest strategies and multiple rotations of coppicing trees. For example, it has become clear from the sample that initial harvest often took place after four or five years in the ground, and more commonly after eight or ten years - especially on somewhat drier mountain sites where a large percentage of the trees were planted.

Tree planting sites inventoried by the study were established between 1982 and 1986. A higher proportion of exotics than native species were planted during the early years of the project. Nevertheless, species inventoried at study sites included the 11 most popular species - 83 percent of PADFs production during the last full year of the project (PADF, 1991). The same pattern holds true for CARE areas. In other words, species planted during the first four years anticipated the same species mix used in latter stages of the project - albeit with a shift in ranking and in relative numbers of exotic and native species. Therefore, analysis of earlier plantings with their greater time depth, greater opportunity for tree harvest and broader perspective for identifying changes in land use, proved to be the most judicious strategy for generating data pertinent to analyzing impact.

Analysis of early years is prudent from another perspective: PADF survival rates after 12 months increased from 30 percent in 1984 to over 52 percent by the end of the decade. CARE survival rates have tended to be even higher, and they reflect the same pattern of improvement over time. Therefore, survival has been significantly higher for the years when most trees were planted. Overall, biomass production will doubtless be higher for trees planted during the final, maximum production stages of the project.

The team's division of labor at study sites required the forester to carry out a detailed inventory of standing and harvested trees, coppice, natural regeneration, and physical characteristics of the planting site. With the site inventory underway, the anthropologist interviewed the farmer responsible for the tree garden. Each team member used a data collection instrument to record data and farmer responses to questions. In each region the team worked with a former AOP animator knowledgeable about the project, local tree planters, and inventory sites where project trees were planted. The former animator and one or two others from the community generally assisted the forester in carrying out site inventories.

Once the team agreed to inventory a particular garden, team members briefly discussed their work with the tree planter and gained his or her permission to cooperate with the study. The forester then executed his site inventory. The tree planter was asked the time of planting, the quantities of each species planted and the planting configuration on site. Site parameters that were recorded included elevation (m), aspect (azimuth), slope (%), site position relative to valley or ridge, site fertility (5 categories according to tree planter's judgement) and current land use. Coordinates were estimated using the 1964 1:100,000 U.S. Army maps at the SECID office. Rainfall data was collected for the nearest weather station from the Meteorological Service's (Ministry of Agriculture) database.

An initial tally of all harvested stumps and live trees was conducted to confirm the information and to estimate stand area. If the trees were planted in block, then the total block area was estimated. If the trees were dispersed or planted in-row along borders or within a field garden, the stand area was estimated as the area occupied by the canopy of the trees. Harvested tree stumps and boles of standing trees were measured for diameters with calipers to the nearest 0.1 cm. Generally, stump diameters were measured at 0.1m and bole diameters at 1.3 m. These measurements were used to estimate wood weights and pole volumes based on weight tables prepared for each species during the AOP (Ehrlich, 1985; Ehrlich et al., 1986; Timyan, 1987).

A tally of volunteers of the AOP trees, either regenerated from seed or as root suckers, was conducted on site for 3 stem diameter classes: < 1 cm, 1-3 cm, and >3 cm. In certain cases, subsampling procedures were necessary to estimate volunteer regeneration due to extremely high stem densities of some species. Subsampling for seedlings <1 cm stem diameter consisted of randomly selecting five 1 m^2 plots and counting all stems falling within the plot boundaries. Subsampling for the 1-3 cm and >3 cm diameter classes consisted of the random placement of five 5m x 5m plots and counting all stems falling within the plot boundaries.

All coppice production was measured for diameters, either as stumps or stems. Volunteers, either standing, harvested or coppicing were measured in the same manner that the original AOP trees were measured. A total of 8 classes of stumps and stems were measured in the study. Standing dead trees were encountered on only one site and were eliminated as a category in the tree inventory analyses. Volunteers of native or naturalized species other than the AOP trees were tallied for 2 height classes: 0.5 - 2.5 m and > 2.5 m. A tally was conducted of the trees that were present on site prior to the planting of AOP trees. The list of tree species encountered during this study is provided in **Appendix 2.**

During interviews the anthropologist worked with the farmer to reconstruct the plot's cropping and tree planting history, farmer considerations in site selection, farmer motivations in planting project and non-project trees, changing land use patterns over time, future plans for the site, harvest and tree utilization history, farmer role in regeneration, the local farm strategy, agricultural calendar, and patterns of fallow. Wherever possible, the anthropologist referred to earlier interview data to establish a sense of who the farmer was, and to elicit changing attitudes and practices over time. The anthropologist used an interview guide rather than a formal survey instrument to elicit information. This facilitated follow-up questions and a conversational tone or dialogue during interviews. At the completion of site inventory and farmer interview, the team usually met briefly with the farmer to report findings from the inventory and clarify information.

CHAPTER 2
TREES AND REGIONS

Site Selection

Given the geographic spread of the project, and the sheer number of farm sites with project trees, it would have been an impossible task to carry out interviews and field observations in all communities where project trees were planted over a ten year period. Therefore, in consultation with staff members of USAID, SECID, CARE and PADF, the team selected a series of study sites in eight far flung regions of the country. See **Figure 2.1** for the locations of the study regions and **Table 2.1** for a summary of their environmental parameters.

The team judged these sites to be representative of the project's field extension by virtue of their geographic spread and physical characteristics. In keeping with Haiti's mountainous character, the study sites demonstrated a considerable degree of microsite variation. To broaden the range of site conditions in the study, the team visited several localities within each region. Finally, site selection criteria favored sites with a preexisting baseline of information gathered in the mid 1980s by the University of Maine (Conway, 1986; Balzano, 1986), and PADF (Lauwerysen, 1985; Buffum, 1985; Buffum and King, 1985; Smucker, 1988). Reports and questionnaires from the earlier studies provided useful comparative data on project tree planters and non-planters, planter criteria for tree site selection, and planter goals and expectation in early stages of the project prior to tree harvest. In the case of the CARE program in the Northwest, all project records were destroyed in the political turbulence of the mid 1980s; however, the team visited two CARE sites discussed by Conway in 1986 - Desforges and Savane Môle.

Geographically, the eight regions fall within all major regions of the country served by CARE and PADF field extension teams under AOP/AFII - Bombardopolis, Savane Môle, and Dos d'Ane in the far Northwest (CARE), St. Michel which straddles PADFs Plateau and North regions, Grenier la Montagne not far from Port-au-Prince, Bainet in the Southeast, Fond-des-Blancs and Ste. Hélène in PADFs southern region. Two of the old AOP sites studied have continuing project extension activities under the current PLUS program - Desforges in the Northwest (CARE), and Ste. Hélène in the South (PADF).

The study sites vary in average annual rainfall from 600 to 2,300 millimeters, and from 160 to 1,000 meters in elevation. These parameters clearly reflect the primary planting target of most AOP and AFII trees. Overall, these regions are representative of common agricultural conditions where most project trees were planted - mountain peasant agriculture characterized by two growing seasons, one major and one minor. The eight regions also exhibit a

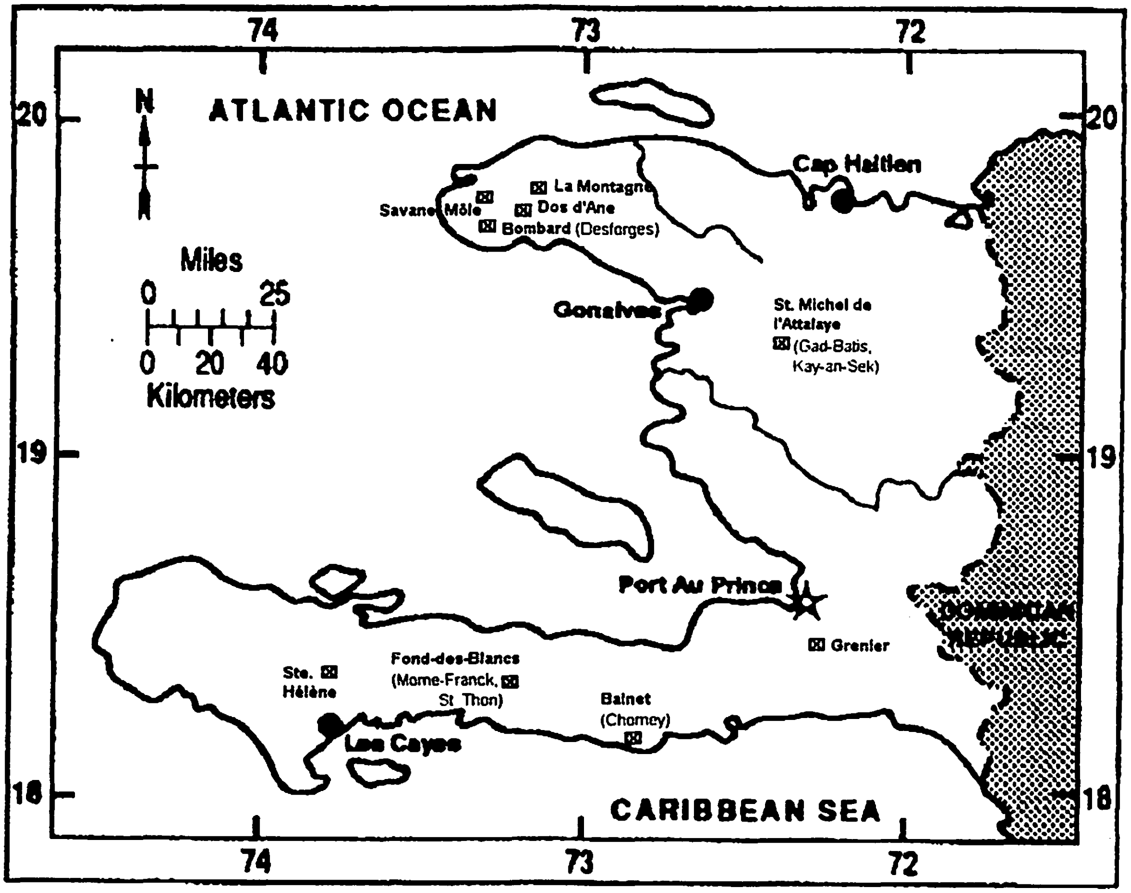

Figure 2.1. Map of Haiti showing the location of the study regions.

Table 2.1. Environmental parameters of the study sites.

REGION	NO. OF SITES	LATITUDE (N)	LONGITUDE (W)	ELEVATION RANGE (m)	ANNUAL RAINFALL (mm)	SLOPE RANGE (%)
Bombard	5	19° 41'	73° 20'	400 - 480	948	5 - 50
Savane Môle	2	19° 46'	73° 21'	240 - 250	608	2 - 5
Dos d'Ane	3	19° 44'	73° 13'	490 - 570	980	4 - 45
La Montagne	2	19° 47'	73° 11'	770 - 800	1,300	5 - 55
St. Michel de l'Attalaye	7	19° 16'	72° 22'	340 - 460	1,289	5 - 45
Grenier	5	18° 28'	72° 19'	870 - 1,000	1,733	0 - 70
Bainet	10	18° 10'	72° 48'	200 - 300	1,572	2 - 72
Fond-des-Blancs	6	18° 19'	73° 10'	290 - 575	1,194	0 - 42
Ste. Hélène	3	18° 20'	73° 47'	160 - 265	2,281	38 - 67

considerable degree of internal range and variation in planting conditions - including some of the driest (e.g., Savane Môle) and wettest (e.g., Ste. Hélène) sites where project trees have been planted in Haiti.

Bombardopolis

CARE established its AOP program in the Northwest with field foresters based in Bombardopolis and Jean-Rabel. CAREs earliest AOP trees were planted at Bombardopolis during the spring planting season of 1982. The study team visited two CARE zones in this region - Desforges and Savane Môle. Desforges is a site of continuing CARE outreach under the PLUS program. CARE outreach in Savane Môle ceased with the termination of AFII.

Desforges is an area of fairly intensive cultivation - dry mountain agriculture with two important planting seasons. Sorghum, manioc, and peanuts are commonly planted during the spring planting season (March-June). Beans, corn and sweet potatoes are commonly planted in the shorter fall planting season (September-October). Depending on the rains and the site, farmers may plant red beans in a brief third season at the end of the year (December). Bitter manioc is left in the ground for two years or more. The area has long produced charcoal during slack periods of agricultural activity, and depends heavily on livestock. Many families experience food shortages in the months of May and June. Despite a broader regional pattern of long fallow cycles, farmers in Desforges practice a fairly short fallowing system - one or more years of production followed by one year in fallow. Informants in Desforges report experience with planting or protecting traditional forest species such as *kajou (Swietenia mahagoni)*, *kapab* (*Colubrina arborescens*), *sèd* (*Cedrela odorata*), *chènn* (*Catalpa longissima*), and *saman* (*Albizia saman*).

In addition to highland plots around house sites, farmers of Desforges commonly have access to drier, less intensively farmed sites at lower elevations. These sites are known as *kadas* where few or no people have permanent residences. Farming in the *kadas* is based on a limited number of cultigens - mostly manioc and sweet potatoes, long periods of fallow, and production of charcoal. These areas are extensively grazed, including the outlawed practice of open range grazing in some areas. A few farmers also have irrigated gardens in distant riparian lowlands.

Tree inventory sites in Desforges fall within areas of more intensive cultivation rather than the drier *kadas*. Some tree gardens have shifted from annual crops to permanent woodlots generating a fair amount of charcoal. More commonly, farmers have incorporated project trees into annual gardens which previously had few or no trees. These gardens have continued to be intensively cropped in combination with short periods of fallow. First harvest here has generally been after eight years. None of the reported harvests were based on clearcutting. Project trees have produced a significant amount of charcoal; however, farmers clearly prefer to hold out for higher value wood products, especially construction materials. Farmers have used the trees extensively for house construction. Informants report most polewood harvests as used directly rather than sold for cash income. A number of farmers in Desforges have sawn *kaliptis* (*Eucalyptus camaldulensis*) for lumber used in peasant house construction. There is a lively sailboat traffic in the region, and farmers report selling tall and straight *kaliptis* for boat masts.

Within the past 20 years local housing materials have gradually shifted from mud-and-wattle (*kay klis*) to rock-and-lime (*kay miraye*) construction. Poles, beams and lumber remain important in rock houses; however, less wood is required for wall construction. This reflects growing wood shortage in the region. This shift has created growing demand for *lacho*, lime or quicklime, made by burning limestone to extract a chemical compound of calcium and oxygen used in cement. Local production of lime has created a growing demand for firewood. A lime producer in Krèv (Desforges) has planted a relatively large number of trees on his lime production site where calcareous rocks are plentiful. He reports a much better rate of return from lime production than from charcoal production - assuming the same quantity of wood.

Interviews in Desforges show changes in harvest intentions over time. Economic hardship has engendered levels of a wood harvest which farmers did not anticipate when they planted trees. Some hoped to establish permanent woodlots to use and pass along to their children for high value products. Instead they have harvested for charcoal and polewood at earlier stages of production, and retained use of tree sites for annual food crops. Others have shifted from a food-and-tree strategy to establishment of woodlots, harvesting a first rotation for charcoal, and successive rotations for charcoal and polewood. In the latter context the team observed old *lisina* (*Leucaena leucocephala* subsp. *glabrata*) hedgerows established in food gardens for conservation purposes, but left unpruned with crop land going out of food production and natural regeneration covering the ground between hedgerows. The farmers chose to manage such sites as long term fallow (10 or more years), harvesting for charcoal and polewood with plans to reestablish annual food crops.

Five sites were selected in the Desforges environs south-west of the Bombardopolis plateau. The landscape of this area is hilly, with moderately steep slopes, typically 35 - 50%, that drain toward a south and westerly direction. Elevations are lower than Bombardopolis, though the area receives a higher amount of rainfall, distributed bimodally with peak rains occurring during April/May and September/October. The soils of the area have developed from a limestone conglomerate comprised of coral reef material interspersed with tuff (*tif*). They range from dark brown, gravelly loams to reddish brown, clayey loams, high in pH (8.1-8.4), and 20-40 cm to the parent material (Guthrie et al., 1990). Rainfall and soils support a Subtropical Moist Forest (*sensu* Holdridge, 1976) that represents the most extensive life zone in Haiti. Common wood species are *kajou*, *chènn*, *palmis* (*Roystonea hispaniolana*), and *fwènn* (*Simarouba glauca*). Common fruit species are *mango* (*Mangifera indica*), *kowosol*

(*Annona muricata*) and *kachiman* (*A. squamosa*), *zaboka* (*Persea americana*), *sitwis* (*Citrus* spp.), and *kokoye* (*Cocos nucifera*). A summary of the site parameters in this region are provided in **Table 2.2.**

Table 2.2. Summary of study sites in the Desforges area of the Bombardopolis region. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
1	Klenet	9/1986	425	262	5	0.03	200	LELE, LEDI, EUCA, COAR ; block 2m x 2m.
2	Krèv	5/1984	480	131	50	0.14	350	EUCA, CASI, CACA, COAR; block 2m x 2m.
3	Demoulin	9/1985	420	48	5	0.16	250	CASI, EUCA, AZIN; block 2.5m x 2.5m.
4	Demoulin	9/1985	400	340	35	0.15	100	COAR; dispersed 3.9m x 3.9m.
5	Krèv	6/1985	440	350	5	0.64	850	CASI, ACAU, AZIN, SIBE, CALO; border 1.5m in-row.

Savane Môle

The arid plains of Savane Môle are located at lower elevations a few kilometers from Bombardopolis. There is less intercropping than in the more humid Desforges. Sweet potatoes, manioc and congo peas may be left in the ground for two years. Peanuts are an important crop. Farmers grow castor beans in a three to four year cycle. Slack seasons and periods of fallow are lengthy. Farmers practice a form of shifting cultivation on small gardens within a larger block of land. A single planting season is commonly followed by four or five years of fallow before the land goes back into crop production. The lengthy fallow allows land to reforest. There is a minor second season in the cool months at the turn of the year (November-December-January) for beans, sweet potatoes and corn. Agriculture is risky. Charcoal and livestock production are important off-season pursuits which mitigate agricultural risk. Grazing is a principal feature of local production.

Informants in Savane Môle have established project trees as charcoal gardens on garden plots where they traditionally practice long term fallow. Tree sites have tended to double the already lengthy fallow period - at least for the first rotation of wood harvest. One couple waited 10 years to harvest charcoal and some polewood. Another farmer, Francoeur Desinor, has used his tree garden as a nursery to transplant volunteers into actively gardened, adjoining subplots. He reports planting such seedlings annually with the spring rains. In doing so he has actively replaced harvested trees, and virtually doubled the size of his original tree plantation. These dry sites reflect two closely linked strategies well adapted to the local context: charcoal gardens and enriched fallow.

Two sites were selected in Savane Môle, northwest of Bombardopolis toward the coastal town of Môle St. Nicolas. The land is flat or gently sloping toward the west, about 250 m above sea level and semi-arid. Annual rainfall ranges between 600-800 mm and stony soils are shallow overlaying ancient coral reef limestone. Rainfall amount and distribution is highly variable from one year to the next, making annual crops risky compared to the more secure grazing and charcoal production systems common in the area. Site conditions support a Subtropical Dry Forest, characterized by a combination of thorny trees (*Acacia farnesiana, Prosopis juliflora, Randia aculeata*) and non-thorny species (*Leucaena leucocephala* subsp. *leucocephala, Guaiacum spp., Exostema caribaeum*) that are desirable for charcoal production and tolerate browsing pressure. The two sites sampled in this area are summarized in **Table 2.3.**

Table 2.3. Summary of study sites in the Savane Môle area between Bombardopolis and Môle St. Nicolas. * = Estimated number planted. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
6	Bousket	6/1983	250	340	2	0.14	250	LELE, AZIN; block 2.4m x 2.4m.
7	Dibois	5/84	246	240	3	0.06	125*	LELE; block 2.5m x 2.5m.

Dos d'Ane

The agricultural regime in Dos d'Ane is similar to Desforges; however, it is drier with a minor second season (September-October). The annual crop mix centers around corn, sorghum, beans and sweet potatoes. Livestock and charcoal are important enterprises. Farmers also make use of distant *kadas* gardens for grazing, charcoal production, peanuts, sweet potatoes and manioc. The sweet variety of manioc is commonly left in the ground for 18 months, and the bitter for up to three years. May-June-July and November are hunger months. People commonly crop annuals for one or two years then leave land in fallow for two to ten years depending on the site and their needs for crop land.

Informants in Dos d'Ane have used project trees to enrich long term fallow. On sites which are cropped more frequently, informants have reserved garden space together with widely spaced trees and border plantings. One farmer is removing giant leucaena stumps from a productive garden site which he crops twice annually; however, he likes giant leucaena on other sites with degraded slopes. Another farmer reports clearcutting all giant leucaena when planting food crops after a lengthy period of fallow, managing coppice for superior stems during the food crop cycle, and letting the trees develop unpruned during the subsequent fallow cycle. This farmer notes that he would prefer to establish a long term woodlot in order to attain higher value wood products for construction; however, he cannot afford to wait, and derives shorter term income from the trees by producing charcoal.

Three sites were selected in the Dos d'Ane area. The terrain is very hilly with weather conditions strongly influenced by the region's leeward position to the mountain chain between Anse Rouge and Jean Rabel. Though similar in elevation (and possibly annual rainfall amounts) to the Bombard Plateau, conditions are drier due to the southerly exposure of the landscape, more rapid runoff and greater extent of erosion. The area is classified as Subtropical Moist Forest, though the shallower soils of many sites can only support Subtropical Dry Forest species. The study sites are summarized in **Table 2.4.**

Table 2.4. Summary of study sites in the Dos d'Ane region. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
8	Nan Jan	5/1984	490	216	4	0.24	500	LELE, CASI, CAEQ; block 2m x 2m.
9	Sou Platon	9/1984	570	110	45	0.1	250	LELE, EUCA; block 2m x 2m.
10	Sou Platon	9/1982	500	40	15	0.15	250	LELE - border 2m in-row; EUCA - 2m x 2m.

La Montagne

At cooler, higher elevations above Dos d'Ane, the local agricultural strategy centers around corn, beans, and sweet potatoes. Sorghum and manioc drop out of the crop mix. There are better rains, and farm units often include some coffee, plantains and sugar cane. Livestock remains important. Farmers seek distant plots in the *kadas* as in other highland regions of the Northwest. May, June and July are hunger months. The fallowing regime is commonly one year of cropping followed by two or three years off.

One informant in this community used project trees to enrich fallow; however, the site was harvested after 10 years with no evidence of natural regeneration or replanting. This site is an example of some project trees playing only an ephemeral role in the local landscape. At the time of the team's visit, the farmer was cutting the last of his trees and reestablishing annual crops. Aside from stumps and the benefits of a lengthy fallow, the plot presumably appeared much as it did before project trees were planted. This was due in part to low survival rates as a result of uncontrolled grazing of young trees by neighbors. It also reflects the difficulty numerous farmers have had in propagating *Casuarina* spp. and *Eucalyptus* spp., both well-liked species that do not regenerate naturally from seed. The farmer had derived some income from the sale of posts and beams which he used to purchase food and invest in goats. Charcoal was being made from an old avocado tree to make room for *kapab* and *chènn* in an adjacent perennial garden.

At lower elevations of La Montagne, a farmer gained significant benefits by selling three subplots from his tree garden. In doing so, he was able to gain premiums of 40, 50 and 70 percent on his sale price - value added which he attributed to project trees. The team spoke with both buyer and seller of these plots. The seller indicated he sold the land to buy food during hard times in the early 1990s. The buyer made a considerable quantity of charcoal in order to buy food, and he built a house for his son. He used project trees to meet virtually all of his post and beam wood requirements for the house. He estimated harvesting more than 1,000 gourdes worth of polewood, mostly *pich pen* (*Casuarina* spp.) from his newly acquired land in order to build the house, thereby avoiding expenditure of scarce cash resources.

Informants in this area and all other study sites in the northwest report harvesting charcoal primarily for sale, and polewood primarily for their own use. They also report a tremendous harvest of trees for charcoal during the economic difficulties of the past few years.

Two sites were selected in La Montagne, a region that occurs on a plateau of the mountain range north of Dos d'Ane. The elevation of this area lies between 800-900 m and receives more rainfall than Dos d'Ane. Combined with cooler temperatures, the region is considerably wetter than Dos d'Ane. The soils are deeper on the plateau, though highly eroded and shallow on the steep slopes that drain the area. The natural vegetation of the area lies in a transition zone between the Subtropical Moist Forest and the Subtropical Wet Forest. *Zaboka* and *sitwis* replace *mango* as the dominant fruit species; *sèd* and *sikren* (*Inga vera*) are common wood trees that serve simultaneously as shade for coffee. The study sites are summarized in **Table 2.5**.

Table 2.5. Summary of study sites in the La Montagne region. * = Estimated number planted. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
11	Des Abbé	5/1985	780	252	55	0.18	250	EUCA, LELE, COAR; block 2.7m x 2.7m.
12	Des Abbé	5/1985	780	300	18	0.1	250*	EUCA, COAR, CAGL; block 2m x 2m.

St. Michel de l'Attalaye

The team visited tree farmers in two localities of the communal section of Las Cidras - Gad-Batis, a plains area, and Kay-an-Sek, a mountain community. PADF tree planting began here in the fall season of 1982 in collaboration with CECI, the Centre Canadien d'Etudes and de Coopération Internationale. Between 1982 and the spring season of 1991, the project distributed 812,171 trees in this area.

There are spring and fall rainy seasons; however, the spring season is far more important. There is one main planting season. Farmers commonly plant food crops on the same site once a year for several years. They may leave land in fallow for a year before returning to several years of annual crops. Many garden sites are planted year after year without fallow periods. Livestock is less important here than in the northwest. Corn, sorghum and beans are key crops. Manioc and sweet potatoes are produced by most farmers, and people grow yams and taro in the mountains. Most farms have *kolombye* (granaries) for storage of grain and other crops during the long slack seasons. Farmers seek out mountain sites capable of growing a short rotation bean crop in the fall. Such land may be rented for a two month period. Another specialized type of field garden is paddy land for growing rice. Some farmers have coffee and plantain groves. Cane is an important crop, especially in the plains areas. There are 17 *gildiv* (distilleries) of *kleren* (raw rum) in St. Michel. This local industry creates a significant demand for sugar cane and firewood.

Land management decisions in this region have been visibly affected by the political and economic difficulties of the 1990s. The 1990 elections and 1991 coup d'état created sharply polarized political camps. Numerous farmers left the area for long periods of time, and left plots in fallow rather than working the land due to fear of persecution by local authorities. Informants reported a sharp rise in land sales during this period due to the need to raise money for support of absentee farmers and their families. Land sales included sale of plots with project trees - including in one case a 67 percent mark-up due to trees on site - according to interviews with buyer and seller. A number of the interviewees in this study had spent time *nan maron* (in hiding). These people returned home following the arrival of U.S. troops in Haiti and the return of President Aristide.

Informants in this area report much less charcoal from project trees compared to the Northwest. There has been some sale of polewood, but the most significant sales elicited were related to sale of land. The tree plots were highly valued as a source of polewood for house construction (primarily autoconsumption), but plantations have not been clearcut nor harvested as heavily as in the northwest. There has been some cutting for saw wood including the use of *kasya* (*Senna siamea*) boards for high value added purposes such as coffin construction. Informants attributed a great deal of importance to trees as a store of value, and a potential source of higher value wood products if left to grow. On several sites the team noted an interesting shift in land use due to establishment of project trees. Farmers planted other perennials in association with trees - notably stands of sugar cane and plantains - thereby significantly reducing the harvest of annual food crops on these sites.

Due south of St. Michel de l'Attalaye about 10 km, seven sites were selected in the Gad-Batis (3 sites) and Kay-an-Sek (4 sites) areas. The region lies on the northwestern fringe of the Central Plateau and forms the drainage area of the Ennery River basin. The soils of Gad-Batis are sandy loams typical of the rolling hills of the Central Plateau, drying out quickly during the dry season, favoring millet over corn and supporting a mix of native species typical of the Subtropical Moist Forest. These include *kampèsh* (*Haematoxylon campechianum*), *kajou* and *palmis*. *Mango* is the dominant fruit species and *fwènn* is a common wood species.

Kay-an-sek is a locality situated in the foothills above Gad-Batis. Soils are generally shallow and stony on the upland slopes, though alluvial soils of the ravines are deep and support productive sugar cane, coffee and plantain gardens. The study sites of this region south of St. Michel de l'Attalaye is summarized in **Table 2.6.**

Table 2.6. Summary of study sites south of the St. Michel de l'Attalaye area. * = Estimated number planted. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
13	Gad-Batis	5/1983	340	116	12	0.07	125	CASI,CALO; block 2.4m x 2.4m.
14	Gad-Batis	5/1984	360	270	15	0.45	250*	CASI, CAEQ, LELE; block 6m x 6m.
15	Gad-Batis	5/1984	390	85	45	0.47	350	CASI; block 2.5m x 2.5m.
16	Kay-an-Sek	5/1983	440	162	30	0.41	500	CAEQ, EUCA, ALSA; block 2m x 2m and border 3m in-row.
17	Kay-an-Sek	5/1984	440	180	25	0.1	250	CASI, EUCA, AZIN, CAEQ, CALO; block 2m x 2m.
18	Kay-an-Sek	5/1983	420	190	5-20	0.25	250	CASI, CALO, CAGL, EUCA; border 2m in-row.
19	Kay-an-Sek	9/1984	460	54	15	0.25	250	CASI, CALO, EUCA, LELE; dispersed 2m x 2m.

Bainet

PADF established a tree planting subproject with the Parish of Bainet which began tree distribution in the spring of 1982. Between 1982 and the spring of 1991, the parish distributed 1,876,455 trees in 14 rural communities of Bainet. The study team inventoried sites in one of these communities - Chomey, a locality near St. Thérèse chapel in the Ninth Communal Section of Bainet. During the first four years of outplanting, the project distributed 48,250 trees to around 150 farmers in Chomey.

Chomey is characterized by an agricultural strategy based primarily on corn, sorghum and beans. Corn is somewhat more important than sorghum. The crop mix includes sweet potatoes, manioc, and yams. Like other sites studied, spring is the primary planting season. On more productive soils there is a secondary season in July-August-September, and a minor season for beans, a two month crop, in December and January. Livestock is important here as a supplement to agriculture. Fallowing is commonly practiced for one or two years following a year's production of annual food crops. There are sites cropped annually without a break. Some people practice longer fallow if they can afford to take land out of production. There is a significant rate of outmigration to Dominican Republic. The team observed cane cutters returning to Chomey during field site visits in February. The area produces virtually no coffee, but does generate a significant amount of charcoal. Sisal is an old sideline for slack season preparation of rope fibers. There is still a limited market for sisal. Local wood supplies have become quite scarce. Informants attribute the disappearance of traditional woodlots to the charcoal trade. April and November are months of food shortage in the area.

Tree gardens in Bainet have produced ample quantities of charcoal for sale, and construction poles for autoconsumption. The primary harvest for cash has overwhelmingly been charcoal. Farmers have in all cases taken annual crop land out of production to plant trees. Some have managed sites as charcoal gardens linked to periodic clearcutting followed by food crops. Some have established permanent multipurpose woodlots. Others created perennial gardens whereby the planting of project trees precipitated addition of other perennial species such as fruit, bamboo, cane and plantains. A number of farmers in Chomey have made effective use of border plantings to enhance wood production from underutilized niches. Border tree plantings have supplanted sisal borders. In a number of cases, establishment of project trees in borders led to protection or transplanting of native species within the border, and to protection or transplanting of project species widely spaced within the adjoining garden space. The team was impressed by farmer initiatives in enriching garden borders and using the border niche as a nursery site for tree propagation.

A recurring theme in farmer interviews is changing intentions - from lumber goals to shorter term, lower value products, especially charcoal. Farmers express strongly the role of their tree plantations as *rezèv,* resources in reserve, a store of value. Interviews in Chomey elicited cases of heavy tree cutting fines extracted by forest agents during the coup d'état period. Some farmers in this area were forced to pay heavily for cutting project trees which they themselves planted - a practice which had virtually ceased during the period of AOP/AFII outreach.

With an rainfall of nearly 1600 mm, this region supports a Subtropical Moist Forest with *chènn, koma rouj (Bumelia salicifolia), palmis, fwènn, kajou, mango* and *lam veritab (Artocarpus altilis)* comprising the typical tree canopy layer. Volunteers of *damari (Calophyllum calaba)* are common in the area. The gravelly, dark brown to reddish brown soils are mostly derived from limestone, exhibiting strong alkalinity with a pH of 8.0 and above (Guthrie et al., 1990). The soils appear on average deeper than other sites in Haiti with similar topography and climate conditions. A summary of the 10 study sites in this area is provided in **Table 2.7**.

Table 2.7. Summary of study sites in the Chomey area west of Bainet. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
23	Kayanwo	9/1982	260	124	54	0.1	250	CASI, LELE; block 2m x 2m.
24	Kayanwo	5/1982	280	36	23	0.18	250	CASI, CAEQ, LELE; block 2m x 2m and border 2m in-row.
25	Zaboka Jòn	9/1982	230	276	72	0.24	250	CAEQ, CASI, LELE; block 2m x 2m.
26	Chomey	9/1983	210	334	2	0.1	250	CALO, CASI;border 1m in-row.
27	Chomey	9/1983	220	50	8	0.12	120	CASI; border 2m in-row.
28	Nan Jwen	5/1982	230	318	20	0.1	250	CASI, LELE, CAEQ, AZIN; block 2m x 2m.
29	Kayanwo	5/1982	250	37	13	0.25	250	CASI, LELE, CAEQ; border 2m in-row.
30	Kayanwo	5/1983	300	86	32	0.1	250	CASI, LELE, CALO; block 2m x 2m.
31	Zaboka Jòn	9/1982	260	278	20	0.25	250	CASI, LELE, CAEQ; border 2m in-row.
32	Jo Fourneau	5/1982	200	308	68	0.1	250	CAGL, LELE, CASI; block 2m x 2m.

Fond-des-Blancs

Two closely related Haitian PVOs, initially the Comité pour le Développement et la Planification (CODEPLA) and later the Coopérative Développement Fond-des-Blancs, planted trees as a PADF subproject beginning in the spring of 1983. This area is located in PADFs Southwest region of Pwoje Pyebwa extension. The team visited a series of localities located on or below the Morne-Franck ridge, and in the plains near the market village of St. Thon.

This dry agricultural zone practices the familiar corn, sorghum and pigeon bean strategy, but sorghum is more important than corn. Livestock, sisal and charcoal are key adjuncts to food crops. In addition to conventional house and field gardens, people commonly maintain specialized grazing plots and sisal fields - although sisal production has diminished greatly. Living fence is frequently used to control slack season grazing. Live fence material includes dry zone bush species such as castor beans, sisal, pigeon peas, bitter manioc and euphorbia. Farmers make use of woodlots and other traditional tree resources for beekeeping and lumber. Many farmers have experience replanting or protecting wildings of native species including *kapab*, *koma rouj*, *latanye fran* (*Sabal causiarum*), *chènn* and *kajou*. There has been a precipitous decline in wood resources since Hurricane Flora (1963).

Planters commonly leave land in fallow for two or three years following a two or three year cycle of annual cropping. March is the primary month for planting. Sorghum is planted at the end of the spring season (June and July), and sweet potatoes are planted in a minor fall season (September). People identify August and December as difficult months characterized by food and cash shortages. There has been a great deal of out-migration from the area - primarily to French Guiana.

According to village study interviews in 1986, most planters in Morne-Franck introduced project trees into garden perimeters together with other configurations within the same plot. In addition to border plantings, the most common planting configuration was the densely spaced woodlot. The 1995 study team observed important links between woodlots and sylvopastoral usage, less clearcutting for charcoal on mountain sites here than in other dry study sites, and generally a very conservative approach to harvesting project trees. Interviews in Morne-Franck suggest a high incidence of virtually no harvest from project sites. Conservative harvest strategies in Morne-Franck seem to be a function of the desire to maintain trees as a store of value - in a context with other wood resources. It is also a result of the local PVO tree extension strategy which held out the promise of cooperative charcoal production in the future. In Morne-Franck some interviewees had selected a few trees for polewood, but none had sold poles. A number had harvested trees for small scale charcoal production during hard times.

In contrast to Morne-Franck planters, lowlanders interviewed near the St. Thon roadhead reported a scale of clearcutting for charcoal not encountered anywhere else during this study. These farmers planted densely spaced woodlots on level sites with deep soils. One such farmer waited 10 years before clearcutting a .25 *carreau* plot for charcoal (18 *gwo sak*), planted annual crops then clearcut the coppice for another charcoal harvest after four years (33 *gwo sak*). This farmer's original harvest intentions - construction poles and lumber - had changed due to pressing needs for cash. On other planting sites not inventoried, this farmer expressed higher value expectations for giant leucaena and cassia than originally planned, i.e., saw wood rather than polewood. Informants identified a number of planters around St. Thon who have managed their tree gardens for charcoal, and have clearcut repeatedly for large scale production. Clearly, the land use observed here is a form of charcoal gardening linked to long term fallow cycles for annual food crops.

The study sites were divided between Morne-Franck (4 sites) and St. Thon (1 site). The Morne-Franck sites were on the south facing slope of the mountain range that lies between Fond-des-Blancs and Fond-des-Nègres. The stony, shallow soils are derived from limestone parent material. Annual rainfall in the area is between 1,100 - 1,200 mm and supports a Subtropical Moist Forest. *Kampèsh*, *kajou*, *mombin* (*Spondias mombin*), and *mango* are abundant in the area as canopy trees, with *koma rouj* and *fwènn* (*Picrasma excelsa*, not *Simarouba*) as common volunteers. Strong trade winds are a characteristic feature along the mountain ridge of Morne-Franck at an elevation of 600 m. The St. Thon study site is flat with deep, black alluvial soils common to the valley bottom. A summary of the five sites in the Fond-des-Blancs area is provided in **Table 2.8**.

Table 2.8. Summary of study sites in the Morne-Franck and St. Thon areas of Fond-des-Blancs. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
33	Morne-Franck	9/1982	485	77	40	0.04	250	CAEQ; block 1.5m x 1m.
34	Nan Freshè	9/1983	575	49	25	0.1	250	CAEQ; block 2m x 2m.
35	Lexy	5/1983	430	226	23	0.1	500	CASI, LELE; dispersed 2m x 2m.
36	Corail	5/1983	300	244	2	0.19	250	CEOD;border 1.5m in-row.
37	Lexy	5/1982	380	68	42	0.2	500	LELE, CASI, CAEQ; block 2m x 2m.
38	St. Thon	5/1982	290	98	10	0.4	750	LELE, CASI; block 2m x 2m.

Ste. Hélène

This highly degraded mountain zone lies along the road to Maniche above the Cayes Plain. Under the AOP it benefited from PADF tree extension services through a local PVO, Développement Communautaire Chrétien d'Haiti (DCCH) based at La Borde. AOP trees were first planted here in 1982. Ste. Hélène is presently a PLUS outreach site managed directly by PADF.

Corn, red beans, pigeon peas and sorghum are standard crops here; however, there is more intercropping than at drier study sites, and a broader range of cultigens including coffee, plantains, yams, manioc, sweet potatoes, and vegetables. Livestock is an important adjunct. Vegetables are planted in the cooler months of September-December; however, the primary planting period falls during the first half of the year. Farmers utilize fallow to regenerate crop land when they can afford to take land out of production. Periods of fallow commonly last one to three years. When feasible, upland farmers supplement standard house and field gardens with irrigable lowland gardens to produce rice, corn, beans and vegetables. Lowlanders seek upland plots for pasture, manioc, pigeon peas, sorghum and corn.

Large quantities of wood and charcoal are produced higher up in the mountains around Maniche. Wood resources in Ste. Hélène have become scarce. Local farmers sometimes purchase firewood or even charcoal for their own use. Retail of firewood is a low status occupation of poor farmers, usually women. People of Ste. Hélène make charcoal as a slack season occupation, especially during the cash scarce months of September and February. Farmers in nearby Madlenn report having ceased the purchase of firewood since planting AOP trees.

Interviews at inventory sites reported no sale of lumber or construction poles, but there have been high levels of charcoal sales. AOP wood has frequently been sold as firewood. Study sites have sustained an appreciable harvest of poles and beams for autoconsumption. Study sites showed farmer preference for densely spaced woodlots, some with three or four harvest rotations since 1982 - usually for multiple end uses but always including considerable charcoal production. Farm sites inventoried appear to have more AOP than non-AOP wood resources. Tree plantations are closely tied into grazing, including cut-and-carry of *lisina* branches and sprouts. One farmer had intended to save AOP trees for high value wood products, but instead has managed his tree plot for charcoal, fodder and pasture. This farmer generally uses rather than sells his AOP charcoal, and depends heavily on livestock rather than charcoal to generate cash during cash-scarce periods.

The three study sites in this area are located in the foothills above the Cayes plain along the road to Maniche. The area receives an annual rainfall over 2,000 mm and erosion is severe on exposed slopes. Erosion is exacerbated by high amounts of runoff originating from the wetter Maniche area and causing massive gully erosion. The Subtropical Moist Forest is dominated by ***mango, fwènn*** **(*S. glauca*)** and to a lesser extent ***bwa ple*** **(*C. arborescens*), *kampèsh, bwa dòm*** **(*Guazuma ulmifolia*)** and ***mombin bata*** **(*Trichilia hirta*)**. The soil is derived from limestone parent material and tends to range from black to yellowish brown, gravelly and shallow (due to the extensive erosion characteristic of the area). A summary of the study sites in the Ste. Hélène area are provided in **Table 2.9.**

Table 2.9. Summary of study sites in the Ste. Hélène area south of Maniche. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
39	Melisan	5/1982	265	90	38	0.63	250	CASI, AZIN; double border row 5m x 5m.
40	Cassis	3/1983	185	204	67	0.07	150	LELE; block 1.5m x 3m.
41	Mas Suzanne	8/1983	160	267	57	0.17	150	CASI, AZIN, EUCA; border 2.2m in-row.

Grenier La Montagne

PADF established a subproject with the Parish of Laboule which began tree distribution in the fall season of 1982. Between 1982 and the spring season of 1985, the project distributed 87,000 trees to 195 households.

Grenier is a steeply sloped, high elevation peasant community located across the Betran ravine from the suburban mountain community of Thomassin. Since 1970 vegetable production has supplanted coffee as the primary cash crop. The area has three principal planting seasons for intensively farmed vegetable crops requiring expensive labor and capital inputs. Primary vegetable crops are potatoes, carrots, cabbages, onions, tomatoes, beets and leeks. Corn, beans, yams, plantains, sweet potatoes and sorghum remain important as traditional crops. People tend to rely on grain, beans and sweet potatoes for domestic consumption rather than for sale. The fallow cycle is variable but tends to be short - one year of production followed by a year in fallow.

Reported harvest of AOP trees is entirely for construction including saw lumber, beams and postwood. Individual trees are frequently sold as standing stock. No informants reported making or selling charcoal. Farmers noted high demand for *ranm*, stakes used to support vegetable and vine crops. Except for house-and-yard groves, all informants planted their trees on garden borders to safeguard scarce garden space for intensive vegetable production. Border plantings of *kaliptis* and *grevilya* (*Grevillea robusta*) have become prized for their prolific production of stakes. Farmers commonly use three or four hundred stakes, each five to six feet long, for every garden with staked plants.

Jean-Paul Polinice had originally established a densely spaced woodlot in a sharply sloped field garden along the primary footpath leading into the community. His intentions changed from construction wood and soil conservation goals when he lost heavily to thieves and uncontrolled harvest by passersby. In response, he clearcut the woodlot, protected the live stumps, reestablished annual crops, and initiated annual harvest of coppiced stems as stakes to support his yams, tomatoes, vine beans.

Farmers in Grenier have also used project species as overstory for coffee groves, replacing traditional shade species such as *sikren* with *grevilya*. Farmer Polinice had an old coffee grove in his house garden. Shade trees and coffee bushes had died, coffee production had diminished, the grove had retracted in size. The farmer rejuvenated and expanded his coffee by planting AOP *grevilya, chènn, roujiòl* (*C. arborescens*), and *sèd* as overstory. He transplanted coffee wildings and further extended the coffee grove as a perennial garden by adding plantains. He added project trees at the edge of the grove and planted yams and other vine crops to take advantage of the trees as climbing poles. The expanded grove developed additional shade cover for livestock tied near the house. AOP species have now largely replaced traditional tree species in this house garden. The planter indicated that he periodically harvests trees from his yard for construction, both polewood and saw wood, and replants what he harvests.

This region is due south of Port-au-Prince on the northern exposure of Montagne Noire, part of the La Selle mountain range. Grenier ranges in elevation from 800 to 1,400 meters, and has an average annual rainfall of 1,800 mm. The terrain is steep with gardens typically on 50-70% slopes, draining into the Rivière Froide that separates the community from La Boule (between Petionville and Kenscoff). The higher annual rainfall supports the Subtropical Lower Montane Moist Forest with *bwa pen* (*Pinus occidentalis*) associated with the drier slopes and ridges and a mix of timber and fruit species (*sèd, sikren, roujiòl, zaboka, banann, sitwis*) associated with coffee groves. A summary of the five study sites selected in this area is provided in **Table 2.10**.

Table 2.10. Summary of study sites in the Grenier area of Montagne Noire. * = Estimated number planted. The AOP species codes are given in Appendix 2.

Site No.	Locality	Plant Date	Elevation (m)	Aspect (°)	Slope (%)	Stand Area (ha)	No. of Trees Planted	Tree Species & Stand Configuration
20	Bois Neuf	5/1986	1,000	90	15	0.15	150	GRRO, COAR, CALO, CEEOD; border 1m in-row.
21a	Grenier	5/1982	890	340	12	0.14	250*	GRRO, COAR, CALO, CEOD; dispersed 2.4m x 2.4m.
21b	Genier	5/1982	870	347	53	0.25	250*	EUCA, CALO, CAGL, COAR; border 2m in-row.
22	Anba Lakou	5/1984	870	308	13	0.29	385*	GRRO, CEOD, PIOC, COAR; border 1.5m in-row.
42	Turin	9/1982	820	228	33	0.23	150	GRRO, CALO, CAGL, CEOD; border 3m in-row.

CHAPTER 3

TREES AND LAND USE DECISION MAKING

This chapter views project trees through the filter of farmer decisions regarding land use. The plot is the unit of analysis rather then the trees *per se*. This helps to establish a sense of context for tree planting, sheds light on impact, and generates an understanding of distinct strategies used by farmers when planting and managing trees on their land.

Site Selection

Current post-harvest interviews with tree planters confirm findings of village studies undertaken in the mid1980s. When planting project trees, farmers first eliminated some plots on the basis of high risk land and labor arrangements. They were much more likely to plant trees on plots held with a reasonable degree of security, and on plots which they managed directly rather than rented out or turned over to sharecroppers. Secondly, they used other important criteria for tree site selection: proximity, overall cropping needs, relative fertility, long term goals for the plot, grazing and fire control, level of existing tree cover.

Informants in this study have strongly reiterated the importance of tree proximity to residence and the need for surveillance due to problems of grazing, theft and uncontrolled harvest. Grazing damage has had impact on initial stages of seedling establishment as well as later stages of natural regeneration. The grazing problem is species sensitive. It is also affected by tree proximity to footpaths and local traffic patterns.

In some cases farmers established densely spaced woodlots with long term production goals, but subsequently clearcut these sites and returned to annual gardening. The farmers attributed these site management changes to theft and their inability to assure adequate surveillance. It is evident from interviews and plot inventories that a considerable portion of tree harvest - perhaps a third or more by volume - has been uncontrolled and not monitored by tree owners. These problems are most notable in field gardens located at some distance from planter residence, but farmers also report theft of project trees from house gardens and other nearby tree sites.

Overall, there is a 46 percent gap between site inventory data on stem cutting, and interview data on tree harvest (see **Appendix 4, Table IV**). Some of this is due to underreporting of harvest data, especially for autoconsumption or gifts to others. Interviewees tended to be more precise about harvest for sale than for consumption, and recent rather than earlier tree harvest. This factor is complicated by the fact that tree harvest is not always monitored directly by the tree owner. Planters have commonly authorized limited cutting by friends and family members. In sum, tree site analysis points to significant losses due to theft and uncontrolled harvest. This has precipitated land use changes on sites more vulnerable to uncontrolled grazing and harvest.

On the positive side, uncontrolled tree harvest is bad for the farmer but good for the local wood economy. Trees have value and continue to be in short supply. Nevertheless, uncontrolled harvest reflects traditional views of wood resources as a free common good mined for individual benefit. Presumably, there would be less of this type of loss if all members of the community had sufficient wood resources on their own land. Tree planters don't generally label as theft the uncontrolled harvest of firewood for household use. They do label as theft the harvest of poles and felling of entire trees. Changes in land use due to loss of control reflect the willingness of farmers to shift strategy and adapt land use to changing needs.

Land Tenure and Tree Tenure

Tree Tenure. Land tenure is pertinent; land ownership is not. The crux of the matter is control over the trees. Control has to do ultimately with the character of personal relationships involved in the tree plot. Many farmers have planted trees on legally insecure sites where their rights of tree tenure were respected. For example, a Grenier farmer planted and harvested trees on land which he has managed since 1965 as *jeran* (unpaid manager with temporary land use rights) for an absentee landlord. Many interviewees have harvested trees planted on legally insecure but socially secure *byen mine,* inheritance land which is jointly owned but informally divided among heirs.

In legally insecure situations, some planters have planted project trees as a maneuver to strengthen claims to land. Interviewees in Desforges and Savane Môle cited this motivation for planting trees on land which they rented from others. Merisain Eldinor, a planter in Krèv, noted that planting trees on a rented plot strengthened his chances for first option to purchase land slated for sale to cover costs of outmigration. Eldinor later made good on his investment by purchasing the land. He has not harvested any of his 10 year old trees which he manages as a store of value reserved for lumber production.

In St. Thon, Jean-Louis Fils gambled on undivided inheritance, the most risky of all land tenure categories, by planting trees on a plot held in common by several heirs. In so doing, he strengthened his rights to claim a favorable site within the plot. Secondly, he anticipated revenue from tree harvest to cover his share of survey costs, land tax and notary fees. Thirdly, he planted trees throughout border areas of the site thereby avoiding controversy over use of the plot by co-heirs. He established the tree garden knowing full well he would lose most of the trees after formal division. By so doing, he was in a position to clearcut the first rotation of trees - even on land falling outside of his share - so long as he harvested before the land was divided. Presumably, by using the trees to build his land tax fund, Jean-Louis was in a favorable position to precipitate formal division at an earlier date than would otherwise be the case. At the time interviewed by the study team, Jean-Louis had cut the trees and was making charcoal at this site. He said he was under no obligation to share the proceeds with his co-heirs.

Sale of Tree Plots. Outright land ownership is essential to activate the option of land sale. The team's recent interviews indicate that alienable plots with tree cover have demonstrated their power to fetch higher prices. There is a lively land market throughout rural Haiti. Land turns over when landowners need large sums of money for life crisis expenditures or major investments. Landowners with current titles may sell to strangers. Land without updated title is readily sold among family members or co-heirs.

This study has elicited nine cases of tree plot sales. One plot was sold when trees were at early stages of growth. The presence of young trees did not appear to affect the sale price although it was not possible to verify conditions of this sale. In a sale noted earlier, a tenant farmer was able to purchase land where he planted trees as a renter. In six other cases, the team interviewed buyers and sellers willing to confirm conditions of sale. These transactions showed tree premiums varying from 43 to 73 percent of the base value of the land. Most sales took place during hard times related to political repression and severe economic pressures of the 1990s.

St. Sauveur, a tree planter in Kay-an-Sek, sold a half *carreau* of land when his project trees were five years old. The seller had harvested some charcoal, construction poles and firewood prior to selling the land. The buyer further enhanced the value of his new tree garden by fencing, mulching, terracing, and planting other perennials. The upper section of the garden produced annual food crops in association with widely spaced trees and border plantings. The lower section was located in a ravine with fairly deep silt due to seasonal runoff and flooding. The new owner harvested very little of his tree crop - six *kasya* for house construction, and firewood for his own use. He terraced the upper slope and continued to grow food crops. He established a perennial garden in the bottom land in association with more densely spaced project trees. He took the bottom land out of annual food production, introduced plantains, sugar cane and fruit trees, and protected wildings of native forest species. The presence of trees on this plot seems to have encouraged the second owner to further invest in the plot - literally transforming land use, increasing production and decreasing environmental degradation.

The study team was impressed by the farmer's use of bottomland trees as a nursery for other species, and the shift from annuals to perennials; however, after investment with long term goals, the buyer suddenly sold the plot in 1993 at twice the price he paid in 1988. The team interviewed both buyer and seller who stated that the price, taking into account tree stock, was 1,600 *gourdes* higher than it would have been without the trees - a markup of 73 percent. According to the informant, his decision to sell was precipitated by threats to his life during a period of local political persecution after the *coup d'état*. To support his family and cover expenses while in hiding, he sold this half *carreau* and another three-quarter *carreau* plot, and rented out three plots including valuable rice land.

This is a good example of changed tree harvest goals. It was this farmer's original intention to retain the land permanently - reserving the tree for long term high value products. Instead, he sold the tree plot for short term gain - to generate emergency cash during a life crisis situation.

Garden Types

Haitian peasant farms are almost invariably composed of several discrete plots of land. This land portfolio is divided between garden sites directly worked by the farmer, and other sites left unworked or farmed by others. Aside from the variable *tenure status* of each plot in a portfolio, farmers distinguish different types of gardens defined by *land use*. Tree site management strategies vary in patterned ways according to these categories. Studies at Salagnac outline a useful typology of land use in mountainous areas of the southern peninsula (Bellande and Paul, 1994). This typology is not all encompassing, but the basic approach is pertinent. The team has adopted a similar categorization of garden types to its tree observations in all regions studied.

Table 3.1 summarizes tree sites according to four types of garden. The team sought to achieve a balance between field sites and other sites closer to home. Interviewees often suggested visiting tree sites near their homes. The team broadened the sample by asking to see field plots as well as nearby gardens in order to assure a representative sample and more variation in site management strategies. The tree sites fall fairly evenly between sites close to the house - *house gardens* and *adjacent gardens,* and sites somewhat further afield. *Humid perennial gardens* are located both nearby and at a distance. In addition to garden types enumerated in **Table 3.1,** interviewees mentioned other specialized garden types where they have generally not planted project trees. These include more distant sites devoted exclusively to grazing (e.g., *kadas* in the northwest), rice paddies (St. Michel and Ste. Hélène), and densely spaced stands of sisal (Bainet and Fond-des-Blancs).

Table 3.1. Percent of tree sites by garden types.

Garden Type	No. of Gardens	Percent
House	18	22
Adjacent	17	20
Field	35	42
Humid Perennials	13	16
Total	83	100

House Gardens. This refers to production within the immediate proximity of the *lakou* (house-and-yard compound). This type of garden is sometimes called a *jaden devan pot kay* (garden by the house door). The house garden is generally characterized by secure tenure, a mix of annuals and perennials, vine and vegetable crops, fruit trees and hardwoods. It is usually wooded, providing shade for people, livestock and shade tolerant cultigens. Clusters of trees on the agricultural landscape almost invariably signal the presence of a current or former house site. In coffee zones, the house garden includes a coffee grove with shade overstory.

The house garden is fertilized by compost created by food preparation, animal dung and residues of cut-and-carry fodder imported from other plots. In areas where field gardens are periodically left in fallow, farmers crop house gardens continuously due to the ready availability of *krem* (literally "cream"), i.e., compost. Farmers rotate kitchen sites within the yard to spread around microsite benefits of kitchen compost. One informant in his 50s reported building at least 12 kitchens, and another at least 15 kitchens over the years.

The relative frequency with which farmers construct kitchens and other simple structures creates a demand for low grade polewood in house-and-yard compounds. In some areas farmers build separate *kolombye* (granaries), and *jenn kay* (small houses) - less substantial structures used for cooking or storage. Such structures need to be repaired and rebuilt from time to time. Informants frequently mentioned the importance of having polewood available for *tonèl*, rustic shelters for guests sitting in the yard during weddings, wakes, funerals and other family ceremonials. Farmers prefer to supply such poles, sometimes on a moment's notice, from their own nearby wood resources.

Farmers frequently planted project trees in house gardens. A fifth of the study's tree site visits were *lakou* plantings. In Grenier, project trees have been used to supplant traditional overstory species in coffee groves. At some sites house plantings have been an important source of lumber, beams and high quality polewood. *Nim* (*Azadirachta indica*) and *kaliptis* in house gardens have served as important sources of fever and cold remedies. The team noted that house plantations were never clearcut. Interviewees cited the aesthetic value of densely spaced trees as trademarks of house gardens. Trees have tended to be harvested individually as needed thereby retaining the overall effect of dense spacing and ample shade. Some 17 percent of farmers reported virtually no harvest from their tree gardens - referring in most cases to house gardens. Farmers have repeatedly stated their desire to leave a stand of trees for their children. Tree planters have anticipated future house placement sites - flat shaded areas - by expanding the tree cover around their compounds. They have also planted trees to create windbreaks around their residential compounds on windy hilltops and flanks.

Adjacent Gardens. *Jaden prè kay* - gardens adjoining the residence - account for another fifth of tree sites visited in this study. These gardens are generally within view of the house but distinctly separate from the shade cover and dense foliage of house gardens. *Adjacent gardens* are intensively farmed for annual food crops. They have little or no tree cover. These gardens tend to surround the house garden and its trees. Due to their proximity to shady house gardens, adjacent gardens are protected from the full sweep of winds and moisture loss.

Project trees are commonly planted around the borders of adjacent gardens. Trees within the garden are widely spaced to allow continued use for annual food crops. In some cases, farmers have planted project trees near coffee groves, thereby expanding tree cover into adjacent gardens. In these cases, farmers have introduced other shade tolerant perennials such as plantains. The team noted a striking feature of tree plantings in adjacent gardens - their active use as nursery sites for wildings including native and project species. Some project species regenerate young seedlings which take root within cultivated areas of the garden. Farmers often select and protect such seedlings. In addition, wildings from native species take root within border plantings. Farmers protect such seedlings - actively propagating fruit and forest species within border niches established with project trees.

In Chomey, farmer Resèvè Michel lost his border trees to Hurricane Flora (1963) in his *adjacent garden*. When he planted AOP trees in 1982, his garden border was occupied solely by a row of sisal. He removed most of the sisal and introduced project trees. Subsequently, he enriched this border niche with *fwènn (S. glauca), kapab, palmis, kajou, sitwon (Citron aurantifolia), zamann (Terminalia catappa), kokoye*, and *vètivè (Vitiveria zizanioides)* - all traditional species. He replanted where seedlings did not survive, and he exported natural regeneration into other tree plots. He intends to retain trees in his garden border on a permanent basis, reserving them for lumber, polewood and some charcoal as needed. He does not intend to clearcut his border at any point. In this and other similar cases, farmers have effectively managed border plantings for species diversity, occasional harvest, and maximum tree growth.

In heavy charcoal producing areas with long fallow cycles, adjacent garden sites may be used as charcoal gardens. This practice retains space to grow annual food crops by clearcutting for charcoal, planting a cycle of food crops, then leaving the site in fallow. This strategy makes effective use of the trees for enriched fallow. Cropping cycles are rotated among several subplots within the tree plantation site. A good example of this is the adjacent garden of Lezias Asmat at Bwa Nef in the mountains above Ste. Hélène. Lezias actively replants *kasya* wildings to extend his garden. At the time of the team's visit, Lezias was on his fourth rotation of tree and coppice harvest with charcoal as his primary product.

In some cases, land has been taken out of adjacent gardens for permanent woodlots. This is somewhat unusual as it reduces space for annual food crops. Orialus Bernard, a farmer in Morne-Franck, cropped his adjacent garden annually for 38 years, then turned the site into a permanent, densely spaced woodlot when he was 63 years old. At this stage in his life, he chose to reduce his labor requirements on a degraded site with reduced potential for food production. In the same community, Osevyo Fanfil took a small portion of adjoining land out of food production to plant a permanent woodlot. His motivation was to make more productive use of a rocky, degraded site, to anticipate eventual construction of a new house site under the trees, and to build a windbreak on his windswept hilltop.

Field Gardens. Field sites are located at some distance from the residence - perhaps only a few minutes walk but generally not more than 30 minutes or so. It is more difficult to assure close surveillance of field gardens. These gardens are more likely than others to be rented out or sharecropped. In more intensive farming areas, field gardens tend to have few or no trees. In areas with long fallow cycles, field gardens are allowed to develop forest cover.

Field gardens made up 42 percent of sites visited by the study team. The team found more varied land use strategies in field gardens than other major garden types. Field gardens contained most study sites managed for charcoal production, enriched fallow, and permanent woodlots. Field sites commonly had border plantings and scattered trees interspersed with annual food crops. Farmers often combined border plantings and food crops with a small woodlot on the same site.

In Bainet, Augustin Cyriaque devoted roughly a fourth of his field garden, the steepest portion, to a densely spaced woodlot. The bulk of the garden continued to be farmed by a sharecropper who cultivated annual food crops. By planting his trees separately as a woodlot, Augustin sought to avoid mortality due to the sharecropper's lack of vested interest in the trees. He noted that the sharecropper benefited from dispersal of naturally regenerated *lisina* as grazing material during slack periods of the agricultural cycle. Augustin's wife observed that they derived greater income from the woodlot (charcoal and polewood) than from their share of the food crops from this plot. Augustin noted that he could have generated better income from the agricultural portion of the site had he farmed it directly rather than turning it over to a sharecropper. By turning the garden over to a sharecropper, Augustin was able to maintain a presence on a distant field site, and economize on labor costs. His woodlot also supported these goals.

Availability of project trees has encouraged farmers to restore some tree cover to deforested field gardens. Farmers have frequently mentioned the need for shade. A common configuration combines border plantings, small woodlot, and garden space for food crops. Farmers report that harvest from woodlots can be more profitable than food crops during dry years. Subdividing field plots into portions devoted to trees adjacent to food crops effectively dilutes agricultural risk. This innovation is a notable strategy shift on deforested sites.

The propinquity of woodlot and annual cultivation also has an interactive character. Natural regeneration creeps onto cultivated space during slack periods. Farmers utilize palatable seedlings for grazing. Woodlots and borders are nurseries for AOP and native species which farmers protect or transplant. Farmers are actively using woodlots as sources of fodder and forage.

In a significant number of cases, planters covered over field sites entirely - dropping annual cultivation altogether in favor of densely spaced tree plantations. Farmers in St. Michel and Bainet planted above springs to protect the local water supply. Others opted out of annuals to save management and labor costs during extended periods of absence due to labor migration. In drier zones farmers have incorporated project trees into long term fallow cycles. The enriched fallow strategy has usually been associated with periodic clearcutting for charcoal production. In high mountain regions with steep slopes, a number of farmers turned degraded sites into permanent woodlots with multipurpose harvest goals. Some farmers shifted from one type of perennial to another, e.g., sisal to hardwoods in Fond-des-Blancs.

Humid Perennial Gardens. These are specialized, high density gardens based on mixed perennials such as plantains, coffee, moisture tolerant tubers, e.g., *malanga* (*Xanthosoma sagittifolium*) and shade tolerant species. Production on such sites is adapted to fertile, moist ravines and microcatchment basins. These humid perennial gardens are scattered sites located nearby or at a distance. In some respects gardens in humid bottoms resemble moist, shady house gardens with coffee groves, but they are generally less diverse. They also share characteristics of traditional woodlots, but with greater species diversity including food production goals.

Farmers have made interesting use of AOP trees as the first step in establishing perennial gardens linking hardwoods to sugar cane, plantains, coffee, bamboo, taro, or other shade tolerant species. Sixteen percent of study sites fall into this specialized niche, sometimes a subplot within a larger field garden. The team noted one strategy of planting project trees at the upper edges of existing humid gardens, further extending them, sometimes together with plantains.

Another variant was to establish dense woodlots on the upper reaches of steep slopes abutting ravines, and humid perennial gardens at the bottom. A good example of this was Desten Joseph's steep ravine in Chomey. He took a deforested, highly degraded slope out of corn, sorghum and bean production to plant project trees in 1982. Since then he has ceased planting erosion intensive annuals on this site. Desten created a densely spaced woodlot, protected native mahogany volunteers, and planted fruit trees including *chadek* (*Citrus maxima*), *limon* (*Citrus* sp.), and *mango*. Along bottomlands at the foot of the slope he planted bamboo, plantains, coconuts, sugar cane, and malanga. In Ste. Hélène, Josias Denasty established a woodlot on an eroded, rocky slope abutting a ravine. At the bottom he had sufficient soil depth to produce yams as a vine crop, using project trees as climbing poles.

The team noted a third variant in Kay-an-Sek linking food crops with widely spaced trees on the upper slope, and more closely spaced trees in the bottomland. Several gardens in this area have introduced sugar cane and plantains after planting project trees in the bottoms. These sites shifted rather dramatically from annual food production to mixed perennial gardens on sites subject to runoff during rainy periods.

Tree and Strategy Shifts

The preceding discussion of site selection, tenure issues and garden types clarified key elements of planter decision making. It revealed discrete land use patterns on peasant gardens where trees were planted. In a number of cases, the introduction of trees has had only a limited impact. Some trees thrived for a time but seemed destined to disappear from the local landscape. In many other cases observed, the sudden introduction of large numbers of project trees actively precipitated distinct shifts in plot management.

In general, farmers made decisions which favored tree control and protection. Two informants hired day laborers to plant seedlings rapidly and reduce mortality. Others built fencing around tree sites. The farmers planted on sites with little or no existing tree cover due to intensive production of shade intolerant food crops. Overall, their planting decisions carefully protected primordial food production goals. Their underlying strategy was to maximize flexibility and multiple use of garden sites. **Table 3.2** below summarizes the team's observations of key planting patterns, and strategic shifts in land use.

Table 3.2. Percent of various land use strategies on study sites by subplots and farmers inventoried.

Strategy	Number of Farmers (n=42)	Percent by Farmer	Percent by Subplot (n=63)
Trees and food crops	27	64	43
Enriched borders	16	38	25
Permanent woodlots	15	36	24
Enriched fallows	11	26	17
Charcoal gardens	11	26	17
Mixed perennials	10	24	16

Notes: The team made site inventories with 42 farmers on 43 plots, and land use observations of 63 subplots within inventory plots. Percentages do not add up to 100 due to tree plots with more than one land use category.

Trees and Food Crops. Two-thirds of the farmers continued to cultivate annual food crops on some portion of the sites where they planted trees. These sites, 43 percent of plots and subplots observed, had little or no tree cover when project trees were planted. Land use shifted from food plots with no trees - to food plots with some trees. This strategy was the most widely used on study plots. The strategy was well adapted to land scarce farmers, but it also had the most limited environmental impact on planting sites.

Most such sites incorporated more than one tree planting configuration. In some cases, the trees competed relatively little with annual crops, and the basic vocation of the plot remained unchanged except for newly associated tree cover - a mix of perimeter plantings and scattered trees or a single line of trees across the plot. Trees created shade cover, and produced additional supplies of wood in the nooks and crannies of peasant farms including all major garden types.

Enriched Borders. The use of border plantings was a common feature of land use strategies which incorporated trees on annual food production sites. Thirty-eight percent of the farmers planted trees at the edge of their inventory plots. Such plantings have often proved to be highly productive. By planting on the perimeter, a relatively large number of trees can be incorporated onto a garden site with minimal disruption of cropping space. In some cases observed, the sudden introduction of large numbers of trees into border niches resulted in impressive shifts in border land use, i.e., from sites devoid of trees - to sites with a diverse mix of exotic and native species.

This strategy builds upon old agroforestry systems of border management in rural Haiti including live fence and boundary markers. In fact, the team did not observe project trees used as *bonn* (boundary markers). This is not surprising since live boundary markers are intended to be permanent rather than harvestable plantings. In some cases trees were incorporated into existing live fence material such as *kandelab* (*Euphorbia lactea*), *piyong* (*Gliricidia sepium*), *pengwen* (*Bromelia pinguin*), *bayonèt* (*Yucca aloifolia*), *bresiyèt* (*Comocladia* spp.), *pit* (*Agave sisalana*), and *vètivè*. In other cases, the trees were carefully planted a half meter or so within the plot rather than on the plot line *per se* in order to safeguard tree ownership. In either case, perimeter tree lines served as visually impressive markers which conspicuously outlined garden perimeters. Visual markers are an important element in boundary maintenance.

Border plantings in Grenier were pruned regularly as sources of stakes. Some interviewees noted the shade and windbreak advantages of border plantings. The most unexpected feature of border planting was its use as a nursery site for natural regeneration of native species as well as project species. In several impressive cases, the introduction of project trees precipitated farmer initiative to diversify the species mix by transplanting and protecting wildings.

Woodlots. Over a third of inventoried sites demonstrated a remarkable shift from erosion intensive food crops to permanent, densely spaced woodlots. This strategy has the greatest potential for environmental benefits to peasant farms. Maximum impact is attained when farmers allow woodlots to create a dense ground cover through natural regeneration. The key constraint to wider environmental impact is the dispersal and small size of woodlots. Where farmers established woodlots, densely spaced plantings usually covered only a portion of inventoried plots. Furthermore, woodlots observed by the team were not always on the steepest available slopes. Some planters chose less degraded sites for their woodlots in order to maximize tree growth.

As with border plantings, woodlots have frequently served as nurseries for natural regeneration of exotic and native species. Establishment of woodlots has almost invariably precipitated farmer efforts to protect or transplant native tree and shrub species. Farmer goals vary, but they frequently cite the importance of woodlots as a *rezèv*, a store of value to be cut in an emergency, and to leave behind as an inheritance for the next generation. They have established woodlots for construction needs and house sites. Stated harvest preference has generally been long term, high value beams and boards. In contrast, actual practice has more often been to manage for multiple purposes including remedies, firewood, poles, masts, beams, lumber and charcoal. In some cases, farmers have clear cut entire woodlots to meet pressing needs. Some woodlots have been managed for repeated charcoal harvest based on selected cutting. Woodlots have also been supplied livestock needs including forage, fodder and shade.

Enriched Fallows. One fourth of the farmers used trees for enhanced management of fallow. Farmers chose to plant trees on sites which they planned to leave in long term fallow - 5 to 10 years - followed by clearcutting, charcoal production, cultivation of food crops - especially sorghum and manioc, and grazing. The team observed this strategy primarily in drier regions with long fallow cycles. In these areas farmers rotated cultivation of food crops among subplots within larger blocks of land. These sites were strongly linked to grazing as an adjunct to semi-arid, extensive agricultural strategies. *Lisina* has been much appreciated in drier areas, and has played an important role in ground cover and forage on these sites.

The enhanced fallow strategy links semi-arid agriculture, grazing, charcoal, long slack seasons and lengthy cycles of fallow. This tree planting strategy mimics and somewhat speeds up natural rhythms of reforestation. On dry sites with enriched fallow, AOP species appeared to supplement wood productivity, and in most cases, made the sites more productive than with native species alone. Harvest of these temporary woodlots tended to favor charcoal production. Some farmers made good use of fallow woodlots as nursery sources for transplanting wildings. During the period of cultivation following wood harvest, farmers managed coppice for poles rather than charcoal.

Charcoal Gardens. Most enriched fallow sites could also be categorized as charcoal gardens harvested by clearcutting. The team observed a second variant on charcoal gardening which was not based on periodic clearcutting. Some farmers used permanent woodlots as charcoal gardens harvested by selective cutting. In these cases, charcoal was harvested annually or biannually as a cash crop in a product mix including construction poles used primarily for domestic consumption. Farmers selected out trees with superior form for construction, and inferior trees and stems for charcoal. The team observed some sites with trees on their fourth rotation in such gardens. Some charcoal gardens show distinct shifts in land use after initial establishment. Farmers may have originally planted for the long term, but subsequently initiated charcoal harvests in response to crop failure and hard times. Others established *lisina* hedgerows for conservation, left sites in fallow, and ceased pruning hedgerows in order to maximize harvest for charcoal.

Mixed Perennial Gardens. Mixed perennial gardens correlate neatly with the *humid perennial garden* described earlier as a specialized peasant garden in moist bottomlands. One fourth of the farmers planted project trees on sites appropriate for mixed perennial gardens. The planting of large numbers of project trees on these sites precipitated a shift out of erosion intensive annual crops. The mixed perennial garden is an environmentally beneficial land use strategy which retains considerable short and medium term production values for farmers, e.g., sugar cane, plantains, coffee, cacao, taro, yams and other shade tolerant tuber and vine crops.

In some cases, the mixed perennial garden developed as a bottomland outgrowth of densely spaced woodlots on drier soils higher up the slope of ravines. In other cases, project trees were planted to extend the borders of existing *humid perennial gardens*. In one case, a farmer shifted his site out of sisal monoculture into a densely spaced woodlot combined with border remnants of the sisal garden. This farmer felt that sisal was potentially more remunerative, but more difficult than charcoal trees due to the onerous labor requirements to transform raw material into revenue, i.e., sisal into marketable fibers versus wood into charcoal. He transformed sisal into trees because it was easier to recruit charcoal workers than sisal workers. These cases illustrate the ability of farmers to make sophisticated adjustments in their decisions about land use.

CHAPTER 4
TREE PLOT ANALYSIS

Tree Inventory

An inventory was conducted of all standing and harvested trees on 43 sites, representing 42 farmers and approximately 8.6 ha of stand area. The tree sites averaged 12.3 years old, with the oldest sites established during the first season of AOP tree distribution (Spring, 1982) and the youngest site planted in the Spring, 1986. An overall survival of 35% was achieved. A third of the surviving trees planted during the AOP are still standing, representing 14 species and 1,385 trees. Two-thirds of the trees have been harvested, representing 14 species and totaling 2,859 trees. Together, the original AOP trees have yielded about 26.3 metric tons (mt) of wood ha^{-1}, equivalent to a productivity of 2.14 mt ha^{-1} yr^{-1}. Coppice production is significant, comprising 4,617 standing and 3,819 harvested stems. This is roughly equivalent to 5.6 mt ha^{-1} of additional wood production since harvesting began. A second generation of volunteer trees, mostly from 5 species, is beginning to enter the harvest cycles and has produced half the wood yield of the coppice stands (3 mt ha^{-1}). Total tree inventory on the 43 sites is summarized in **Appendix 3, Tables I - III,** for tree and stem tallies, basal area (m^2) and estimated wood yields (mt), respectively.

Survival

Survival is the first step in assessing the adaptability of a tree. It is also important in determining program efficiency, as the centralized nursery production of seedlings is relatively expensive. If any tree planting project is to have a lasting impact, trees must survive in sufficient numbers and reproduce. Though survival was not monitored on the study sites over the 10-13 year period, estimates of survival rates at the time of the first harvest were possible for over two-thirds of the sites (**Appendix 3, Table IV**). It was not possible to calculate survival on a third of the sites for a combination of the following reasons:

1) the original tree planter could not recall accurately the number of trees planted;

2) too many stumps were removed or decayed for an accurate assessment;

3) the farmer did not plant all his trees at the study site.

In several cases, the farmer could recall the actual number of each species that was planted. Thus, it was possible to further break down site survivals to the species level, as summarized in **Table 4.1**. The significance of the species survival rates should be carefully interpreted given the small sample sizes. It makes sense that *L. leucocephala* is the highest surviving species. The rates for the other species generally fall within the ranges of past AOP studies (i.e., Bannister, 1990).

Table 4.1. Survival [at time of first harvest] by species compared to overall site survival.

Species	Site Estimates	*Total Sites Planted*	Number Planted	Number Survived	Survival (%)
Senna siamea	9	25	1,585	519	33
Leucaena leucocephala	7	22	1,125	758	67
Casuarina equisetifolia	4	15	825	309	37
Eucalyptus camaldulensis	5	13	475	168	35
Cedrela odorata	3	7	300	36	12
Colubrina arborescens	3	10	200	105	53
Catalpa longissima	3	12	150	47	31
Azadirachta indica	2	8	175	22	13
Grevillea robusta	2	5	125	51	41
Casuarina glauca	2	4	75	44	59
Albizia saman	1	1	175	11	6
Acacia auriculiformis	1	1	40	17	43
Total Site Survival	32	43	9,070	3,181	35

The overall survival rate of the gardens is estimated at 35%. This is likely an underestimate of the true survival, especially on the sites that were harvested earlier with a higher probability of missing an exact stump count. In any case, it should be lower than the 12 month survival statistics reported by PADF and CARE, even if the most significant drop in survival occurs during the first year. A comparison of the survival rates in this study with those provided by PADF and CARE (**Table 4.2**) suggests that a similar population of sites is being sampled. It should be noted that the period between 1982-1986, when most of the trees in this study were planted, suffered higher mortality than the later years.

Table 4.2. Delivery and early survival of CARE and PADF tree seedlings during 1982-1991.

	SEEDLINGS (x 000)										
CARE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
Nursery Production	403	1,312	1,337	1,641	1,610	1,737	2,460	2,445	2,223	2,297	17,464
Seedlings Delivered[1]	334	1,467[2]	1,110	1,362	1,336	1,442	2,042	2,029	1,845	1,907	14,874
6 Month Survival (%)	50	52	40	60	73	57	61	65		Avg.	57
12 Month Survival (%)			32	56						Avg.	44
PADF											
Seedlings Delivered	1,911	3,405	4,648	5,368	4,547	5,034	6,607	6,932	6,219	3,531	48,202
12 Month Survival (%)			32	41	42	43	50	52		Avg.	43

[1] The number of seedlings delivered to farmers was estimated as 83% of the CARE nursery production, as reported by CARE in 1985 (78%), 1986 (82%) and 1990 (89%). [2] An additional 378,209 seedlings produced by ODH were distributed to farmers.

Campbell (1994) estimated survival rates in the Lascahobas area (PADF Region 5) for seedlings delivered to farmers between 1984-1988. A rate of 13% was estimated for all species assumed to be between 4-8 years old. The highest survival rate was calculated for *S. siamea* (27%) and the lowest for *C. odorata* (1.8%). Survival estimates were not based on numbers planted by each farmer, but by seedling production of a central nursery and average numbers delivered to farmers.

Standing Trees

The most important species standing as an original tree is *S. siamea*, both in terms of trees, basal area (cross sectional area of the stem) and average wood yield per tree. The species makes up nearly a third of the original trees left standing, 40% of the basal area and over half of the standing wood yield. More farmers (26) planted this species than any other, increasing its importance in areal coverage. The average tree has an estimated standing wood weight of 70.4 kg, the highest value for any of the species. It is being managed for lumber, charcoal, shade and aesthetics.

L. leucocephala subsp. *glabrata*, a tree that was also widely distributed during the AOP, does not make up a great share of the trees (7%) and what is being managed is much smaller than *S. siamea* (23.1 kg $tree^{-1}$). Other important species are *C. equisetifolia* (42.8 kg $tree^{-1}$), *C. glauca* (54.6 kg $tree^{-1}$) and *E. camaldulensis* (45.1 kg $tree^{-1}$). These species are being kept in the ground for house beams and small lumber. *C. equisetifolia* is especially important, since it was planted in large numbers and the farmers are managing 85% of their trees for a rotation greater than 10 years. *C. longissima*, *G. robusta* and *C. odorata* are being managed for high value lumber. The impressive growth of *G. robusta* is allowing farmers in the higher elevation regions to significantly shorten the rotation age for lumber. This species has a lower proportion of trees standing compared with the native provenances of *C. longissima* and *C. odorata* lumber species. However, farmers are beginning to harvest the faster growing provenances of *C. odorata* for lumber at 6 years of age. The demand for both species is expected to be high enough to warrant the establishment of regional seed orchards.

Harvested Trees

More AOP trees were harvested than left standing for all species except *C. equisetifolia*, *C. longissima*, *C. odorata*, and *G. robusta*. These species are being managed for high-value beam and lumber products. The most important tree harvested up to the present time is *S. siamea*, representing nearly half the basal area (=23 m^2) of all species harvested. The average tree harvested has a wood yield of 62.3 kg, the highest value for any of the species. However, in terms of harvested trees and total yield, *L. leucocephala* exceeds *S. siamea*, contributing 47% of the trees harvested and 44% of the wood yield. This reflects the farmers' desire to harvest *L. leucocephala* on a shorter rotation, while leaving *S. siamea* in the ground for longer time periods. *L. leucocephala* is used more frequently for medium-sized post and pole needs, makes a better charcoal earlier in its rotation, and is cut sooner in response to the farmers' need to minimize weed problems or eliminate it from the site for annual monocultures. *S. siamea* is not considered a suitable construction post and farmers generally skip this harvest in favor of lumber. However, in times of financial crisis, it is not unusual for the farmer to fell a large tree for charcoal. Together, these two species represent 84 % of the wood volume harvested to date. Most of the wood has been used for charcoal production.

A large share of *E. camaldulensis* (71%) has been harvested, mostly for a combination of joists, beams and charcoal, but also for lumber. Of the fast-growing species distributed by the AOP, it best combines broad adaptability with good form. This combination has made, and continues to have, an economic impact on farmers, particularly in the Northwest. What will happen after the current stands are exhausted should be a continuing concern of PLUS.

C. arborescens has been heavily harvested for its main product - cross beams and joists. About three fourths of the trees have been cut, mostly high-graded, with the best-formed and fastest growing individuals being harvested. The long-term effects of such practices on genetic quality should continue to be a focus of PLUS and their efforts to support farmers in managing tree germplasm. On several highland sites, poorly adapted lowland varieties of this species were not being eliminated and replaced, even after a decade of poor form and growth. This suggests a reluctance by farmers to make critical decisions toward more efficient tree management. It further illustrates the dangers of distributing seedlings from centralized nurseries without regard for proper provenance selection.

Coppice

Coppice production is a natural mode of regeneration of tree species that have evolved under stressed environments, particularly prone to drought and fire. This trait allows farmers to manage wood production over lengthy periods of time, thereby significantly increasing the impact of AOP trees. This is critical in the drier regions of Haiti, where erratic rainfall and drought patterns limit regeneration from seed. Furthermore, the coppice vigor of several exotic species has been selected over centuries of domesticated use, as in the case of *L. leucocephala* ssp. *glabrata* from southern Mexico (Hughes, 1994). This has allowed the AOP to enjoy advantages of a genetic base that is both productive and responds favorably to management.

Nine species in this study are coppicing, though the number of coppicing species distributed by the AOP is probably much greater. **Table 4.3** shows the mean wood weights and ratios of coppice stems:stumps for both current and harvested production. These ratios are based on the total number of stumps and show that at least 4 species (*A. indica, S. siamea, L. leucocephala, E. camaldulensis*) have replaced themselves several times in terms of stem numbers. When considering only those stumps that are currently in production, the ratios are higher. Farmers have harvested as many as 4 coppice rotations on the most productive sites, though the norm is to closer to 1-2 rotations.

Total coppice production is still below yields of the first harvest for wood production. *A. indica* and *E. camaldulensis* are the most productive species, yielding 77% and 63% respectively, of the wood produced during the first rotation. *L. leucocephala* ranks third, with coppice wood production 58% that of the first harvest. Farmers have tended to eliminate *L. leucocephala* from their sites field garden sites more than any other coppicing species, resulting in much lower coppice yields than is possible.

The coppice that is being harvested for charcoal is generally clearcut; otherwise, the stems are selectively cut depending on the farmer's needs. The largest stems on each stump are not necessarily cut first. Many farmers are managing a single coppice stem for beams and lumber. This is a natural choice for several species, as farmers have noted the superior growth and form of a selected coppice stem. The most vigorous stems originate near the root collar of the original tree.

The continuing decline in coppice production, as reflected by the decrease in average stem weights in Table 4.3, should be a concern as the stumps decline in vigor and wood harvest exceeds a sustainable rate of ingrowth (i.e, when trees are first considered harvestable). There is a continuing need to develop a sustained yield strategy by species, region and garden type. Farmers who have benefited considerably from their coppice harvests appear willing to make additional investments in wood production and are likely candidates for training in improved silvicultural methods.

Table 4.3. Ratios of coppice stems:stumps for major AOP species in this study. Mean wood weights (kg) per coppice stem are shown in parentheses.

Species	Standing Coppice	Harvested Coppice
Nim (*Azadirachta indica*)	4.25 (2.2)	1.3 (4.9)
Kasya (*Senna siamea*)	1.63 (3.8)	1.51 (11.8)
Lisina (*L. leucocephala* ssp. *glabrata*)	1.58 (2.3)	1.35 (4.2)
Eucalyptus (*E. camaldulensis*)	1.06 (3.3)	1.00 (11.1)
Kaliptis (*C. glauca*)	0.43 (3.9)	0.17 (5.5)
Kapab (*Colubrina arborescens*)	0.3 (2.3)	0.06 (15.9)
Sèd (*Cedrela odorata*)	0.52 (na)	
Chènn (*Catalpa longissima*)	0.38 (3.8)	
Grevilya (*Grevillea robusta*)	0.27 (na)	

Natural Regeneration

The ability of a species to regenerate is fundamental to its survival. As basic as this sounds, natural regeneration is often overlooked as an important factor in the lasting impacts of a tree planting program such as the AOP. Regeneration from seed is by far the most important source of seedlings for the small farmer. As long as a species can regenerate, the farmer is given multiple opportunities to undertake tree management. If the species regenerates poorly, this is hardly possible unless seedlings are supplied by a nursery. Furthermore, the speed at which a species regenerates, particularly under exploitative pressures, is an important attribute for temporal and spatial rotation of gardens and contributes toward environmentally sound agroforestry systems. What is regarded by the farmer as a weedy nuisance (e.g., *Leucaena*) may in fact be part of the long-term solution for soil conservation and habitat restoration.

The amount of natural regeneration varied considerably by species and garden type. Trees differ significantly in their reproductive strategies, varying in factors such as seed bearing age, primary dispersal agents, seed crop quantities and periodicity. While most of the species, especially the prolific pioneers, had yielded several seed crops, others had not yet flowered, such as *Cedrela odorata, Pinus occidentalis* and *Simarouba berteroana.* While the latter species is known to fruit at an age of 3 years on fertile sites, the only trees observed in this study were on poor sites. Several other wood species planted by the AOP fall into the same class of the later maturing species, including most of the higher value timber species. Volunteers of many later maturing species were tallied on AOP sites, though they did not originate from AOP trees.

E. camaldulensis and *C. equisetifolia* had yielded several cycles of seed crops on most sites, but failed to show any signs of natural regeneration. It is safe to assume that the seed of these species from project trees is fertile, since seed crops from stands of similar age have been collected in other regions of Haiti. Rather than a problem of seed viability, it appears that site conditions are not favorable for germination and the seed crops are preyed heavily by insects after fruiting. While *E. camaldulensis* regenerates well by basal sprouts and coppice shoots, *C. equisetifolia* does so poorly. *C. glauca,* while closely resembling *C. equisetifolia,* has never been observed to bear seed in Haiti, though it regenerates as root suckers that supplement the basal sprouts and coppice production on favorable sites.

Among the project species that are naturally regenerating by seed are: (a) species that seed regularly, but whose volunteers are widely scattered outside the stand area (*C. longissima*); (b) species with a light and highly variable amount of regeneration within and outside the stand area (*Acacia auriculiformis, A. indica, G. robusta, S. mahagoni*); (c) species with a light, but regular crop of volunteers (*S. siamea, C. arborescens*); and (d) species with a heavy and regular crop of volunteers (*C. calothyrsus, L. leucocephala* subsp. *glabrata, L. diversifolia* subsp.

diversifolia). No matter how well a species regenerates, the way the land is being used remains a far more important factor in sustainable tree production.

L. leucocephala accounts for the greatest source of volunteer regeneration of all species planted by the AOP in this study. About 2 volunteer trees (greater than 1 cm) are on site for every mother tree either harvested or left standing. Other species for which the mother tree:volunteer ratios were significant included *S. siamea* (1.64) and *C. arborescens* (0.56). Farmers were deliberately selecting and spacing the dominants on sites where annual food crops were cultivated. On wood lots, selection was much less intensive and natural thinning of the regeneration stand appeared closer to the norm. However, stem distributions were skewed toward the smaller size classes, as the larger stems were being harvested for fuelwood and small poles and the smaller stems tended to be continually browsed or damaged by livestock.

AOP Species

***Leucaena leucocephala* subsp. *glabrata*.** Among all species, this is the tree that Haitian farmers watch most carefully due to its weedy nature. It is not surprising that it was the most abundant species in the smallest category of volunteer seedlings (i.e., < 1 cm diameter). In several cases, the farmers were adapting quite well to the prolific crop of volunteers, particularly in cases where woodlots (*rak bwa*) or charcoal gardens (*jaden chabon*) were established on site conditions too degraded to cultivate regularly. On these sites, the size distribution of the volunteer stems were being controlled either by the continual browsing of tethered animals (in which case the small stem diameters would stagnate with seasonal sprouting of tender shoots) or the harvesting of small stems for fuelwood and small construction wood. **Appendix 3, Table V** summarizes the regeneration status of *L. leucocephala* on sites where the species was planted.

Stem densities vary widely from site to site, depending in large part on land use and site conditions. Over half of the 22 sites are being managed for wood lots, either in association with other perennial crops, as a charcoal garden or as a wooded fallow. The volunteers on these sites are beginning to contribute a significant portion of the wood harvested for charcoal or fuelwood. Several stands have a blanket cover of volunteers in the understory. In some cases, the understory is being heavily browsed by livestock tethered in the stand for feeding and shade. The farmers are aware of the soil ameliorating and conserving properties of *lisina* sites and occasionally report this as an important reason for letting the species capture the site. In contrast, volunteers were generally weeded out on sites that were cultivated annually with mixed annuals, annual/perennial mixes, or annual monocultures.

The ratio of volunteers to the number of original parent trees was significantly higher on the sites where a primary objective of the farmer was to grow wood, as shown in **Table 4.4**. The ratio declines sharply from about 147 for stems < 1 cm diameter to 0.55 for stems > 3 cm diameter. However, it indicates that *Leucaena* comes close to replacing itself to harvestable size through seeding alone. In contrast, very few volunteers greater than the 3.0 cm diameter class were present on annually cropped land. Over time, *Leucaena* will disappear if no further interventions take place under this land use option.

Table 4.4. Volunteer:parent tree ratios of *L. leucocephala* for 3 stem size classes.

Type of Garden	< 1 cm	1-3 cm dia.	3+ cm dia.
Mixed wood lot/perennial garden (n=12)	146.92	2.81	0.55
Mixed annual/perennial garden (n=10)	2.8	0.04	0.01
All gardens (n=22)	93.73	1.79	0.35

Table 4.5 summarizes the management strategies of *L. leucocephala* observed during this study. As stated previously, the importance of natural regeneration must be placed in the context of farmers and their utilization of the land. Only when volunteers are considered an asset for wood production, as on 13 of the sites, are they considered with any degree of value that allows them to develop as a new generation of trees.

Table 4.5. Summary of *L. leucocephala* volunteer management strategies.

Description of management strategy	No. of Sites
Absent or negligible regeneration	3
Eliminated or in the process of eliminating *Leucaena.*	5
Neglected for use, but effective soil conservation and improvement.	1
Occasional seedling selected for wood production.	3
Stand managed for browse and charcoal production.	3
Stand managed for wood/charcoal production only.	7
Total number of sites	22

Senna siamea. A total of 26 sites, over half of all sites inventoried in this study, was established with *S. siamea* as part of the parent tree population. The regeneration of this species is much lighter than *L. leucocephala* on most sites, but ranks next in importance since it was the most planted species of the AOP and AF II projects. It's likely that the *S. siamea* population is greater and more extensive than that of *L. leucocephala* in Haiti, since it was the most planted species of the AOP. Though heavy regeneration can occur on the wetter sites, farmers do not perceive the species to be weedy. They are less apt to eliminate the volunteers from their original planting locations and take greater efforts to transplant seedlings to other locations. Its better form in densely spaced stands and browse resistance encourages farmers to manage the species as a source of small pole wood, used mostly for roofing needs. The suitability of the wood for lumber, reported to take a good polish, also encourages farmers to transplant volunteers to protected areas. The species is easy to manage and appears to adapt well to the various land-use patterns of the Haitian farmer.

Appendix 3, Table VI summarizes the inventory of *S. siamea* volunteers on the sites where parent trees were planted. Since the species remains in the ground for longer rotations, mainly for lumber production, the stem sizes span a wider range and tend to be more evenly distributed. The influence of farmers deciding to leave volunteers on crop land is reflected by the ratios in **Table 4.6**. The ratio of volunteers: parent trees for annual crop land is twice as high for *S. siamea* than for *L. leucocephala* (**Table 4.4**). However, the presence of volunteers is much more variable than *L. leucocephala* from site to site, with several sites completely barren of volunteers even where the species grows well.

Table 4.6. Volunteer:parent tree ratios of *S. siamea* for 3 stem size classes.

Type of Garden	< 1 cm	1-3 cm dia.	3+ cm dia.
Mixed wood lot/perennial garden (n=11)	18.95	2.53	0.34
Mixed annual/perennial garden (n=15)	3.31	0.16	0.28
All sites (n=26)	11.07	1.34	0.31

A summary of the strategies adopted by farmers for managing *S. siamea* volunteers is provided in **Table 4.7**. Volunteers are managed for wood production on about half of the sites. It can be expected that on these sites, active transplanting and spacing of volunteers will keep the sites in *S. siamea* production for some time into the future. However, if no additional inputs are provided to restock the stand, *S. siamea* will decline in importance to levels on par with other native species. The species may be in faster decline on sites that are devoted to annual cropping activities, though it appears a selected portion of the volunteer population will be present, probably near the garden borders long after the elimination of the parent generation.

Table 4.7. Summary of *S. siamea* volunteer management strategies in this study.

Description of management strategy	No. of Sites
Total number of sites	26
Absent or negligible regeneration	5
Eliminated or in the process of eliminating *S. siamea*.	4
Neglected for use, but effective soil conservation and improvement.	2
Managed for wood production	15

Azadirachta indica. A total of 7 sites in this study was planted with *A. indica* as part of the parent tree population. Though the species has a tendency to be invasive in the wetter areas in Haiti, no such cases were observed in this study. Except for the poor survival and growth of the parent trees on a couple of sites, it is difficult to attribute this to any single factor. The seed loses viability rapidly and is likely sensitive to environmental factors that affect natural rates of germination. It also seeds poorly in dense stands, requiring sunlight to reach the full canopy for adequate flowering and seed production. This is somewhat counter balanced by the vigorous coppicing and root suckering of the species. In some cases, particularly in the Ste. Hélène region, root suckers were so prolific that regeneration from seed falls in importance as a means of regenerating the stand. The density of root suckers dramatically increased where neem roots were injured during soil tilling.

One site that was not originally planted with the species had volunteers originating from another nearby AOP site. Presumably, the seed was taken to the site by birds where it germinated. This illustrates the difficulty in assessing regeneration for species such as *A. indica* that are part of the faunal diet. It is safe to assume that the volunteer:parent tree ratios in this study are an underestimate. **Appendix 3, Table VII** summarizes the inventory of *A. indica* volunteers on the sites where parent trees were planted. Due to the small sample size for this species, all sites were combined to calculate the ratio of volunteers:parent trees in **Table 4.8.**

Table 4.8. Volunteer:parent tree ratios of *A. indica* for 3 stem size classes.

Type of Garden	< 1 cm	1-3 cm dia.	3+ cm dia.
All sites (n=7)	0.45	0.05	0

Colubrina arborescens. A total of 11 sites was planted with *C. arborescens* as part of the species mix. Regeneration was absent on 6 of the sites. Only one site had volunteers advanced in age and size for the harvest of construction wood. The farmer on this field garden site was spacing the volunteers at approximately 3.8 m and interplanting regularly with a mixture of annual crops. There was also considerable browse damage to the species by goats, a common problem associated with field garden sites. **Appendix 3, Table VIII** summarizes the inventory of *C. arborescens* volunteers on the sites where parent trees were planted. An additional 4 sites not planted with *C. arborescens* had densities ranging from 25-353 volunteers ha^{-1} for stems < 1 cm diameter and 20-118 volunteers ha^{-1} for stems 1-3 cm diameter.

Table 4.9 summarizes the ratios of volunteers:parent trees on the 11 sites. *C. arborescens* appears to be more successful than *A. indica* for volunteers originating from seed, though regeneration from coppice and root suckering is not nearly as vigorous. Due to the high value of the species as a source of house construction wood, farmers are likely to make up for a lack of natural regeneration by transplanting volunteers from other sites or direct seeding (Campbell, 1994).

Table 4.9. Volunteer:parent tree ratios of *C. arborescens* for 3 stem size classes.

Type of Garden	< 1 cm	1-3 cm dia.	3+ cm dia.
All sites (n=11)	1.53	0.29	0.27

Other AOP Species. Several species were represented by one site where volunteers were noted. Caution is advised in placing any significance on these values. *G. robusta* was planted on 5 of the sites, but only one site had volunteers. *C. calothyrsus* and *L. diversifolia* were planted on only one site each, though these sites had relatively high densities of volunteers. These species and the size distribution of their volunteers are summarized in **Appendix 3, Table IX**. The volunteer:parent tree ratios for 3 diameter classes are provided in **Table 4.10**.

Table 4.10. Volunteer:parent tree ratios for AOP species that were observed on 1 site. * = No stems present due to elimination by farmer.

Species	< 1 cm	1-3 cm dia.	3+ cm dia.
Leucaena diversifolia	*	1.4	2.99
Calliandra calothyrsus	3,189	0	0
Catalpa longissima	0.34	0.34	0
Acacia auriculiformis	27.3	0	0
Grevillea robusta	0.78	0	0

Volunteers of Native Species

An important phenomenon occurring on many of the AOP sites is an increased diversity of tree species by natural regeneration of native species, particularly those valued by the farmers as wood species. Several of the sites being managed as wood lots (*rak bwa*), charcoal gardens (*jaden chabon*), house gardens (*jaden devan pot*) or adjacent gardens (*jaden prè kay*) were favoring the regeneration of native species by modifying site conditions and acting as perch sites for important seed dispersal agents. These are the birds and bats that feed on the fruits of several economically important species. The AOP trees are acting as "nurse" species for native species that are not likely to be planted directly in the same location. Like the AOP species, the management of the site is a critical factor determining what fraction of the natural regeneration develops to harvestable size. On sites managed for annual crop species, volunteers of native species valued for construction wood and lumber were generally spaced to densities of 100 - 200 stems ha^{-1}. Densities increased and volunteers were less managed in the woodlots or charcoal gardens.

Another important niche for the regeneration of native species is the border of field gardens (*jaden lwen*). These are the "nooks and crannies" of the agricultural landscape where vulnerable seedlings find some relief from disturbance, particularly livestock browsing, traffic damage and soil cultivation. Seedlings are protected by the common live fence species armed with thorns and poisons such as *pit*, *pingwen*, *bayonet*, *bresiyèt* and *kandelab*.

An inventory of native species that had germinated on site since the planting of AOP trees was conducted to better understand the richness of these species versus the overstory species. Native volunteers were found on about half of the 43 sites. The most abundant species, in percentage of all sites, were *S. glauca* (33%), *C. calaba* (26%), *S. mahagoni* (23%), *B. salicifolia* (12%), *Chrysophyllum oliviforme* (12%), *Comocladia* spp. (12%), *C. longissima* (9%), and *R. hispaniolana* (9%). Most of these species are being protected and managed for future wood needs. *C. oliviforme* is a common colonizing species and used for charcoal and small poles. *Comocladia* is an important source of live fence material for the farmers, noted for its toxic sap and ease in propagation by branch and stem cuttings. *S. glauca*, *B. salicifolia*, *C. oliviforme*, *Comocladia* spp. and *R. hispaniolana* are primarily dispersed by birds; *C. calaba* by bats; and *C. longissima* and *S. mahagoni* by wind. Several of these species are important throughout Haiti, whereas others have a more restricted occurrence. A summary of the native volunteer inventory is provided in **Appendix 3, Table X**.

CHAPTER 5

UTILIZATION OF PROJECT TREES

This chapter discusses categories of tree harvest, services rendered by project trees, and information on yield. Two-thirds of AOP trees on study sites have already been harvested. The most important products were charcoal, and wood for peasant house construction. Both have played key roles in the household economies of tree planters. The most significant levels of wood harvest by value occurred between eight and eleven years after tree planting. Project trees have also rendered important services which are difficult to quantify, but these services may well exceed the value of harvestable tree products.

Tree Products

Harvest values from the study sample are outlined in **Table 5.1** below according to percentage of wood product categories, direct use value and sale for cash income. The team elicited price equivalents for products used, and sales information for products sold. Monetary equivalents are estimated since independent price information was not always available for earlier years. The study period for harvest data covers 13 years. An eighth of inventory farmers had tree plots with no reported harvest. These planters were protecting their trees as providers of services, and long term stores of value.

Table 5.1. Value of wood product categories, used or sold, reported from the 43 AOP sites in this study. Percentages are in parentheses.

	Charcoal (*chabon*)	Roof Board (*lat*)	Kitchen Post (*poto jen kay*)	Roof Lattice Pole (*lat*)	Rafter Pole (*chevron*)	House Board (*plansh*)	House Post (*poto*)	Joist & Beams (*travè, filyè*)	Other Products (*pye bwa, piket*)	ALL
USED	279.0 (4)	1035.0 (78)	732.5 (100)	130.8 (100)	1574.0 (80)	540.0 (37)	2535.0 (89)	4007.0 (68)	1550.0 (84)	12,383.3 (52)
SOLD	7157.5 (96)	300.0 (22)	(0)	(0)	390.0 (20)	925.0 (63)	320.0 (11)	1855.0 (32)	320.0 (16)	11,267.5 (48)
TOTAL VALUE (gdes)[1]	7,436.5	1,335.0	732.5	130.8	1,964.0	1,465.0	2,855.0	5,862.0	1,970.0	23,750.8

[1] **gdes refers to gourdes, equivalent to $0.07 US during the time of this study.**

There is an arresting gap of some 46 percent between tree harvests reported by informants, and higher estimates of harvest based on detailed site inventories (see **Estimated Wood Yield** below). This is due to under reporting, theft and other forms of uncontrolled harvest. Monetary estimate of harvest values shows 48 percent sold, and 52 percent autoconsumed or given to others as gifts. In view of the evidence of significant uncontrolled harvest - primarily for use, the amount used rather than sold is undoubtedly underestimated. Over 60 percent of harvest has been for construction wood, primarily polewood for domestic use rather than sale. Wood products produced primarily for sale are charcoal and house lumber (boards) - the lowest and highest grade product categories. Farmers generally target lumber as their primary harvest goal to generate income. In actual practice, charcoal has been the single most important category of harvest for cash income.

Charcoal. In this study, charcoal consumed about 83% of reported wood harvest by volume, and 31% of its monetary value. Planters consider charcoal a cash crop, and harvest reports indicate that charcoal was produced primarily for cash sales (96%) rather than use; however, most trees were not specifically planted and managed for this purpose. Charcoal harvest is most often a farmer's response to urgent needs for cash. It is a product readily converted to cash within 10 days of tree harvest. This reflects the relatively stable and constant market for charcoal in urban sectors. Farmers rely on the steady demand for charcoal to generate scarce cash during slack agricultural seasons, crop failure, annual hunger months, family crisis, and deadlines for paying school bills.

Charcoal production is also a substitute for expenditure of scarce cash. Farmers produce charcoal and send it to absentee family members, especially children attending school in distant towns and cities where cooking fuel is expensive. Informants also report making charcoal as hospitality gifts to defray the expenses of host families who lodge them when they travel to the city for personal business.

Aside from its role as emergency fund, some farmers manage trees specifically as charcoal gardens. This takes the form (a) of clearcutting land left in fallow, or (b) repeated, selective harvests from permanent woodlots with multiple production goals. Charcoal farmers produce on a larger scale than the occasional emergency producers. Charcoal farmers note the efficiency of building charcoal kilns repeatedly on the same spot. More charcoal is produced per unit of wood when the kiln site is reused. Labor requirements for charcoal production are often met by *demwatye*, literally sharecropping, with payment made in kind. If the wood owner does not share production costs up front, the owner's share is less than half of the harvest in order to defray the worker's expenses. Charcoal farmers in Fond-des-Blancs note that labor costs are cheaper for AOP species than spiny native species. Workers are willing to forgo their extra share for expenses if the wood doesn't have *pikan* (spines).

One charcoal farmer in St. Thon hired four workers to build four production kilns on a 0.75 *carreau* plot. The farmer clearcut his 11 year old stand of *S. siamea* and *L. leucocephala*, and harvested 71 *gwo sak* sold in 1993 at 25 gourdes per sack. Djo Poteau, another charcoal farmer in St. Thon, clearcut one-half of his eight year old 0.5 carreau stand of *S. siamea* and *L. leucocephala*, and produced 29 *gwo sak* selling at 25 gourdes per sack in 1991. Three years later he made charcoal from the coppice growth plus 0.25 carreau of *A. indica*, producing 40 *gwo sak* at 30 gourdes per sack (1994).

Most of the charcoal is produced from *S. siamea* and *L. leucocephala*, with lesser amounts from *E. camaldulensis*, *A. indica*, and *C. arborescens*. All species make charcoal, but denser species such as *Casuarina* and *Guaiacum* spp. make better charcoal than lighter species such as *S. siamea*. At the present time charcoal is undoubtedly the most lucrative option for juvenile wood, less dense species and poorly formed trees. Farmers are well aware of alternative uses for each species. They constantly take into account the potential for high value products when striking a balance between short-term cash needs versus long-term savings. The pivotal factor is the urgency of current cash needs. When strapped for cash, the farmer assigns lower priority to longer term, high value products such as lumber or commercial fruit. Therefore, it is not uncommon to observe farmers making charcoal from species normally reserved for higher value products.

Construction Wood. Wood products for house construction consumed 15% of reported harvest by volume, and 60% by monetary value. Construction wood, mostly polewood, is in high demand by farmers for both use and exchange values, but 69% of construction wood was consumed directly rather than sold - a consumption pattern opposite that of charcoal. Planters tap into national markets for charcoal sales; however, market demand for house construction wood in rural Haiti is less stable than charcoal, and locally restricted. There is unquestionably high demand for construction materials, but this demand is met primarily from nonmonetary sources, especially for polewood. The most important category of construction material is joists and beams, 62% of construction harvest by volume, and 41% by value. Farmers have tended to sell high grade lumber used for construction of doors, windows and furniture. Low grade saw wood (*lat*) in the sample was consumed rather than sold; however, 63% of high grade boards (*plansh*) was sold. High grade lumber constituted only 10% of harvest devoted to construction materials. This figure will likely increase as more trees attain harvestable size for lumber. All other construction products in the sample were primarily used rather than sold.

Farmers purchase construction wood, especially boards, but they characteristically use a variety of maneuvers to avoid outlay of scarce cash for house construction. This includes reusing beams and postwood from old houses, and soliciting gifts of trees or poles from others. One informant had "lent" two *kasya* trees to a friend who needed polewood for house construction. He planned to call in the loan in another two or three years by felling comparable *kasya* from the friend's tree garden. Planter Vertius of Desforges was building a 5-room rock house for his son. He used AOP trees to meet most of his needs for postwood, poles, and beams. He hired a sawyer to saw two *E. camaldulensis* into 21 low grade boards as door and window backing, and worked together with the sawyer to limit his labor costs. To economize on scarce wood for wattle, he decided to build walls with rock and quicklime, using AOP firewood and calcareous rocks on site to make lime.

Informants also seek to purchase wood at discounted rates. Tree planter Francoeur in Savane Môle purchased an entire house for 300 gourdes in order to salvage its post and beam wood. Tree planter Cidoine in La

Montagne purchased land with the intention of harvesting its stand of AOP trees to establish a house site and build a new house for his son. He harvested 27 *C. equisetifolia* posts, 55 *C. equisetifolia* and *C. arborescens* rafter poles, joists, and beams, and roofing stakes. He purchased two dozen planks for doors and windows, *latanye* leaves for roofing, and metal hinges, hooks and nails. His out of pocket costs were 790 gourdes - about 40 percent of the value of construction materials in the house.

House construction is an important element of peasant household economy. Farmers build numerous kitchens and storage structures over a period of years, and a new house for each son who stays in the community. Houses may be disassembled and rebuilt if farmers move to new house placement sites. A Morne-Franck farmer, Orialus Bernard, has ten children, five of whom eventually emigrated to French Guiana. He has built nine houses over the years. In Grenier, Rozilis François has built four houses - two of mud-and-wattle and two rock-lime houses. He anticipates building three more houses for three sons still at home. Wood for house construction is a significant expense in peasant households, and a veritable obsession for farmers with several sons.

Interviewees in various study regions note a shift in construction materials from mud-and-wattle construction to rock-lime construction due to growing scarcity of wood. This shift is evident in new house construction observed by the team, especially at sites where calcareous rocks are locally available. This shift appears to have taken place over the past 20 years.

The primary products for construction are house posts (*poto*), beams (*travè*), joists (*filyè)* and rafter poles (*chevron*). House posts must be durable in the ground. The traditional standard for post species is *H. campechianum*. Among the AOP species, *L. leucocephala* and *A. indica* come the closest as substitutes for native species. Informant reports of their relative durability vary according to region and the age they are cut; however, they are generally considered inferior to traditional species.

Beams and joists are mostly above the ground and must be long, straight and moderately durable. Decay problems are less a factor than for posts. The ideal traditional species for beams is *C. arborescens*. Here the AOP has a greater potential of making an impact. *Eucalyptus* and *Casuarina* spp. are particularly valued as a source for long, straight beams, especially in the Northwest. A shortage of long beams exists in many regions of Haiti, particularly 10 meter ridgepoles and boat masts. Consequently, the prices fetched for the longest poles make a significant jump from the commonly available lengths of four to six meters. It remains uncertain if *Eucalyptus* and *Casuarina* can adequately substitute for the local species if on-farm silvics associated with propagation and early seedling management remain poorly developed.

A small amount of lumber is being cut from AOP trees, mostly *E. camaldulensis, G. robusta, S. siamea, L. leucocephala*, and an introduced Honduran provenance of *C. odorata*. Two types of lumber are being sawn, depending on demand and log dimensions. The smaller lumber is used mostly for roof lattice and purlin material, while the larger is being cut for studs, doors, windows, coffins, and furniture. Some planters invest in standing tree stock in order to engage in lumber commerce. This commerce has primarily been in native species, and includes export out of the community into urban centers including the lucrative Port-au-Prince market. Peasant lumber merchants in Fond-des-Blancs were unable to sustain their trade to Port-au-Prince during the embargo period, and at the time of this study had not yet reactivated active trade. The team did not uncover cases of AOP lumber exported to the city; however, AOP lumber has definitely played a role in the local lumber trade.

Fuelwood. Fuelwood has little cash value, but it is important in the daily lives of farmers. Virtually all sites inventoried produced varying amounts of firewood, generally stumps and the branchwood not converted into charcoal. It is very difficult to quantify the value of fuelwood from AOP trees. A number of farmers in Desforges used project trees as fuelwood for *lacho* (quicklime) production. Some farmers are aware of the rough monetary value of fuelwood as a production cost for quicklime. A limemaker in Desforges determined that he derived a better return from quicklime than from charcoal when using AOP trees as fuelwood. A tree planter and baker in Bainet derived a far better rate of return from charcoal than from using AOP trees as fuelwood for his small bakery. He was able to heat his oven by recycling agricultural waste - pigeon pea and sorghum stalks - rather than using denser wood species.

In fuel scarce areas such as Ste. Hélène and Desforges, local farmers sometimes buy fuelwood or even charcoal for domestic consumption. Women of Ste. Hélène retail fuelwood locally and in the wood scarce Cayes plain. Ambulatory wood sellers in Ste. Hélène reported retail sale of firewood by the headload two or three times a week at around 10 gourdes per headload. Small distilleries in St. Michel buy donkey loads of firewood, mostly native species. A large distillery owner uses his own trucks to travel to Biligi for fuelwood. He pays 250 *gourdes* per truckload of native wood, and estimates his transport cost at 750 *gourdes* per trip. He has planted AOP species near his distillery which he uses as backup fuelwood when his trucks are unable to travel to Biligi during the rains.

Stakes and Small Stems. In the Grenier area, tool handles and stakes (*ranm*) for vegetable and vine crops are important products harvested from trees on marginal sites, and from the coppice stems of *E. camaldulensis, C. glauca* and *G. robusta*. There is considerable local demand for such stakes due to the importance of yams, climbing beans and tomatoes as principal cash crops in this area. Farmers use hundreds of stakes five to six feet long in their staked gardens. Bundles of 100 stakes may be purchased for 20 *gourdes* per *pake* (bundle).

Small stems are periodically harvested for small diameter posts and poles used in constructing kitchens, storage structures (*kolombye*), and roofing (*roslay*). *L. leucocephala* coppice are frequently harvested as fodder, especially for pigs. These harvests and small stems for firewood and other purposes are particularly subject to theft and often under reported by farmers.

Remedies. An important but under reported tree product is the harvest of bark, leaves and roots for medicinal purposes, usually in the form of herbal baths, teas and rubs. Tree species planted by the AOP are used extensively for their medicinal properties. Informants in this study report wide use of *A. indica* and *Eucalyptus* spp. leaves in teas and baths for treatment of fevers. *Eucalyptus* leaves are also a remedy for colds and headaches. *Eucalyptus* spp., *C. arborescens* and *C. longissima* leaves are used as a febrifugal rub (*fwote fey nan do* - leaf back rub) and for treatment of *fwedi* (cold state in humoral medicine). Bitter coffee is a common remedy. *Leucaena* seeds are roasted and brewed as a coffee substitute.

Availability of inexpensive and nontoxic insecticide would be of considerable economic benefit to rural Haiti. Farmers report using *Eucalyptus* and *A. indica* to treat animals plagued by ticks and fleas. *A. indica* seeds and leaves are also dried and crushed for use as an insecticide to protect grain surpluses and seed stocks held in storage.

In view of high prices and unreliable supplies of pharmaceuticals in rural Haiti, it would be beneficial to take these concerns into account in species selection and promotion of farm forestry in future program efforts. For further information on tree species and herbal remedies in Haiti, see Brutus and Pierre-Noel, 1959, 1960, 1966; Weninger, 1985; Weninger and Rouzier, 1986; and Liogier, 1990.

Sale of Tree Plots. Informants have occasionally sold stocks of standing trees, usually one or two at a time, or given gifts of such trees. For example, a buyer and seller in Desforges confirmed the sale of one 10 year old, estimated 15 inch diameter *S. siamea* for 85 gourdes in 1994. Some planters have engaged in the lumber trade by buying individual trees, hiring sawyers to saw them into boards, and selling boards - usually by the dozen.

Another strategy for tree sale is to sell plots of land at significantly higher prices based on calculation of the value of standing stock of trees on the land. The team encountered nine cases of tree plots sold with project trees present at the time of sale. Six cases are summarized in **Table 5.2** below. Buyers and sellers indicated that they calculated the value of standing stock of AOP trees based on their suitability for charcoal production - even though the trees had potentially higher value for lumber or other long term products. In these cases, the price of charcoal served as a standard measure of tree value.

Table 5.2. Tree plot sales, prices and percent mark up for trees.

Site	Plot Size (ca)[1]	Year of Sale	Base Value (gdes)[2]	Tree Value (gdes)	Sale Price (gdes)	Mark Up (%)
La Montagne		1992	500	350	850	70
La Montagne		1993	350	150	500	43
La Montagne		1993	400	225	625	56
St. Michel		1990	600	400	1,000	67
St. Michel	0.5	1988	800	500	1,300	63
St. Michel	0.5	1993	1,500	1,100	2,600	73

[1] ca refers to *carreau*, equivalent to 1.29 ha. [2] gdes refers to gourdes, currently about $ 0.07 US.

Wood Yield and Value

Appendix 4, Table I summarizes the products, in unit values, that were harvested from the 43 sites in this study. The wood products are arranged in order of increasing unit volume from left to right. Farmers could usually recall the number of trees required to produce the reported units. Multiple products were usually harvested from most trees, particularly the pole, post and charcoal combination. The reported monetary values for these products is summarized in **Appendix 4, Table II**. For instances in which the farmer did not give a cash value, an estimate based on the average product values by species was used (**Appendix 4, Table III**). The averages are based on separate harvest events by farmers during the 1985-1995 period. Any one farmer could have reported several harvests of a particular product.

Table 5.3 provides the total yield and value of wood products from 40 sites. The average value of wood products reported per site, including those not harvested, is about 551 gourdes, around $39 at the current exchange rate. These values may appear insignificant, though they are not adjusted for the 3-fold decline in exchange value of the gourde since the mid1980s, inflation or discount rates at time of harvest. These factors would increase the importance of the reported values. Considering further the value of total products consumed, but not reported, the real impact that AOP trees is significant in the economy of rural communities.

Table 5.3. Wood product yield (units, metric tons and solid cubic meters) and value (gourdes) from 43 sites in this study. ⁺ indicates that a minimum quantity was reported by the farmers.

	Charcoal[1]	Roof Board	Kitchen Posts	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Beams	Other Products[2]	TOTAL
YIELD (UNITS)	400.5⁺	72	110	38⁺	252⁺	89	261	159	Mixed	Mixed
WOOD WEIGHT (mt)	79.10[3]⁺	0.04	0.12	0.06⁺	1.11⁺	0.64	3.30	8.75	2.87	95.85
WOOD VOLUME (m^3)[4]	143.82⁺	0.07	0.22	0.11	2.02	1.16	6.00	15.90	5.22	174.26
VALUE (GDES)	7,436.5⁺	1335.0	732.5	130.8⁺	1,964.0⁺	1465.0	2855.0	5862.0	1970.0	23,750.8

[1] 39.5 kg sack. [2] Includes stakes and trees, both used and reported stolen. [3] Assumes an average conversion efficiency of 0.2 from wood weight to charcoal weight (Timyan, 1987). [4] Assumes an average specific gravity of 0.55 (Ehrlich, 1985; Ehrlich et al., 1986).

Estimated Wood Yield. Wood yield, defined as the amount of wood actually harvested, was estimated for each study site as much as possible. It was assumed that all wood measuring greater than 2 cm diameter of a harvested tree was used, sold or converted to charcoal. Estimated wood yield represents a rough measure of what was harvested from the site.

A problem that was faced throughout the study was how to resolve the difference between reported harvests, and yield estimates calculated from the site inventory. Clearly, the owner of the trees is rarely the only one benefiting from the trees. The difference should be considered in light of the following factors:

1) Estimation errors are involved in the derivation of weight estimates and the assumed conversion rate (20%) of dry wood weight to charcoal weight;

2) There may have been variation in the unit sizes reported;

3) Farmers were imprecise at times regarding the quantities of wood harvested from their trees since many trees were harvested by members of the extended household or community members. For example, the farmer might grant permission to harvest, and the beneficiary would harvest more than the agreed number of trees;

4) Farmers recognized that trees were being stolen, but often were imprecise to what extent;

5) Farmers did not remember all harvests, particularly small harvests to meet a household needs;

6) In some cases, harvest from one site was combined with harvests from other non-inventoried sites.

A summary of the difference between reported harvests and stand inventories is given in **Appendix 4, Table III**. The proportional allocation of this difference to the various wood product categories has obvious limitations, particularly for those categories that are sensitive to form factors (i.e., lumber, joists and beams). The data pertains only to those sites for which both the reported harvest and site inventories were available, representing 35 sites. Several sites were omitted for various reasons: Sites 14 and 36 (inventoried, but no harvest was reported); Sites 5 and 20 (harvest history reported by farmer does not match the site inventory); Site 15 (harvest report was not possible as the owner was not available); sites 21a, 22 and 42 (volume estimates are not available for *G. robusta* and *C. odorata* in Haiti). **Figure 5.1** shows a breakdown of weights among the wood products, and the difference between stand yield estimates and reported weights.

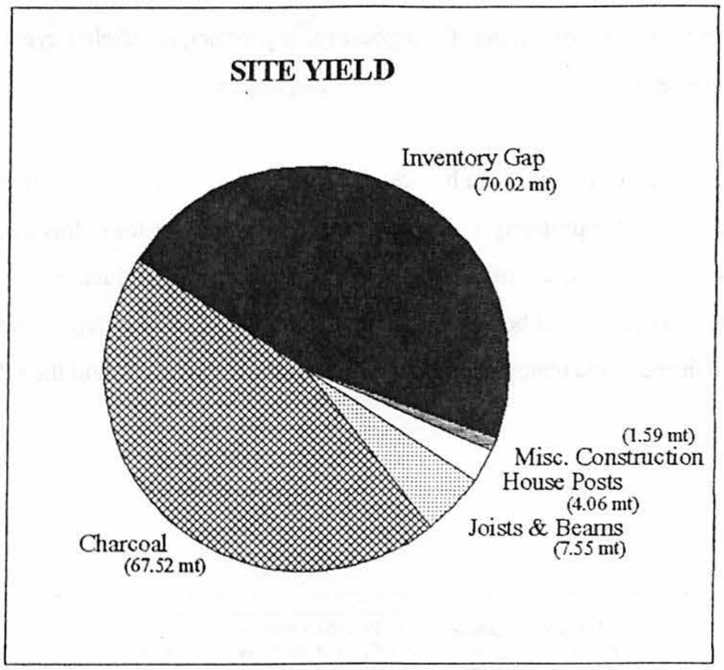

Figure 5.1. Estimated wood yield from 35 sites in this study. "Inventory gap" refers to the difference between reported yields and estimates (weight basis) based on the tree inventory.

Overall, 46% of the estimated wood harvest is not accounted for by the reported harvests. Firewood and non-utilized wood can make up some of the difference, as well as an unknown bias in weight estimates and assumed wood equivalents for charcoal. It remains that much of the difference is likely to be the elusive wood harvests that are forgotten, stolen or imprecisely known.

Time Analysis. The time it takes to grow trees for the various products varies according to (a) species productivity (how fast does it produce wood?), (b) wood quality (what good is the wood?) and (c) the economic status of the farmer (how badly is his or her need for wood?). These 3 factors must be considered before making an estimate on the rotation period of the trees planted by the AOP and the timing of their impact on the economy of the farmer. For data in which both establishment and harvest dates were known, a time analysis reveals how soon farmers harvest the trees after planting. This in no way reveals what proportion is being harvested, nor the potential maximum value, since most farmers would rather leave their trees in the ground if they could afford to do so. But it does reflect the time when the greatest returns are being realized.

Figure 5.2 illustrates the gross value of wood products, in gourdes, over elapsed time since tree planting. The first harvest is wood for charcoal production which remains an important product throughout the harvest cycle of a tree stand. Joists and beams share an equivalent or better value than charcoal beginning at 4 years and peaking toward 8-10 years. Maximum values for lumber, the highest value product, are likely beyond the time intervals of the graph and have yet to be realized.

So far, the greatest value of products are harvested between 8-11 years from the tree planting date. The decline in yield value after 10 years is probably a sampling artifact since most sites in this study were between 10-13 years old. It is difficult to predict the future trends of sites similar in age and production, but values should rise with the harvesting of higher valued lumber and beams. Naturally, values will fluctuate depending on the economic situations of the individual farmers, the regional and national economic conditions and the relative prices of the various wood products.

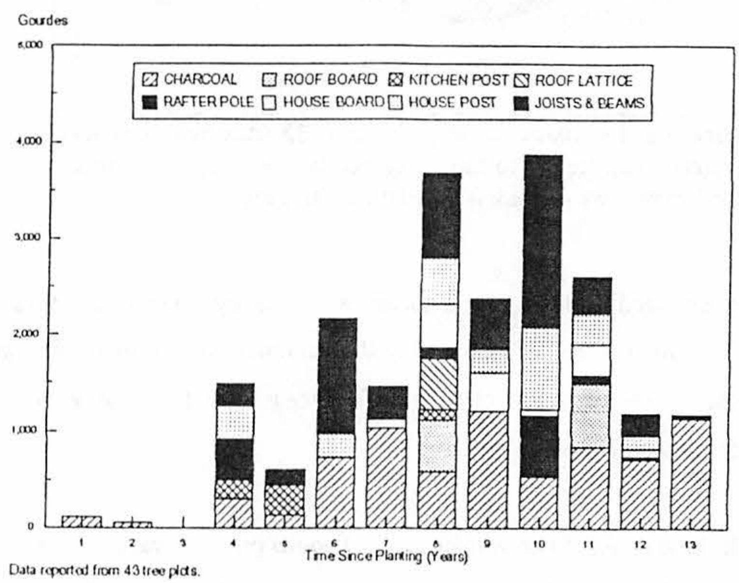

Figure 5.2. Value of harvested wood products since time of planting.

The available information on average rotation ages by wood product is still inadequate. This varies considerably relative to the needs of the farmer and not necessarily to optimal tree management. The oldest sites in the PADF harvest studies were 6.5 years, with no indication of the proportion of surviving trees that were harvested (Bannister, 1990). Estimates based on young stands are not valid, with the possible exception of clearcut charcoal production. In this study, the harvesting of the most highly valued product, lumber, has just begun to enter the rotation. A rough estimate for the most popular product combination - charcoal and large poles - is probably similar to the peaks in **Figure 5.2**, about 8-10 years.

Figure 5.3 shows the gross value of wood products during the decade between 1985-1994. Data for 1995 is not shown; however, informants indicate that the value of charcoal produced up to mid-February (1995) is already more than half of last year's production. The used category represents those products reported by the farmer coupled with harvest dates. The used category of products is considerably under reported, as illustrated for 1989 - no wood products directly used by the farmers were reported for this year. Harvest dates and values for the used category were less likely known, especially for the early harvest years. Therefore, the real value of products used by either the farmer or the extended community is not known for sure and should be considered an underestimate.

There are several converging factors which influence the trend shown below. The recent economic embargo and heightened economic insecurity have forced several farmers to harvest their trees as an alternative means of income. Rising charcoal prices coupled with a maturing of the AOP stands and leveling off of growth rates are sensible reasons to increase harvesting activities. It may be that local demands for crop land have precipitated conversion of some AOP sites to other land uses. Certainly, the team has observed many sites where farmers completely eliminated project trees and reverted back to a land use pattern devoid of trees.

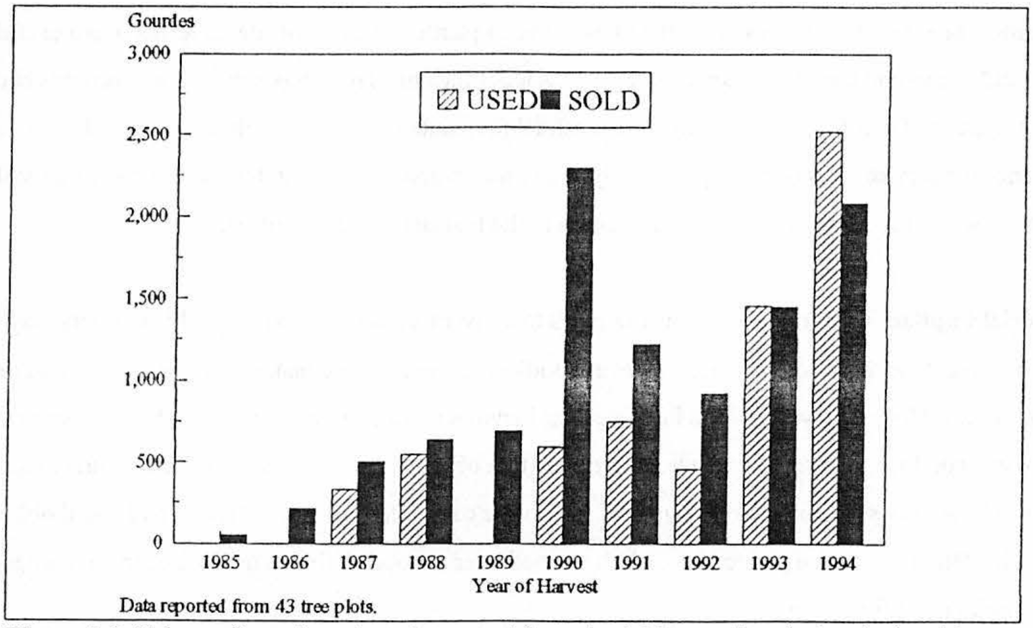

Figure 5.3. Values of wood products harvested from the AOP tree sites during the last 10 years.

Tree Services

In addition to wood products, AOP trees render a series of useful services to tree owners and surrounding communities. These services are much more difficult to quantify or value in monetary terms. In many situations, the service role of trees may in fact be more important than the tree products. The most notable examples are the use of trees as windbreaks, coffee shade, live fencing, aesthetics, shade and fodder for livestock, land improvement, store of value and emergency fund. Interviews indicate very clearly that farmers make active use of project trees to manage their social capital in a complicated nexus of ties, obligations, and patron-client relationships. Tree gardens have also played an immensely important role as an emergency insurance fund to dip into when all else fails.

Improved Land Use. Most farmers in Haiti recognize the value of trees for enhanced production of organic matter, soil conservation, improvement of soil fertility, and creation of more favorable microclimates for associated crops and livestock. Significant numbers of inventory farmers established enriched fallows on one or more sites, and shifted sites out of erosion intensive annual crops into permanent woodlots, charcoal gardens, and mixed perennial gardens. These changes were precipitated by the sudden introduction of large numbers of AOP seedlings onto a range of garden sites. Had the trees not been planted, the rate of site conversion to a useful, alternative land use would have been slower and perhaps less efficient. These types of land use benefits should be kept at the forefront of agroforestry research. It is essential to maintain support for cheaper methods of investment which enhance the service roles of trees, particularly soil conservation and habitat diversity. This would shift the focus from the worn out discussion of overexploitation to the real issue of underinvestment.

Social Capital. The store of value in a farmer's tree inventory is managed carefully. Farmers may be unable to use directly all the wood produced in their woodlots; however, they make effective use of these resources to create opportunity for employment or to increase their benefits in other ways. For example, a farmer in Bainet made use of his wood resources to provide house timbers free of charge to members of the community as a strategy to secure local house construction jobs for himself. In another case, a farmer in Ste. Hélène had social obligations to help care for his father. In lieu of giving him cash, he turned over a woodlot for his use as a charcoal garden, thereby generating employment for his father.

Over half of the farmers report making gifts of trees to friends and family members. In so doing they were able to respond to special needs, fulfill social obligations, incur potentially useful obligations of reciprocity, and capture agriculture labor. As noted earlier, plot sales show that trees add considerable value to land, and this value may be passed along to others via opportunity for purchase. Giving others access to tree plots for land purchase also tends to enhance one's social capital since opportunity for purchase is viewed as a special favor.

The owners of many woodlots allow family members and neighbors to use their stands of trees as a source of shade and fodder for livestock. This is critical during seasons when fodder is scarce, or when livestock is being readied for market. The sharing of such services with other members of the community benefits the owner by instigating reciprocity. When this use is approved or controlled by the owner, it maintains a useful presence on the tree plot and increases security, particularly for sites located at a distance from the owner's residence. Tree security is a widespread problem that plagues farmers and creates a strong disincentive to maintain wood species on distant sites.

Trees also have magical qualities in a social milieu where there are charges of witchcraft. *C. odorata* are planted at the entrance of house-and-yard compounds as a protection against *movez espri* (witches) which cause illness and misfortune. Coffin makers extract a premium price for sale of cedar coffins reputed to protect against theft of *zombi* (dead souls) from recently buried corpses.

Positive and Negative Services. The establishment of fast growing exotics can generate both positive and negative services. Practically all negative services associated with trees are in the context of light or moisture competition with annual crops. Light competition is more important in the wetter regions and moisture competition is more important in the sub-humid regions. The negative effect of certain species on soil moisture dynamics (e.g., *Eucalyptus, Zanthoxylum, Swietenia, Prosopis, Acacia*) is recognized, particularly in the sub-humid regions where moisture, and perhaps nutrients, are limiting. It is difficult to observe nutrient competition and other negative effects on soil structure, since these are longer term in nature and probably not consistent across sites.

One can hardly plant a *L. leucocephala* and not recognize the negative effects in terms of labor inputs required for weeding. Conversely, capturing the site with such species both improves and conserves the soil for future agricultural use, while offering an opportunity to short-cut the time it takes to develop a harvestable fallow. In many cases, the trees offer a shelter to other seed dispersers and allow a greater diversity of species to establish on site that would not otherwise incur such benefits.

The sheer magnitude of seedlings planted in one location was a new experience for most AOP farmers. In many cases, this contributed positively to environmental services by facilitating decisions in favor of woodlot management. In other cases, land selected for trees was too marginal for agricultural investments, and tree cover was the best land use option. On steep slopes formerly under cultivation, dense volunteer stands of *L. leucocephala* and *S. siamea* have considerably reduced soil and water erosion and benefited neighbors downslope. Unfortunately, the scale and landscape pattern of these type stands are too dispersed to have a widescale impact on soil conservation.

CHAPTER 6

FINDINGS AND RECOMMENDATIONS: PROJECT IMPACT AND PROGRAM IMPLICATIONS

Impact on Farms

Site selection

1. ***Crop land*** - Most farmers in the sample planted project trees on actively farmed garden sites, and shifted at least portions of these sites out of erosion intensive annual food crops into tree cropping.

2. ***Garden type*** - Farmers established trees in a range of configurations on all major garden types characteristic of peasant farm units: house gardens, adjacent gardens, field gardens, and mixed perennial gardens.

3. ***Land tenure and tree ownership*** - Farmers tended to favor sites with greater land tenure security and proximity for closer surveillance. Tree tenure proved to be more important than land tenure status per se.

Site management strategies

4. ***Food cropping*** - Two-thirds of the farmers continued to cultivate annual food crops on some portion of sites where they planted trees. They shifted from garden sites with few or no wood resources, to food cropping with some associated tree cover - usually perimeter plantings along with widely spaced trees within the plot. This strategy is well adapted to land scarce farmers, but it also has the most limited environmental impact on planting sites.

5. ***Enriched borders*** - Border plantings on more intensively farmed sites have also tended to diversify species mix, and have made good use of the border as a more productive niche without sacrificing much cropland for food. This strategy builds upon traditional peasant notions of border agroforestry. It has resulted in significant shifts in border land use, and resulted in a surprisingly diverse mix of exotic and native species.

6. ***Woodlots*** - About a third of sites inventoried demonstrated a remarkable shift from cultivation of erosion intensive annual food crops to establishment of permanent, densely spaced woodlots. This strategy has the greatest potential for environmental benefits to peasant farms. These benefits, however, are microsite benefits. The key constraint to wider environmental impact is the dispersal and small size of such woodlots.

7. ***Enriched fallows*** - One fourth of the farmers used trees for enhanced management of fallow. This strategy was used most commonly on sites left in long term fallow cycles, followed by clearcutting and return to agricultural crops. These drier sites were strongly linked to grazing as an adjunct to semi-arid, extensive agricultural strategies.

8. ***Charcoal gardens*** - Most sites managed for enriched fallow also serve as charcoal gardens. A second type of charcoal garden strategy emphasizes selective cutting for repeated charcoal production. In these woodlots, charcoal serves as an important cash crop in multipurpose woodlots which are never clearcut. This strategy has proved to be an excellent means to enhance the farmer's ability to dilute agricultural risk.

9. ***Mixed perennial gardens*** - In a significant number of cases, planting large numbers of trees has precipitated a shift out of erosion intensive crops to perennial gardens linking AOP hardwoods with other perennials such as sugar cane, plantains, fruit trees, coffee, cacao, and shade tolerant vine and tuber crops. This is an environmentally beneficial land use strategy which retains considerable short and medium term production values for farmers. It tends to be limited in impact due to site specific characteristics - moist bottomlands or house gardens.

10. ***Sylvopastoral links*** - In regions with significant grazing as an adjunct to agriculture, project trees have tended to improve grazing resources. There is ample use of tree sites for pasture, cut-and-carry forage and shade for livestock.

11. ***Exotic and native species*** - Ironically, introduction of exotics has fostered propagation of native species on sites denuded of forest cover. This has tended to diversify the woodlots, garden borders and long term fallow sites. This has a significant impact on the environment as well as farmers who generally value native species.

Impact on Farmers

Utilization of Project Trees

12. ***Harvest cycle*** - Two-thirds of AOP trees on study sites have already been harvested. The most important products were charcoal, and wood for peasant house construction. The most significant levels of wood harvest by value occurred between eight and eleven years after planting.

13. ***Income*** - Wood products primarily sold have been charcoal and house lumber (boards), the lowest and highest grade product categories. Farmers generally target lumber as their primary harvest goal to generate income. In actual practice, charcoal has been the single most important category of harvest for cash income. Planters consider charcoal a cash crop, and 96% of the charcoal was sold. Charcoal constitutes 31% of the total estimated value of reported harvest, and 82% by volume.

14. ***Domestic consumption*** - Wood products for house construction consumed 15% of reported harvest by volume, and 60% of its monetary value. Construction wood is in high demand by farmers, but 69% of construction wood in the sample was consumed directly rather than sold - a consumption pattern directly opposite that of charcoal.

15. ***Use and exchange values*** - Monetary estimate of harvest value indicates that 48% of the harvest was sold, and 52% autoconsumed or given to others as gifts. In light of significant levels of uncontrolled harvest, the amount used rather than sold is undoubtedly underestimated.

16. ***Product preference*** - Farmer preference tends to favor high value products, especially beams used in peasant house construction, and lumber. The AOP species that match or exceed the quality of native species in use are *Eucalyptus* and *Casuarina* spp. for beams and joists, and *G. robusta* and the Honduran provenance of *C.*

odorata for high grade lumber. *L. leucocephala* and *A. indica* come the closest to the preferred native species for post wood, but are generally considered inferior.

17. ***Harvest practice*** - In contrast to farmers' stated preferences for high value beams and lumber, the actual pattern of harvest emphasizes charcoal production for sale and polewood harvest for use.

18. ***Lumber*** - Low grade saw wood in the sample was primarily consumed, but most high grade boards were sold. High grade lumber constituted 10% of harvest devoted to construction. This figure will likely increase as more trees attain harvestable size for lumber. All other construction products in the sample were primarily used rather than sold. Introduced lumber species are allowing shorter rotations.

19. ***Other products*** - (a) Virtually all sites produced varying amounts of firewood for domestic use. There is some commercial harvest including fuelwood sales and manufacture of quicklime. (b) In some areas stakes and tool handles are important products, especially from coppice stems. (c) Project trees are important sources of remedies and insecticides. (d) Trees are sold for their stumpage value as individuals, or as added value in land sales.

20. ***Delayed harvest*** - One eighth of tree planters in the sample have tree plots with no reported harvest. These planters are holding out for higher value products, and they intend to leave tree resources for their children.

21. ***Tree services*** - In many situations the service role of trees may be more important than tree products, e.g., use of trees as windbreaks, coffee shade, live fence and border management, aesthetics, shade for people and livestock, land improvement, risk management, store of value and emergency fund.

Planter Preoccupations

22. ***Store of value*** - Almost all planters attribute tremendous importance to the role of project trees as a store of value, a specialized reserve in the peasant scheme for managing risk. During periods of crop failure, trees are able to survive as hardy perennials. When animals are scarce, trees can be cut as a choice of last resort. The high incidence of charcoal harvest in the past three years highlights the role of trees as an emergency fund. Planters almost invariably state their interest in passing along stands of trees to the next generation.

23. ***Theft*** - There is a near universal problem of unauthorized cutting of trees. There is a consistent gap between trees harvested by tree planters and the actual number of stems cut. Interviews and site visits suggest that other people's trees tend to be mined covertly by people short of wood resources, especially for polewood and firewood. More distant field gardens are much harder hit than house-and-yard or gardens nearby. Unauthorized cutting presumably has a positive impact on local wood economies, but at the farmer's expense.

24. ***Multiple use*** - Farmers do not generally manage their trees primarily as a cash crop, but rather as a store of value with multiple uses both monetary and non-monetary.

25. ***Social capital*** - Most farmers report numerous gifts of trees to friends and family members. Clearly the trees play a role in managing farmers' social capital, instigating rights of reciprocity, capturing agricultural labor, securing employment, fulfilling social obligations and reinforcing patron-client relations.

26. ***Peasant house construction*** - Farmers value highly the opportunity to extract polewood for construction of houses and other shelters. In most areas visited, farmers are shifting from wood based mud-and-wattle houses to rock-lime houses which require fewer wood resources. Farmers generally assist all male children in house construction, and most kitchens are rebuilt every few years.

Impact of Trees

27. ***Survival*** - A survival of 35% was achieved by the farmers for trees planted between 1982-1986. This is a conservative estimate of the overall AOP and AFII survival, considering the better survival rates recorded during later years of the AOP and AFII when most trees were planted.

28. ***Wood productivity*** - Over 2 metric tons of wood per hectare are produced annually on sites planted to AOP trees. This includes standing and harvested trees, coppice stems and volunteers.

29. ***Standing trees*** - A third of the surviving trees are still standing. The most important species is *S. siamea* which was also the most widely planted species during the AOP and AFII. It makes up nearly a third of the original trees left standing, 40% of the basal area and over half of the standing wood yield. *C. equisetifolia*, *C. longissima*, *C. odorata*, and *G. robusta* have significantly more individuals standing than harvested and are being managed primarily for lumber, beams and joists.

30. ***Harvested trees*** - *S. siamea* and *L. leucocephala* account for 80% of the wood volume harvested to date. Most of the wood has been used for charcoal. Seventy-one percent of the *E. camaldulensis* and 74% of the *C. arborescens* have been harvested, mostly for construction wood. *G. robusta*, *E. camaldulensis* and improved *C. odorata* have considerably shortened the rotation age for lumber and are expected to increase in popularity.

31. ***Coppice regeneration of AOP trees*** - At least 4 species (*A. indica, S. siamea, L. leucocephala* and *E. camaldulensis*) have replaced themselves several times in terms of coppice stems. Coppice regeneration has the capacity to at least double the biomass production of the original trees for 5 species sampled in this study: *L. leucocephala* ssp. *glabrata*, *L. diversifolia* ssp. *diversifolia*, *S. siamea*, *Azadirachta indica*, *Eucalyptus camaldulensis*. So far, *A. indica*, *E. camaldulensis* and *L. leucocephala* are the most productive species, due in large part to their early harvests, yielding up to three fourths the wood volume harvested during the first rotation.

32. ***Seed regeneration of AOP trees*** - Regeneration from seed of the AOP trees is not considered sufficient on most sites to sustain current or future harvest demand. This is due more to land use decisions than reproductive capacity. Only 6 species were regenerating from seed at rates required for adequate restocking: *L. leucocephala* ssp. *glabrata*, *L. diversifolia* ssp. *diversifolia*, *S. siamea*, *C. arborescens, C. calothyrsus* and *A. indica*. Even the most prolific species, *L. leucocephala* and *S. siamea*, are variable in their regeneration across sites in Haiti, largely influenced by land management. At this stage of the project, most of the higher valued timber species have not regenerated from seed ***within the stand area***. However, a significant number of high value native species are being protected as volunteers from non-AOP sources.

33. ***Other regeneration modes of AOP trees*** - Root suckering is an important mode of regeneration for *A. indica* and *C. glauca*, which has been incorporated in the silvicultural strategy of several farmers. Injuries inflicted to the surface roots during crop cultivation has encouraged root suckering. Farmers are selecting stems for form and position within garden plots.

34. *Non-regenerating AOP trees* - *E. camaldulensis* and *C. equisetifolia* do not regenerate naturally from seed in Haiti and appropriate propagation techniques are still lacking amongst farmers. No farmers were interviewed that had a practical solution to the problem. Some of the *Eucalyptus* and *Casuarina* have survived 13 years of rugged site conditions and drought cycles. Superior tree selection at this stage should significantly increase genetic gain and broad adaptability. Timing is essential, since well adapted provenances are likely to be lost as AOP trees continue to be harvested.

35. *Native species* - Volunteers of native species were found on about half of the 43 sites. *Simarouba* spp., primarily dispersed by birds, was the most common volunteer on a third of the sites. Other valuable volunteer species included *C. calaba* (bat dispersed), *S. mahagoni* and *C. longissima* (both wind dispersed), and *B. salicifolia*, *R. hispaniolana* and *P. excelsa* (bird dispersed).

Bumelia salicifolia and *Cordia alliodora* regenerate well on disturbed sites and provide an excellent source of timber for the medium rotation periods (i.e., 8-10 years) that farmers prefer. Native species such as these merit greater attention by PLUS.

36. *Silvicultural systems* - Intensive inputs to tree management require a spatial scale and level of security that is out of reach for most of the AOP planters. There is a reluctance of many farmers to make critical decisions that would greatly increase the efficiency and efficacy of tree production, primarily shifting to improved genotypes and propagation techniques that shorten rotation age. The fact that farmers rely heavily on natural regeneration for their seedlings excludes many valuable species from consideration. PLUS should develop simple training material that would outline options available to the farmer, including species selection, sources of improved germplasm, simple cost benefit analyses, alternative propagation techniques, pest management, and sensible methods to improve stand yield. Innovative techniques to better manage trees are scattered and beg to be channeled more effectively through the PLUS extension system.

Impact on the Environment

Sustainable Agriculture

37. ***Stewardship of natural resources*** - Trees foster improved land management by serving as *plugs* to keep carbon and nutrients from leaking out of production, and as *pumps* to maintain carbon and nutrient cycling processes. The increase in tree densities on AOP sites achieves production while conserving the resources on which production depends.

38. ***Change in soil management*** - The impact of trees *per se* on rates of soil loss are less important than the change in soil management associated with tree planting. The most impressive sites had project trees growing on undisturbed soil. These were the woodlots and enriched borders that had developed a litter layer and dense understory. They typically surround cultivated fields and pasture land, playing an important role in inhibiting soil erosion, protecting soil nutrients in the field and improving hydrologic processes.

39. ***Landscape development*** - Tree dominated sites enhance greater stability across the Haitian landscape. Various configurations, densities and management strategies involving AOP trees increase the mosaic nature of the landscape, support a wider diversity of food webs that maintain ecosystem processes, and balance agricultural landuse by physically protecting a fragile substrate. These combine to insure greater environmental stability (Margalef, 1970; Ewel, 1986).

Habitat Diversity

40. ***Natural tree nurseries*** - The AOP trees are playing an important role as nurse trees that both attract seed dispersers and modify the microsite to favor germination. This in turn conserves natural pathways to tree regeneration which is the primary source of seedlings for the small farmer. Stocking rates are critically affected by the size, distribution and diversity of the tree configurations.

41. ***Wooded habitats*** - The availability of AOP trees, all at one time, facilitated a decision by farmers to establish woodlots, charcoal gardens and enriched fallows. The shortened time it took to develop a useful mix of tree species gave farmers a decisive advantage in creating a wooded habitat. However, before individuals can be expected to invest on a wider scale, wood theft and grazing rights must be controlled.

42. ***Degraded lands*** - Tree planting has increased the biomass production of degraded sites and enriched habitats both ecologically and economically. The planting of marginal sites that are no longer cultivated for crop production has allowed farmers to utilize the land more effectively. Several of the AOP species accumulate and process carbon and nutrients more efficiently than do many non-selected species. In doing so, they improve the soil and site quality, increase the potential of income, create habitats that provide food and shelter for native fauna, and pave the way for succession by other species.

Genetic Conservation

43. ***Genetic diversity*** **-** The genetic diversity of trees cultivated by farmers can be managed to increase productivity and enhance sustainability. The AOP introduced a number of tree species to peasant society that have generated important benefits. Use of a wide range of species is the easiest way to reduce risks, ensure stable production and optimize product quality. There are many underexploited native species that merit wider utilization. Germplasm coupled with improved management is still inaccessible to most AOP farmers, and opportunities are being forfeited.

44. ***Germplasm improvement*** **-** The fundamental issue is to provide broad adaptability while conserving an adequate genetic base for long term stability. Small farmers have limited ability to control the flow of improved genetic material, conserve a broad genetic base, and ensure sufficient seed supplies. Seed orchards established with well managed institutions and long-run time horizons are one option that should be continued to ensure genetic material for economically important species. Central nurseries provide a sensible means to distribute improved tree germplasm to farmers and are worth the cost of subsidized seedlings.

45. ***Exotic species vs. native species*** **-** The AOP has shown how adaptable many of the exotic species are in the Haitian context. As long as site conditions remain in a constant state of flux, exotic species will play an important role. However, the many endemic species are a heritage in danger of being lost. Also vulnerable is the ethnobotanical knowledge of peasant society. Both can be better utilized in development projects designed to reverse the environmental degradation in Haiti.

Project Assumptions in Retrospect

In the late 1970s and early 1980s, project planners made a series of assumptions in order to attain proposed project goals and objectives. From the privileged vantage point of a 16 year retrospective, how did project goals and assumptions hold up over time? These assumptions are summarized in Chapter I under the subtitle *Project Assumptions*. The following brief assessment moves from the guiding premise and related assumptions, to overall objectives and general purpose.

Underlying Premise: ***Peasant farmers can be motivated to plant large numbers of trees by undertaking the production of fast growing tropical hardwoods to be harvested as a cash crop.***

It is abundantly clear that farmers have been highly motivated to plant large numbers of project trees; however, planting motivations and patterns of harvest have been much broader than cash cropping, and much longer term than the anticipated quick turnaround on investment. Farmers cite a mix of long and short term goals, with a decided preference for long term, higher value products. In practice, preferred long term goals have frequently been sacrificed to meet pressing needs for cash, and to meet other household needs through piecemeal harvest of project trees for domestic consumption. Harvest of wood products has been decidedly mixed rather then focused on a single product. In most cases, the trees are managed as a long term store of value with multiple purposes. In any case, basic elements of the premise have proved valid: peasant farmers have planted large numbers of trees as a harvestable crop.

1. ***Peasant farmers are willing to try new crops if given the opportunity to do so without great risk.***

This has proved valid. In fact, woodlots and other configurations on peasant farms have visibly decreased agricultural risk. Farmers have had a general preference for familiar native species; however, they have shown a willingness to plant exotics previously unknown to them.

2. ***Farmers are oriented to cash crops with a relatively quick return on investment.***

This is true, but farmer motivations have proved to be more complicated than assumed. They do not view project trees as primarily a cash crop. They are more than willing to preserve trees for the long term if they can afford to do so.

3. ***Market incentives, especially for fuelwood and charcoal, are sufficient to motivate small farmers to plant hardwood trees on their own land.***

Most farmers have not planted primarily for fuelwood and charcoal sales. Many farmers with charcoal gardens have not managed their woodlots specifically for charcoal production. In long fallow zones of the northwest, farmers may come closer to fulfilling this proposition - particularly on enriched fallow sites where they practice periodic clearcutting. There is also a specialized commercial link between fuelwood plantations and quicklime production in Desforges.

4. ***Land tenure arrangements are adequate to promote investment of perennials on land which farmers hold securely.***

It was commonly assumed that farmers would plant trees on plots which they owned. In reality, they have been willing to plant on a much greater range and variation of land tenure arrangements than originally expected. The underlying issue is tree tenure rather than land tenure *per se*. In any case, the land tenure arrangements have not prevented farmers from planting trees.

On the other hand, land tenure insecurity does impose an overall constraint to the amount of land turned over to trees. This is a question of scale since farmers are willing to plant on a broad range of sites, but not on all possible sites within the land portfolios of peasant farms. Farmers clearly eliminate some sites from consideration. Furthermore, the scale of planting is limited by the need to preserve space for other uses, especially food crops. In most cases, project woodlots cannot compete with annual food cultigens as a cash cropping strategy.

5. Planters own the trees they plant on their own land, and are able to exercise full control over management and harvest.

Outright ownership of the trees was an extremely important element of project extension strategy. It remains an important ingredient of project success; however, planter rights have not always been respected by local authorities. This problem has continued as illustrated by the abusive extraction of cutting taxes noted by the team in Bainet. There is not yet adequate formal protection for tree planters in the legal framework for forestry and the environment. Existing laws are also not properly enforced.

Planter control is constrained by local practices which foster indiscriminate harvest of wood resources on private woodlots. Grazing violations also diminish planter control over wood management and harvest. These problems help to account for the tremendous gap between reported tree harvest and site inventory data.

6. Fast growing, leguminous fuelwood species with the ability to coppice are readily adapted to the peasant farm context.

This is generally valid, but there have sometimes been problems of proper species-site matching. The AOP species tend to be vigorous, opportunistic species resistant to fire and able to survive on harsh sites. Their survivability and coppicing ability are characteristics deemed highly desirable by most farmers. Species which farmers like because of desirable form, e.g., *Casuarina* and *Eucalyptus,* have proven difficult for farmers to propagate. This poses a potential problem of long term viability for these species on Haitian farms. In retrospect, greater knowledge and reproduction of native species would have been highly desirable. Future program efforts should actively promote propagation technologies accessible to farm practice.

7. It is feasible to plant fast growing hardwoods as a lucrative cash crop, harvestable within two or three years for fuelwood and charcoal.

Cash cropping fuelwood trees has not proved itself to be particularly lucrative, but charcoal species have proved their ability to be transformed into cash when farmers have pressing cash needs and no alternatives. There has been relatively little harvest after two or three years. There has been more harvest after four or five years, but peak harvest periods have generally been after eight or ten years. The fast growing trees can only compete with food crop revenues on highly degraded sites, or during periods of drought or crop failure, or as an alternative labor arrangement, e.g., in lieu of sharecropping annual crops, or as an alternative to food cultivation during periods of absentee plot management. Instead of being a lucrative alternative to annual cash crops, AOP tree cropping has served as an emergency fund, a backup system, a useful means of mitigating agricultural risk. Its greatest benefits to farmers have not been as a short term cash crop, but rather as a medium and longer term insurance fund and store of value.

Objectives: Formal AOP objectives stated in the Project Paper have been attained. Peasant farmers have proved to be highly motivated to plant and maintain trees for a variety of reasons including ***soil conservation, fuelwood*** and ***income***, and they have planted far more than a ***substantial number of trees.*** The willingness of farmers to plant trees only increased over time. Original tree planting targets were achieved many times over, and planter motivation showed no signs of slacking when the tree planting program was closed down in 1991. The project also carried out applied research as planned.

Purpose: The project desired *to help reverse environmental degradation, help restore green cover and improve the natural resource base.*

High levels of tree planting by small farmers have unquestionably been helpful to the environment. As a large scale strategy, the AOP has undoubtedly been the most successful tree planting project Haiti has ever seen. It has also created an extension system able to channel useful services directly to unprecedented numbers of peasant farmers. At the farm level, this success can be attributed in large part to key project innovations: (a) direct investment of the farmer in terms of land and labor, (b) planting strategies which build upon traditional practices, (c) promoting and protecting peasant rights to harvest trees which they plant, (d) distributing large allotments of trees per farmer - a practice which stimulated farmers to undertake major shifts in land use. The large numbers were made possible by subsidizing seedling distribution. The farmers would not otherwise have planted trees in such large numbers, and the environmental impact would have been minimal.

The AOP has had an important environmental impact; however, the farm forestry strategy has not restored the overall natural resource base. Green cover has been restored on thousands of widely dispersed microsites, but there are limits to this strategy due to the inherent fragmentation and dispersal of peasant farm plots with competing priorities. Overall, cash cropping of trees cannot compete with the relative price incentive of food crops.

The primary limitation on green cover is the sheer magnitude of agricultural occupation of the landscape. The Project Paper noted that 27 percent of the land was suitable for cropping, but 43 percent of Haiti's surface was farmed. The project has effectively taken some of this land out of production and turned it into green patches and perennial gardens - but this alone is not enough to restore Haiti's environment. The project paper takes note of fuelwood and charcoal harvest as the "major cause of excessive exploitation of forest resources." Project trees have diminished fuelwood pressures on other forest resources, but they haven't been channeled uniquely to this purpose nor have they supplanted the harvest of native species for fuelwood.

There are undoubtedly over a million peasant households in rural Haiti. The project has enrolled no more than 25 percent of scattered peasant households in the tree extension program. It has had an additional impact on other farm families not enrolled, but the majority of peasant families in Haiti remain untouched by the project. Total saturation of the peasantry with tree extension would help restore forest cover, but it would not resolve the problems of a peasant society in a chronic state of crisis, nor would it solve the problems of a natural resource base stressed to the breaking point.

A response to the environmental crisis should include, but not be limited to, continuing support for farm forestry. In fact, there are numerous project activities which have continued despite the absence of continued AFII funding. Jean-François Sauveur, a supplier of ongoing Rootrainer nurseries in Haiti, reports many continuing nursery operations. This includes such organizations as Parole et Action (Dutch funding), Helvetas (Swiss), Mouvman Peyizan Papay, Petits Frères de Ste. Thérèse, the Baptist Mission (Fermathe), ORE (Camp Perrin), Operation Double Harvest, CRWRC (Pignon), the Methodists (Gébeau), Cooperative Développement de Fond-des-Blancs, the Catholic Parish of La Chandlé (Gros Morne), and others. Sauveur is aware of at least a dozen organizations operating around 70 Rootrainer and plastic bag nurseries of varying production capacities. PVO seedling production levels this year are roughly estimated to be around four million trees. This does not include ongoing nursery and tree distribution through the PLUS program nor other organizations unknown to the study team and its informants.

Farmers protect volunteers and actively propagate project trees, but most farmers have not continued to plant trees on the same scale that they originally planted AOP trees. They note that central nursery seedlings are superior, that some species are difficult to propagate, and production of large numbers of seedlings is expensive. Jickling and White (1994) suggest that soil conservation investments generate a better economic return than agroforestry investments, and indigenous agroforestry yields are higher than project agroforestry.

This suggests several conclusions:

- Farm forestry should not be construed as a simple alternative to other forms of agricultural extension. From the farmer's perspective, hardwood production is not a cash crop on par with agricultural production. It occupies special niches and plays a complementary role in risk management and storage of value. Farmers are inclined to invest some land and labor in trees, but unlikely to invest scarce cash resources nor sacrifice opportunities for more lucrative food cropping.

- The AOP purpose for tree distribution has been different from farmer's goals, i.e., long term, macroenvironmental values versus shorter term household needs and microproduction values. There is a convergence of interests at the level of strategy - small scale production forestry. Environmental concerns justify farm forestry investments in ways that a simple calculus of farmer returns on investments do not. Environmental concerns and farmer self interest also argue strongly in favor of investment in other soil and water conservation services.

- ❑ Protection and promotion of native species, and traditional agroforestry practice, should be given greater emphasis in future agroforestry outreach programs. Safeguarding Haiti's unique biological diversity should be given very high priority. It is essential to make improved germplasm available to farmers.

- ❑ Environmental investments should include farm forestry but not be limited to this sector. It is crucial to support a much broader environmental strategy for Haiti including soil and water conservation services to farmers, farm forestry, protection of natural forests and other ecosystems, natural resource issues in urban planning, and other elements of national resource management. The present time is literally the last possible opportunity to protect important remnants of Haiti's unique forest ecosystems, e.g., mangroves, pine forests, thorny woodlands, dry forests, rainforests, and numerous endemic species (especially floristic species).

- ❑ Environmental and forest legislation needs to be assessed and reformed. Farm forestry itself is in need of improved legal protection including better safeguards for tree planter rights to harvest.

In the Haitian context, an environmental strategy is a futile exercise unless it goes beyond ecological assessments, and takes into account practical means for implementation in the face of overwhelming institutional problems, weak governmental structures, private sector interests, and the intractable problems of an overly stressed and underinvested agricultural landscape. In the long run, there must be a broader range of alternatives to peasant farming as the primary livelihood for most Haitians. Otherwise, little can be done for an environment stretched to the breaking point.

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APPENDIX 1

NON-PLANTER INTERVIEWS

Bombardopolis
Moise Lores
Aubriel Orius
Merisel Merisen

St. Michel de l'Attalaye
Michael Jackson Michel, ex-CECI technician
Jespere Jean, ex-CECI staff
Herod St. Juste, small *kleren* mill manager, Gad-Sevè
Jean Delatour, large *kleren* mill owner
Farmer, Trou Jean-Pierre

Grenier La Montagne
Dieujuste Lafleur, ex-animator
Farmer, Turen
Father André Martin, La Boule Parish, ex-tree project manager
2 charcoal vendors, Ste. Thérèse Market, Petionville

Bainet
Woman on road, swineherd, Chomey
Father Jean Parisot, ex-tree project manager

Fond-des-Blancs
House builder on footpath near site #37
Jean Thomas, ex-tree project manager

Ste. Hélène
Gaspard Brice, PADF regional team leader
3 PLUS planters (women), Banatt
Roadside firewood seller, Maniche road
3 charcoal wholesalers (women), Maniche Tuesday market

Port-au-Prince
Staff members of the USAID Mission, SECID, CARE and PADF

APPENDIX 2
LIST OF SCIENTIFIC AND COMMON TREE AND SHRUB NAMES MENTIONED IN THIS STUDY

Species Distributed by the USAID Agroforestry Outreach Project

LATIN NAME	AOP CODE	ENGLISH COMMON NAME	CREOLE COMMON NAME
Acacia auriculiformis A. Cunn. ex Benth.	ACAU	ear pod wattle	akasya
Albizia saman (Jacq.) F. Muell.	ALSA	raintree, saman	saman, gwanegoul
Azadirachta indica Adr. Juss.	AZIN	neem	nim
Calliandra calothyrsus Meissner	CACA	calliandra	kaliandra
Casuarina equisetifolia L. ex J.R. Forst.	CAEQ	casuarina, Australian pine	pich pen, kazowina
Casuarina glauca Sieb. ex Sprengel	CAGL	casuarina, Australian pine	pich pen, kazowina
Catalpa longissima (Jacq.) Dum. Cours.	CALO	Haitian catalpa, Haitian oak	chènn, bwa chènn, bwad chènn
Cedrela odorata L.	CEOD	Spanish cedar	sèd
Colubrina arborescens (Mill.) Sarg.	COAR	snake bark, coffee colubrina	bwa ple, kapab, roujiòl
Eucalyptus camaldulensis Dehnh.	EUCA	eucalyptus, red river gum	kaliptis
Gliricidia sepium (Jacq.) Walp.	GLSE	mother-of-cocao	lila etranje, piyon, pinyong
Grevillea robusta A. Cunn. ex R. Br.	GRRO	silver oak, silk oak, grevillea	grevilya, chènn dostrali
Guazuma ulmifolia Lam.	GUUL	West Indian elm, bastard cedar	bwa dòm
Leucaena diversifolia (Schlecht.) Benth. subsp. *diversifolia*	LELE	diversifolia	lisina ti fey
Leucaena leucocephala (Lam.) de Witt subsp. *glabrata* (Rose) S. Zarate	LEDI	giant leucaena, Salvador leucaena	lisina, lisina gran fey, delen etranje
Pinus occidentalis Swartz	PIOC	Hispaniolan pine	bwa pen, bwa chandel, pich pen
Senna siamea (Lam.) Irwin & Barneby	CASI	Siamese senna, Siamese cassia	kasya
Simarouba berteroana Krug & Urb.	SIBE	simarouba, princess tree	fwènn, fwènn etranje,bwa blan
Swietenia mahagoni (L.) Jacq.	SWMA	West Indian mahogony	kajou, kajou peyi

Native (& Naturalized) Tree and Shrub Species

SPECIES	CREOLE COMMON NAMES	FRENCH COMMON NAMES
Acacia spp.	bayahonn, bayahonn rouge, zakasya rouj, zakasya nwa	acacia noire, acacia rouge, bayaronne
Acacia farnesiana (L.) Willd.	bayahonn, zakasya, zakasya fran, zakasya jòn	acacia, acacia jaune, acacia odorant
Acacia scleroxyla Tuss.	kandelon, tandrakayou, bwa savann	candelon, tendre-à-cailloux, bois savane
Agave sisalana Perrine	pit	pite, pite sisal, sisal
Annona muricata Macf.	kowosol	corossol, corossolier
Annona squamosa L.	kachiman	cachiman, cachiman cannelle

SPECIES	CREOLE COMMON NAMES	FRENCH COMMON NAMES
Artocarpus altilis (Parkinson) Fosberg	lam veritab, labapen	arbre-à-pain, arbre véritable
Atelia gummifer (Bert.) D. Dietr.	bwa santi	bois senti
Bauhinia divaricata L.	bwa kalson	bois caleçon, collègue, matourin
Beilschmiedia pendula (Sw.) Hemsl.	bwa nwa	bois noir
Bromelia pinguin L.	pengwen	pinguin
Bumelia salicifolia (L.) Sw.	koma rouj, m'panash, sip	acomât rouge, sapotille marron
Bunchosia glandulosa (Cav.) L.C. Rich	bwa kaka, bwa poulet	bois caca, bois poulette
Calophyllum calaba L.	damari, dalmari, galba	dame-marie
Capparis cyanophallophora L.	bwa dajan, bwa kaka, bwa piant	bois caca, bois d'argent, bois fétide, bois puant, bois sénégal
Cecropia peltata L.	twompet	bois canon, bois trompette, trompette
Chrysophyllum cainito L.	kaymit	caïmite, bon caïmite,caïmite des jardins, caïmite franche, caïmitier, caïmitier à feuilles d'or, grande caïmite
Chrysophyllum oliviforme L. var. *oliviforme*	kaymit mawon, kaymit sovaj	caïmite, caïmite marron, caïmite sauvage, caïmitier ferrugineux, caïmitier olivaire
Citrus aurantifolia (Christm.) Swingle	sitwon	citron, citron vert, citronnier
Citrus aurantium L.	zoranj si	orange sure
Citrus maxima (J. Burm.) Merr.	chadèk	chadèque
Citrus sinensis (L.) Osbeck	zoranj dous	orange douce, oranger
Coccothrinax argentea (Lodd. ex Schult.) Sarg. ex Becc.	gwenn, latanye bourik, latanye mawon, palm koyo	gouane, latanier bourrique, latanier marron, palme coyau
Cocos nucifera L.	kokoye	cocotier, cocoyer, noix de coco, coq au lait
Comocladia spp.	bwa panyol, bresyèt, brizyèt	bois pagnol, brésillet
Daphnopsis americana (Mill.) J.R. Johnst. ssp. *cumingii* (Meissn.) Nevl.	maho	mahaut
Eugenia spp.	ti fey	bois petites feuilles, malaguette, maguette, merisier, merise
Euphorbia lactea Haw.	kandelab	candélabre, raquette
Exostema caribaeum (Jacq.) Roem. & Schult.	kenkena	chandelle anglaise, quinine, quinquina
Guaiacum officinale L.	bwa sen, gayak, gayak fran, gayak mal	arbre de vie, bois saint, gaïac, gaïac mâle
Guaiacum sanctum L.	bwa sen, gayak, gayak blan, gayak femèl	gaïac, gaïac blanc,gaïac femelle, gaïac cardasse
Haematoxylon campechianum L.	kampèsh	campêche, campechier
Inga vera Willd. ssp. *vera*	sikren, pwa dou	sucrin, pois doux, pois sucrin, sucrier
Leucaena leucocephala (Lam.) de Witt subsp. *leucocephala*	delen, madelin	bois bourro, graines de lin, graines de lin pays, marie jaune, tcha-tcha marron
Mangifera indica L.	mango, margo	mango, manguier
Melicoccus bijugatus Jacq.	kenèp	quenèpe, quénépier
Musa acuminata Colla x *M. bulbisiana* Colla 'AAB'	banann	banane, bananier

SPECIES	CREOLE COMMON NAMES	FRENCH COMMON NAMES
Persea americana Miller	zaboka, zabelbok	avocat, avocatier
Picrasma excelsa (Sw.) Planch.	fwènn	frêne, gorie frêne, goric
Prosopis juliflora (Sw.) DC.	bayahonn, gwatapana	bayahonde, bayahonde français, chambron
Pseudolmedia spuria (Sw.) Griseb.	meriz	bois mérise, longue barbe, mérisse
Psidium dictyophyllum Urb. & Ekm.	magèt	malaguette, maguette
Psidum guajava L.	gwayav	goyave, goyavier
Randia aculeata L.	krok chien	croc-à-chien, croc chien
Roystonea hispaniolana L. H. Bailey	palmis	palmiste, palmier royal
Sabal causiarum (Cook) Bailey	latanye, latanye fran, latanye jòn	latanier, latanier chapeau, latanier franc, latanier jaune
Senna atomaria (L.) Irwin & Barneby	bwa kabrit	bois cabri, casse marron, casse-à-bâton, manger cabri
Simarouba glauca DC. var. *latifolia* Cronq.	fwenn, bois blan	frêne, bois blanc, d'olive, bois négresse
Spondias mombin L.	mombin, mombin fran	grand mombin, gros mombin, mombin, mombin franc, myrobalane
Terminalia catappa L.	zamann	amande, amandier des indes, amandier tropicale, badannier
Trichilia hirta L.	mombin bata	mombin bâtard, marie-jeanne, boudou, gommier sauvage, bois arada
Vetiveria zizanioides (L.) Walsh	vetivè	vétiver
Xanthosoma sagittifolium (L.) Schott	malanga	malanga
Yucca aloifolia L.	bayonet	bayonette
Zanthoxylum spp.	bwa pine, bwa pini	piné, bois épineux, pinit

APPENDIX 3
INVENTORY OF AOP TREE PLOTS

Table I. Number of stems (> 2 cm diameter) tallied on 43 sites for the major AOP tree species planted between 1982-1986.

Species	Standing Original Trees	Harvested Original Trees	Standing Coppice Stems	Volunteers	Harvested Coppice Stems	Harvested Volunteers	Standing Coppice/ Volunteers	Harvested Coppice/ Volunteers	TOTAL STEMS
Lisina *Leucaena leucocephala*	100	1,335	2,107	5,515	1,799	171	195	87	11,309
Kasya *Senna siamea*	415	823	1,342	1,237	1,245	305	73	61	5,501
Nim *Azadirachta indica*	35	100	425	130	340	60	98	15	1,203
Kaliptis *Eucalyptus camaldulensis*	106	255	270		254				885
Pich Pen *Casuarina equisetifolia*	348	63							411
Kapab *Colubrina arborescens*	41	115	35	84	7				282
Chènn *Catalpa longissima*	127	13	5						145
Grevilya *Grevillea robusta*	87	49	13						149
Pich Pen *Casuarina glauca*	38	53	23		9				123
Sèd *Cedrela odorata*	59	27	14						100
7 spp.	29	26	17	22	2	0			96
TOTAL	1,385	2,859	4,251	6,988	3,656	536	366	163	20,204

Table II. Estimated basal area (m^2) of trees and coppice stems tallied on 43 sites for the major AOP tree species planted between 1982-1986. Stump basal areas are in brackets.

Species	Standing Original Trees	Harvested Original Trees	Standing Coppice Stems	Volunteers	Harvested Coppice Stems	Harvested Volunteers	Standing Coppice/ Volunteers	Harvested Coppice/ Volunteers	TOTAL Stand. Harv.
Kasya *Senna siamea*	6.77	18.43 [23.04]	3.00	0.88	3.82 [4.77]	1.53 [1.91]	0.05	0.10 [0.12]	S10.70 H23.88
Lisina *Leucaena leucocephala*	0.48	12.60 [15.75]	1.83	2.51	3.53 [4.41]	0.99 [1.23]	0.12	0.24 [0.31]	S 4.94 H17.36
Kaliptis *Eucalyptus camaldulensis*	2.01	1.89 [2.36]	0.37		0.71 [0.89]				S 2.38 H 2.60
Pich Pen *Casuarina equisetifolia*	3.61	0.50 [0.62]							S 3.61 H 0.50
Nim *Azadirachta indica*	0.4	1.54 [1.92]	0.4	0.11	0.80 [1.00]	0.29 [0.36]	0.09	0.02 [0.03]	S 1.00 H 2.65
Pich Pen *Casuarina glauca*	0.5	0.85 [1.06]	0.03		0.02 [0.03]				S 0.53 H 0.87
Kapab *Colubrina arborescens*	0.31	1.02 [1.28]	0.04	0.09	0.02 [0.02]				S 0.44 H 1.04
Chènn *Catalpa longissima*	0.99	0.03 [0.04]	0.01						S 1.00 H 0.03

Species	Standing Original Trees	Harvested Original Trees	Standing Coppice Stems	Volunteers	Harvested Coppice Stems	Harvested Volunteers	Standing Coppice/ Volunteers	Harvested Coppice/ Volunteers	TOTAL Stand. Harv.
Sèd *Cedrela odorata*	0.85	0.18 [0.23]	0.04						S 0.89 H 0.18
Grevilya *Grevillea robusta*	0.91	0.96 [1.20]	0.07						S 0.98 H 0.96
7 spp.	0.53	0.28 [0.35]	0.06	0.04	0	0	0	0.01 [0.01]	S 0.63 H 0.29
TOTAL	17.36	38.27 [47.85]	5.85	3.63	8.90 [11.13]	2.81 [3.51]	0.26	0.37 [0.46]	S 27.10 H 50.35

Table III. Estimated dry wood weights (metric tons) tallied on 43 sites for the major AOP tree species planted between 1982-1986. Mean tree wood yields, in kg, are given in parentheses. Dry weights for *Cedrela odorata* and *Grevillea robusta* were not estimated for lack of volume tables in Haiti.

Species	Standing Original Trees	Harvested Original Trees	Standing Coppice Stems	Volunteers	Harvested Coppice Stems	Harvested Volunteers	Standing Coppice/ Volunteers	Harvested Coppice/ Volunteers	TOTAL Stand. Harv.
Kasya *Senna siamea*	29.23 (70.4)	(62.3) 51.24	5.14 (3.8)	2.25 (1.8)	(11.8) 14.6	(21.7) 6.63	0.05 (0.6)	(6.1) 0.37	S 36.67 H 72.84
Lisina *Leucaena leucocephala*	2.31 (23.1)	(41.3) 55.16	4.89 (2.3)	7.09 (1.3)	(4.2) 7.54	(25.4) 4.34	0.33 (1.7)	(6.0) 0.52	S 14.62 H 67.56
Pich Pen *Casuarina equisetifolia*	14.89 (42.8)	(29.5) 1.86							S 14.89 H 1.86
Kaliptis *Eucalyptus camaldulensis*	4.78 (45.1)	(23.3) 5.94	0.89 (3.3)		(11.1) 2.83				S 5.67 H 8.77
Nim *Azadirachta indica*	1.16 (33.1)	(34.6) 3.46	0.97 (2.2)	0.26 (2.0)	(4.9) 1.68	(7.0) 0.42	0.21 (2.1)	(3.7) 0.06	S 2.60 H 5.62
Kapab *Colubrina arborescens*	0.8 (19.5)	(56.6) 6.51	0.08 (2.3)	0.23 (2.8)	(15.9) 0.11				S 1.11 H 6.62
Pich Pen *Casuarina glauca*	2.07 (54.6)	(47.1) 2.50	0.09 (3.9		(5.5) 0.05				S 2.16 H 2.55
Chènn *Catalpa longissima*	2.17 (17.0)	(2.1) 0.03	0.02 (3.8)						S 2.19 H 0.03
TOTAL	57.41 (excl. 6 spp.)	(excl 6 spp) 126.70	12.08 (excl. 4 spp)	9.83 (excl. 1 sp)	(excl 2 spp) 26.81	11.39	0.59	0.95	S 79.91 H 165.85

Table IV. Survival of trees at time of first harvest, as measured during this study. Site survival rates are indicated in **bold face.** * = uncertain actual number planted on site or survival estimates were not possible.

Site No.	Location	Est. Date	No. Planted	No. Surv.	Survival Rate (%)	Comments (including reasons why survival estimates were not possible)
1	Klenèt	9/86	**200**	**57**	**28**	Overall survival of 4 spp.; block; part of total lakou garden.
2	Krèv	5/84	**350**	**186**	**53**	Overall survival of 5 spp.; block; lakou garden.
3	Demoulin	9/85	**250**	**95**	**38**	Overall survival of 6 spp.; block; lakou garden.
4	Demoulin	9/85	100	54	54	*Colubrina arborescens*; dispersed; close garden.
5	Krèv	5/85	190	122	64	*Senna siamea*; border; distant garden.
5	Krèv	5/85	40	17	43	*Acacia auriculiformis*; border; distant garden.
5	Krèv	6/85	**850**	**270**	**32**	Overall survival of 8 spp.; border; distant garden.

Site No.	Location	Est. Date	No. Planted	No. Surv.	Survival Rate (%)	Comments (including reasons why survival estimates were not possible)
6	Boukèt	6/83	**250**	**190**	**76**	Estimated by subsampling of original and current tree densities and approximate area planted to trees; *Leucaena leucocephala*; block; distant garden.
7	Dibois	9/84	125*	*	*	Did not tally total stand; sub-sampled *Leucaena leucocephala* harvest area.
8	Nan Jan	9/84	500	*	*	*Leucaena leucocephala*; eliminated many stumps in annual garden.
9	Sou Platon	9/84	150	143	95	*Leucaena leucocephala*; block; close garden.
9	Sou Platon	9/84	100	54	54	*Eucalyptus camaldulensis*; block; close garden.
9	Sou Platon	9/84	**250**	**197**	**79**	Overall survival of 2 spp.; block; close garden.
10	Sou Platon	9/82	100	50	50	*Eucalyptus camaldulensis*; block; close garden.
10	Sou Platon	9/82	150	*	*	Eliminated too many *Leucaena leucocephala* stumps prior to visit.
11	Des Abbé	9/85	100	44	44	*Eucalyptus camaldulensis*; block; close garden.
11	Des Abbé	9/85	100	77	77	*Leucaena leucocephala*; block; close garden.
11	Des Abbé	9/85	50	41	82	*Colubrina arborescens*; block; close garden.
11	Des Abbé	9/85	**250**	**162**	**65**	Overall survival of 3 spp.; block; close garden.
12	Des Abbé	5/85	250*	*	*	Planted on more than one site; uncertain actual site numbers; eliminated stumps on annual garden site.
13	Gad-Batis	5/83	25	6	24	*Senna siamea*; border; close garden.
13	Gad-Batis	5/83	100	32	32	*Catalpa longissima*; block; close garden.
13	Gad-Batis	5/83	**125**	**38**	**30**	Overall survival of 2 spp.; mixed; close garden.
14	Gad-Batis	5/84	250*	*	*	Planted on more than one site; uncertain actual site numbers.
15	Gad-Batis	5/84	**350**	**143**	41	*Senna siamea*; dispersed; distant garden.
16	Kay-an-Sek	5/83	125	17	14	*Eucalyptus camaldulensis*; dispersed; close garden.
16	Kay-an-Sek	5/83	175	11	6	*Albizia saman*; border; close garden.
16	Kay-an-Sek	5/83	75	9	12	*Casuarina equisetifolia*; dispersed; close garden.
16	Kay-an-Sek	5/83	125	1	1	*Azadirachta indica*; dispersed; close garden.
16	Kay-an-Sek	5/83	**500**	**38**	**8**	Overall survival of 4 spp.; mixed; close garden.
17	Kay-an-Sek	5/84	**250**	**63**	**25**	Overall survival of 5 spp.; dispersed; lakou garden.
18	Kay-an-Sek	5/83	**250**	**67**	**27**	Overall survival of 4 spp.; mixed; close garden.
19	Kay-an-Sek	9/84	**250**	**93**	**37**	Overall survival 4 spp.; block; lakou garden.
20	Bois Neuf	9/86	50	36	72	*Grevillea robusta*; border; distant garden.
20	Bois Neuf	9/86	50	10	20	*Colubrina arborescens*; border; distant garden.
20	Bois Neuf	9/86	25	12	48	*Catalpa longissima*; border; distant garden.
20	Bois Neuf	9/86	25	12	48	*Cedrela odorata*; border; distant garden.
20	Bois Neuf	9/86	**150**	**70**	47	Overall survival of 4 spp.; border; distant garden.
21a	Grenier	5/82	250*	*	*	Repeat farmer; uncertain # of originals and dates.
21b	Grenier	5/82	250*	*	*	Repeat farmer; uncertain # of originals and dates.
22	Anba Lakou	5/84	385*	*	*	Repeat farmer; uncertain # of originals and dates.
23	Kayanwo	9/82	125	51	41	*Senna siamea*; block; close garden.

Site No.	Location	Est. Date	No. Planted	No. Surv.	Survival Rate (%)	Comments (including reasons why survival estimates were not possible)
23	Kayanwo	9/82	125	*	*	*Leucaena* not tallied due to weed growth and rotten stumps.
24	Kayanwo	5/82	**250**	**124**	**50**	Overall survival of 3 spp.; mixed; close garden.
25	Zaboka Jòn	9/82	**250**	**119**	**48**	Overall survival of 3 spp.; block; close garden.
26	Chomey	9/83	**250**	**16**	**6**	Overall survival of 3 spp.; border; close garden.
27	Chomey	9/83	**120**	**44**	**37**	*Senna siamea*; border; close garden.
28	Nan Jwen	5/82	**250**	**75**	**30**	Overall survival of 4 spp.; block; close garden.
29	Kayanwo	5/82	**250**	**71**	**28**	Overall survival of 3 spp.; border; lakou garden.
30	Kayanwo	5/83	**250**	**45**	**18**	Overall survival of 3 spp.; block; lakou garden.
31	Zaboka Jòn	9/82	**250**	**66**	**26**	Overall survival of 3 spp.; border; lakou garden.
32	Jo Fourneau	5/82	50	38	76	*Casuarina equisetifolia*; block; distant garden.
32	Jo Fourneau	5/82	100	38	38	*Senna siamea*; block; distant garden.
32	Jo Fourneau	5/82	100	41	41	*Leucaena leucocephala*; block; distant garden.
32	Jo Fourneau	5/82	**250**	**117**	**47**	Overall survival of 3 spp.; block; distant garden.
33	Morne- Franck	5/82	**250**	**80**	**32**	*Casuarina equisetifolia*; block; close garden.
34	Nan Freshè	9/83	**250**	**56**	**22**	*Casuarina equisetifolia*; block; lakou garden.
35	Lexy	5/83	**250**	**43**	**17**	Overall survival of 3 spp.; dispersed; lakou garden.
36	Corail	5/83	**250**	**20**	**8**	*Cedrela odorata*; border; close garden.
37	Lexy	5/82	125	106	84	*Leucaena leucocephala*; block; close garden.
37	Lexy	5/82	125	27	22	*Senna siamea*; block; close garden.
37	Lexy	5/82	250	164	66	*Casuarina equisetifolia*; block; close garden.
37	Lexy	5/82	**500**	**296**	**59**	Overall survival of 3 spp.; block; close garden.
38	St. Thon	5/82	500	79	16	*Senna siamea*; block; close garden.
38	St. Thon	5/82	250	137	55	*Leucaena leucocephala*; block; close garden.
38	St. Thon	5/82	**750**	**216**	29	Overall survival of 2 spp.; block; close garden.
39	Melisan	5/82	250	67	27	Overall survival of 2 spp.; border; close garden.
40	Cassis	3/83	**150**	**63**	**42**	*Leucaena leucocephala*; block; close garden.
41	Mas Suzanne	8/83	50	21	42	*Azadirachta indica*; border; distant garden.
41	Mas Suzanne	8/83	50	9	18	*Senna siamea*; border; distant garden.
41	Mas Suzanne	8/83	50	3	6	*Eucalyptus camaldulensis*; border; distant garden.
41	Mas Suzanne	8/83	**150**	**33**	**22**	Overall survival of 3 spp.; border; distant garden.
42	Turin	9/82	75	15	20	*Grevillea robusta*; border; close garden.
42	Turin	9/82	25	3	12	*Catalpa longissima*; border; close garden.
42	Turin	9/82	25	6	24	*Casuarina glauca*; border; close garden.
42	Turin	9/82	25	4	16	*Cedrela odorata*; border; close garden.
42	Turin	9/82	**150**	**28**	**19**	Overall survival of 4 spp.; border; close garden.

Table V. Regeneration from seed of *L. leucocephala* subsp. *glabrata* (columns 4-6) on AOP sites planted between 1982-1986. Stem diameter classes are measured at 1.3 m above ground level.

Site No.	Stand Area (ha)	Surviving Parent Trees	Stem Diameter Class <1 cm	1-3 cm	3+ cm	*Leucaena* Management Notes
1	0.03	14	0	0	5	Wood lot. Small volunteers weeded out for garden. Browse for livestock and larger volunteers thinned for pole production with other species.
2	0.14	1	19,600	0	0	Wood lot. Eventual thinning of volunteers for charcoal production underneath *Eucalyptus* for beams, masts and lumber.
6	0.14	201	2,059	965	14	Charcoal garden. Allowing volunteers to compete with coppice toward a mixed-aged stand for charcoal production.
7	0.06	63	252	10	5	Same as # 6.
8	0.24	415	199	0	0	Annual garden and 9 yr. fallow. Eliminating volunteers on productive garden site; allowing volunteers to be browsed heavily by livestock as fodder bank.
9	0.1	143	40,000	550	0	Charcoal garden. Soil conservation on 45% slope. Thinning heavy regeneration to create mixed-aged stand for charcoal production.
10	0.15	37	0	0	0	Annual garden. Eliminates natural regeneration completely for the cultivation of lima beans (*pwa chous*).
11	0.18	77	0	0	0	Wood lot. Negligible regeneration at high elevation (780 m).
14	0.45	3	36	9	0	Annual garden. Sparse regeneration; no attempt to manage volunteers.
19	0.25	1	0	0	0	Annual garden. Negligible regeneration from one mother tree.
23	0.1	19	2,000	275	37	Charcoal garden. Heavily browsed by goats as fodder bank; larger volunteers thinned and managed for charcoal production toward a mixed-aged stand.
24	0.18	8	0	0	0	Annual garden. Eliminated natural regeneration from garden sites; no regeneration present due to elimination of parent trees.
25	0.24	41	600	5	0	Wood lot. Soil conservation on 72% slope. May thin volunteers for charcoal and pole production.
28	0.1	3	350	8	0	Annual garden. Heavily browsed by livestock and currently weeded out for cultivation of beans (*pwa koulè*).
29	0.25	51	0	0	2	Annual/perennial garden. Weeds out volunteers, but occasionally allows one to reach harvestable stem size (10-12 cm) along with a diversity of native species.
30	0.1	3	0	0	0	Annual garden. No regeneration observed as a result of intensive garden cultivation for beans and sweet potato.

Site No.	Stand Area (ha)	Surviving Parent Trees	Stem Diameter Class <1 cm	1-3 cm	3+ cm	*Leucaena* Management Notes
31	0.25	5	900	6	1	Annual/perennial garden. Regeneration only occurring in vicinity of 1 mother tree. Occasionally allows one to reach harvestable stem size (16 cm) along with a diversity of native species.
32	0.1	41	1,500	30	6	Wood lot. Soil conservation on 68% slope. Natural thinning of volunteers for charcoal production.
35	0.1	4	0	0	0	Annual/perennial garden. Negligible regeneration due to continual cultivation of food crops.
37	0.2	106	40,400	43	20	Wood lot/pasture. Soil conservation on 42% slope. Multiple-use as animal browse and wood production of volunteers through natural thinning.
38	0.4	137	24,000	0	0	Charcoal and annual garden. Volunteers released by recently harvested stand of *Leucaena* and *Senna siamea* overstory. Will select with occasional stem with diversity of native species in a bean (*pwa nwa*) garden.
40	0.07	63	2,700	670	410	Charcoal garden. Soil conservation on 67% slope. Allowing full regeneration toward mixed aged stand by harvesting stems greater than 7 cm diameter for charcoal and firewood.
TOT	3.83	1,436	134,596	2,571	500	

Table VI. Regeneration from seed of *S. siamea* (columns 4-6) on AOP sites planted between 1982-1986. Stem diameter classes are measured at 1.3 m above ground level.

Site No.	Stand Area (ha)	Surviving Parent Trees	Stem Diameter Class <1 cm	1-3 cm	3+ cm	*Senna* Management Notes
2	0.14	21	26	0	0	Wood lot. Neglected. Proposes management for charcoal with *Leucaena* under canopy of *Eucalyptus* for lumber, masts and beams.
3	0.16	69	32	0	0	Annual garden. Occasional stem selected and spaced for pole and wood production.
5	0.64	196	139	0	0	Annual garden. Regeneration only in block of 25 adult trees, not along garden border. No attempt to thin.
8	0.24	0	0	0	0	Annual garden and 9 yr. fallow. Species completely failed on site.
12	0.1	8	0	0	0	Annual garden. High elevation site (790 m); no regeneration.
13	0.07	8	1,020	0	0	Annual garden. Eventual pruning for pole and lumber production.
14	0.45	21	128	6	0	Annual garden. No attempt to manage volunteers.
15	0.47	143	715	572	0	Charcoal garden. Released stand for mixed-aged charcoal production.
17	0.1	24	384	104	17	Wood lot and annual/perennial garden. Thins and selects for pole and lumber production.

Site No.	Stand Area (ha)	Surviving Parent Trees	Stem Diameter Class <1 cm	1-3 cm	3+ cm	*Senna* Management Notes
18	0.25	36	0	70	35	Annual garden. Thins and selects for pole and lumber production.
19	0.25	52	1,300	45	0	Wood lot. Restricts volunteer stand development in new area of garden.
23	0.1	59	27	3	0	Charcoal garden. Developing toward a mixed-aged stand for charcoal production.
24	0.18	90	8,372	828	180	Wood lot. Mixed-aged stand managed for charcoal and pole production. Productivity could be increased by eliminating heavy volunteer competition.
25	0.24	55	0	0	0	Wood lot. No regeneration on site.
26	0.1	2	0	0	0	Annual garden. No regeneration on site.
27	0.12	44	0	0	58	Annual garden. Past selection and spacing for stem wood. Recent seed crops weeded out for annual garden.
28	0.1	42	51	2	0	Annual garden. Current crop of volunteers likely to be clear weeded for bean (*pwa nwa*) garden.
29	0.25	12	18	20	7	Annual/perennial garden. Actively selects volunteers during garden preparation for pole and lumber production.
30	0.1	33	23	0	0	Annual garden. Complete elimination of volunteers in garden area. All volunteer production in border area with sisal (*Agave* sp.).
31	0.25	58	536	1	44	Annual/perennial garden. Volunteer stem distribution up to 29 cm; manages and selects for pole and lumber production trees, including diversity of other wood species. Actively transplants to other garden locations.
32	0.1	39	9	1	3	Wood lot. Selects and spaces volunteers for small wood production with diversity of other wood species.
35	0.1	41	0	0	0	Annual garden. Complete elimination of volunteers in garden area.
37	0.2	27	0	0	0	Wood lot/pasture. No regeneration.
38	0.4	95	800	0	0	Charcoal and annual garden. Selects for dominant volunteers at wide spacing with other native wood species. Intercropped with bean garden (*pwa nwa*).
39	0.63	54	120	2	28	Annual/perennial garden. Selects for dominant volunteers at wide spacing with other native wood species. Intercropped with bean garden.
41	0.17	9	2	1	6	Wood lot/pasture. Left to grow for charcoal production on land no longer in food production.
TOT	5.91	1,238	13,702	1,655	378	

Table VII. Natural regeneration of *Azadirachta indica* (columns 4-6) on AOP sites planted between 1982-1986. Stem diameter classes are measured at 1.3 m above ground level.

			Stem Diameter Class			
Site No.	Stand Area (ha)	Surviving Parent Trees	<1 cm (stems)	1-3 cm dia. (stems)	3+ cm dia. (stems)	*Azadirachta* Management Notes
3	0.16	8	17	0	0	Annual garden. Occasional stem selected and spaced for pole and wood production.
5	0.64	8	4	0	0	Annual garden. Regeneration only in an area of 3 adult trees. No observable interventions.
16	0.41	1	0	0	0	Annual/pereniial garden. Poor parent tree survival and no regeneration.
17	0.1	22	0	0	0	Annual/perennial garden. No regeneration.
28	0.1	6	8	1	0	Annual/perennial garden. Current crop of volunteers are located near a path and damaged from the traffic. No attempt to protect or transplant volunteers.
39	0.63	12	6	3	0	Annual garden. Allowing the volunteers to grow in place. Significant amount of root suckering as a result of root injury during soil tilling activities. Managing root suckers as individual stems.
41	0.17	21	0	0	0	Wood lot/pasture. Left to grow for charcoal production on land no longer in food production. Difficult to distinguish between volunteers and root suckers. Managing large number of root suckers (up to 1,400 stems ha^{-1}) as individual stems for charcoal production.
TOT	2.21	78	35	4	0	

Table VIII. Regeneration from seed of *Colubrina arborsecens* (columns 4-6) on AOP sites planted between 1982-1986. Stem diameter classes are measured at 1.3 m above ground level.

			Stem Diameter Class			
Site No.	Stand Area (ha)	Surviving Parent Trees	<1 cm (stems)	1-3 cm dia. (stems)	3+ cm dia. (stems)	*Colubrina* Management Notes
1	0.03	2	0	0	0	Wood lot/annual garden. No regeneration, though farmer is managing *Leucaena* volunteers for poles.
2	0.14	1	0	0	0	Wood lot. No regeneration. Neglected volunteers of other species, with intention of converting to mixed charcoal/pole wood lot.
3	0.16	3	2	2	0	Annual garden. Volunteers interspersed with annual garden and left to grow for construction wood. Periodic transplanting of volunteers to site from other locations for *Cedrela odorata* and *Catalpa longissima*.
4	0.15	54	156	42	42	Annual garden/pasture. Volunteers are spaced to an average 3.8 m and intercropped. Most regeneration extends out 20 m from parent stand. Fringe area of volunteer stand heavily damaged by goat browse.
5	0.64	4	1	0	0	Annual garden. No observable interventions.
11	0.18	41	31	0	0	Wood lot. Poor site matching of lowland small-leaf variety.

Site No.	Stand Area (ha)	Surviving Parent Trees	Stem Diameter Class <1 cm (stems)	1-3 cm dia. (stems)	3+ cm dia. (stems)	*Colubrina* Management Notes
12	0.1	21	49	2	0	Annual garden. All parent trees harvested; most of the volunteers occur in shade of wooded perennial garden adjacent to planting site.
20	0.15	8	0	0	0	Annual garden. No regeneration. Site is heavily cultivated in vegetable crops; parent trees are planted as single row border and harvested early for small construction wood.
21a	0.14	9	0	0	0	Annual/perennial garden. No regeneration. Site is a mixed perennial garden near owner's residence.
21b	0.25	6	0	0	0	Annual garden/pasture. No regeneration. Sites is heavily cultivated in vegetable crops. Insecure site problems with stolen parent trees. Species gradually eliminated from site.
22	0.29	7	0	0	0	Annual garden/pasture. No regeneration. Insecure site problems with stolen parent trees. Species gradually eliminated from site.
TOT	2.23	156	239	46	42	

Table IX. Regeneration from seed of selected species that were observed (columns 4-6) on AOP sites planted between 1982-1986. Stem diameter classes are measured at 1.3 m above ground level.

Site No.	Stand Area (ha)	Species	Surviving Parent Trees	Stem Diameter Class <1 cm (stems)	1-3 cm dia. (stems)	3+ cm dia. (stems)	Management Notes
1	0.03	*Leucaena diversifolia*	5	0	7	15	Wood lot/annual garden. Volunteers thinned for pole production with other species.
2	0.14	*Calliandra calothyrsus*	9	28,700	0	0	Wood lot. Vigorous regeneration, but neglected. Intends to manage for charcoal production under canopy of *Eucalyptus for* pole and lumber production.
3	0.16	*Catalpa longissima*	6	2	2	0	Annual garden. Volunteers left to grow interspersed with mixed annual garden. Periodic transplanting of volunteers from other locations to site.
5	0.15	*Acacia auriculiformis*	19	659	0	0	Annual garden. Good regeneration from 19 parent trees. High mortality expected if no intervention.
21a	0.14	*Grevillea robusta*	37	29	0	0	Annual/pereniial garden. Most volunteers from 1 parent tree. Volunteers are transplanted to new sites to replace harvested trees.
TOT	0.62	Mixed Species	76	29,390	9	15	

Table X. Seedling density and size category of native volunteer species found on sites planted to AOP tree species between 1982-1986.

Site No.	Stand Area (ha)	AOP Species	0.5 - 2.5 m (stems ha^{-1})	> 2.5 m (stems ha^{-1})	Genera and species of native volunteers in order of dominance on site.
6	0.14	*Leucaena leucocephala, Azadirachta indica(*	* (not tallied)	* (not tallied)	*Acacia* sp., *Senna atomaria, Exostema caribaeum, Guaiacum* spp., *Randia aculeata, Comocladia* sp., *Atelia gummifer*, statzi
8	0.24	*Leucaena leucocephala*	* (not tallied)	* (not tallied)	*Chrysophyllum oliviforme, Capparis cyanophallophora, Acacia scleroxyla, Annona squamosa, Bunchosia glandulosa, Psidium dictyophyllum, Eugenia maleolens, Exostema caribaeum, Coccothrinax argentea*
13	0.07	*Senna siamea, Catalpa longissima*	657	228	*Simarouba glauca, Swietenia mahagoni, Roystonea hispaniolana, Calophyllum calaba*
17	0.1	*Casuarina equisetifolia, Catalpa longissima, Azadirachta indica, Eucalyptus camaldulensis, Cassia siamea*	* (not tallied)	50	*Simarouba glauca, Swietenia mahagoni*
18	0.25	*Casuarina glauca, Catalpa longissima, Cassia siamea*	* (not tallied)	* (not tallied)	*Simarouba glauca, Chrysophyllum oliviforme*
19	0.25	*Catalpa longissima, Eucalyptus camaldulensis, Cassia siamea, Leucaena leucocephala*	108	12	*Simarouba glauca, Roystonea hispaniolana, Guazuma ulmifolia*
23	0.1	*Cassia siamea, Leucaena leucocephala*	20	170	*Calophyllum calaba, Bumelia salicifolia, Swietenia mahagoni, Comocladia* sp., *Simarouba glauca, Chrysophyllum oliviforme*
24	0.18	*Senna siamea, Leucaena leucocephala, Casuarina equisetifolia*	* (not tallied)	* (not tallied)	*Simarouba glauca, Calophyllum calaba*
25	0.1	*Casuarina equisetifolia, Senna siamea, Leucaena leucocephala*	* (not tallied)	120	*Calophyllum calaba, Simarouba glauca*
26	0.1	*Catalpa longissima, Senna siamea*	90		*Calophyllum calaba, Psidium guajava, Terminalia catappa*
27	0.12	*Senna siamea*	658	33	*Calophyllum calaba, Chrysophyllum cainito, Simarouba glauca*
28	0.1	*Senna siamea, Leucaena leucocephala, Casuarina equisetifolia, Azadirachta indica*	30		*Calophyllum calaba, Simarouba glauca*
29	0.25	*Senna siamea, Leucaena leucocephala, Casuarina equisetifolia*	236	128	*Calophyllum calaba, Simarouba glauca, Catalpa longissima, Roystonea hispaniolana, Zanthoxylum* sp.
30	0.1	*Senna siamea, Leucaena leucocephala, Catalpa longissima*	160	200	*Simarouba glauca, Swietenia mahagoni, Colubrina arborescens, Calophyllum calaba*
31	0.25	*Senna siamea, Leucaena leucocephala, Casuarina equisetifolia*	236	184	*Swietenia mahagoni, Simarouba glauca, Calophyllum calaba, Catalpa longissima, Annona muricata, Sabal causiarum*
32	0.1	*Senna siamea, Leucaena leucocephala, Casuarina glauca*	380	200	*Calophyllum calaba, Simarouba glauca, Bumelia salicifolia, Swietenia mahagoni, Zanthoxylum* sp.
33	0.06	*Casuarina equisetifolia*	333	183	*Haematoxylon campechianum, Bumelia salicifolia, Colubrina arborescens, Swietenia mahagoni, Chrysophyllum oliviforme, Picrasma excelsa, Comocladia* sp., *Sabal causiarum*
37	0.2	*Casuarina equisetifolia, Leucaena leucocephala, Senna siamea*	* (not tallied)	260	*Bumelia salicifolia, Haematoxylon campechianum, Swietenia mahagoni, Bauhinia divaricata, Atelia gummifer*, bwa langi chat, bwa jeritout

Site No.	Stand Area (ha)	AOP Species	0.5 - 2.5 m (stems ha⁻¹)	>2.5 m (stems ha⁻¹)	Genera and species of native volunteers in order of dominance on site.
38	0.4	*Leucaena leucocephala, Senna siamea*	* (not tallied)	* (not tallied)	*Bumelia salicifolia, Picrasma excelsa, Annona muricata, Chrysophyllum oliviforme, Eugenia* sp., *Beilschmiedia pendula, Trichilia hirta, Zanthoxylum* sp., *Melicoccus bijugatus, Catalpa longissima, Bunchosia glandulosa, Roystonea hispaniolana, Sabal causiarum, Coccothrinax argentea, Comocladia* sp., *Psidium guajava, Daphnopsis americana*
39	0.63	*Senna siamea, Azadirachta indica*	25	231	*Simarouba glauca, Colubrina arborescens, Swietenia mahagoni*
41	0.17	*Senna siamea, Azadirachta indica, Eucalyptus camaldulensis*	* (not tallied)	29	*Simarouba glauca, Bumelia salicifolia, Swietenia mahagoni, Haematoxylon campechianum, Colubrina arborescens, Trichilia hirta, Catalpa longissima, Comocladia* sp., *Spondias mombin, Cecropia peltata, Zanthoxylum* sp., *Melicoccus bijugatus, Psidium guajava, Annona* spp.
TOT	3.91				

APPENDIX 4
REPORTED AND ESTIMATED WOOD HARVESTS

Table I. Reported harvest of wood products from 43 sites in Haiti. Only AOP trees are considered. Number of product units, number of trees and tree species reported are indicated. (The volume and weight equivalents are average values taken from the site inventories). A = Akasya = *Acacia auriculiformis*; C = Cassia = *Senna siamea*; E = Eucalyptus = *Eucalyptus camaldulensis*; G = Grevillea = *Grevillea robusta*; H = Chenn = *Catalpa longissima*; K = Kapab = *Colubrina arborescens;* L = Leucaena = *Leucaena leucocephala*; N = Neem = *Azadirachta indica*; P = Casuarina = *Casuarina* spp.; S = Sed = *Cedrela odorata*. T = top portion of the harvested tree; cp = coppice; $^+$ = additional harvest of uncertain amount.

Site Number	Sack of Charcoal	Roof Lattice Board	Kitchen Post	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Other Products
Volume (x 10^{-3} m^3)		1	2	3	8	13	23	100	
Weight (kg)	39.5	0.55	1.1	1.65	4.4	7.15	12.65	55	
1	10 100L&N						18 18L&N		
2								16 16E	
3	22 N,C,E					27 3E	4 4E&N	4 4 E	
4	27 L,C,K,E	25 3E			62 50E&K	8 1C	12 E,K	5 E	
5	7 23C							8 A,P	
6	11 L, N								
7	43 L						3 2L		
8	23 L						24 24L		
9	10 E,L							9 9E	
10	12 L,E				7 7E			15 13E	
11					22 E,K		40 E,K	10 E,K	
12							8 E,P	5 E,P	
13	0.5 1C							1 1C	
16							1 1E	12 7E,5P	
17							5 C	5 E,4C	
18	3$^+$ 15$^+$C		4 C	2 C			12 6C	8 T6C$^+$	
19	6.5 7C&E						8 2C	2 2C	

Site Number	Sack of Charcoal	Roof Lattice Board	Kitchen Post	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Other Products
20					12 T5E		12 5E		Stakes - E Firewood - G
21a		12 1G			8 8G	36 2G		4 4K&H&G	1 Tree - E
21b			45 45K&P		6 5P, 1E			8 8E	250 Stakes - E
22					7 T5S		10 5S		Firewood - 100^{+} G
23	13 58 L&C								
24	28 15^{+}L,C,Ccp				8 T5C		5 5C	4 T4C	
25	10 C,L		11 5C,3P						
26					1 1H		1 1C		
27							50 19C		
28	3 L,C				5 T9P		7 9P	4 T9P	
29	21 C,L					5 1L			
30	10 C,L								
31	14 11C,L,Ccp						5 4P, 1L	4 T4P	
32	24 L,C,P	20 P						5 5P	5 Trees - P
33								1 1 P	
34								2 P	
35	4.5 C								
37	6 L,C							4 4P	
38	51 C,L								
39	14 C,L					4 1S			21 Trees - N,C,S
40	21 L			24+ 24L	54+ 54L				66 Trees - L,C,K, F
41	6 N, C		50 50 N		60 N,C		36 N,C	23 23C&E&N	70 Trees - C,N,E
42		15 1G		12 1 G		9 2G			3 Trees - G Firewood - 5G

Site Number	Sack of Charcoal	Roof Lattice Board	Kitchen Post	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Other Products
TOTAL UNITS	400.5^{+}	72	110	38^{+}	252^{+}	89	261	159	Mixed
ESTIMATED WEIGHT (mt)	15.8^{+} Wood=79.1	0.04	0.12	0.06^{+}	1.11^{+}	0.64	3.3	8.75	2.87
ESTIMATED VOLUME (m^3)	63.3^{+} Wood=143.8	0.07	0.22	0.11	2.02	1.16	6	15.9	5.22

Table II. Reported and estimated values of wood harvests from 40 sites in Haiti. Only AOP trees are considered. Values are given in gourdes and cover a period from 1982-1995. Estimates based on average product values are shown in parentheses.

Site Number	Sack of Charcoal	Roof Lattice Board	Kitchen Post / Tool Handles	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Other Products
Volume ($x 10^{-3} m^3$)		1	2	3	8	13	23	100	
Weight (kg)	39.5	0.55	1.1	1.65	4.4	7.15	12.65	55	
1	150						180		
2								2,400	
3	235					405	40	120	
4	261	375			372	85	120	125	
5	175							200	
6	82.5								
7	683						30		
8	690						240		
9	92							81	
10	450				42			400	
11					550		800	400	
12							200	200	
13	5							15	
16							15	840	
17							25	54	
18	36		10	6			60	92	
19	97.5						40	6	
20					(180)		(220)		
21a		150			(88)	640		200	(50)
21b			(112.5)		115			204	100
22					49		150		
23	264								
24	326				8		25	10	
25	160		(110)						
26					5		15		
27							250		

Site Number	Sack of Charcoal	Roof Lattice Board	Kitchen Post / Tool Handles	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Other Products
28	48				25		105	40	
29	374					(75)			
30	140								
31	216						10	12	
32	456	660						85	50
33								30	
34								60	
35	175								
37	60							30	
38	1,310								
39	90.5					(60)			105
40	692			(120)	(405)				(600) 80
41	168		500		125		330	258	(700)
42		150		(4.8)		200			225
TOTAL REPORTED VALUE	7,436.5	1335	510.0	6.0	1,291	1,330	2,635	5,862	560
TOTAL ESTIMATED VALUE	0	0	222.5	124.8	673	135	220	0	1,350
TOTAL VALUE (GOURDES)	7,436.5	1,335	732.5	130.8	1,964	1,465	2,855	5,862	1,970

Table III. Table of average product values by species in this study. The data was derived from interviews with farmer intervies in 7 major regions of Haiti during January 23 - February 16, 1995. All values are in Haitian gourdes and cover a period from 1985 - 1995. The reader should be aware that the gourde has steadily weakened against the dollar during the period that the products were harvested (from 5 gdes/$ to 14/$) and the regional differences in product value are significant. The number of reported values are indicated in parentheses.

Species	Rafter Pole	Roof Lattice Pole	Stakes	Packet of Wattle	House Post	Kitchen Post	Joist	Cross Beam	Mast	House Board	Charcoal	Wood for Lime Kiln
Acacia auriculiformis								25.0 (1)			16.9 (2)	
Azadirachta indica	5.0 (2)				9.6 (4)	10.0 (2)		8.0 (1)			15.2 (9)	300.0 (1)
Casuarina equisetifolia	5.6 (4)			12.5 (1)	10.1 (4)		16.7 (2)	23.1 (9)			10.0 (1)	
Casuarina glauca					25.0 (1)		20.0 (1)	25.0 (1)		33.0 (1)	20.0 (1)	
Catalpa longissima	5.0 (1)							50.0 (1)				
Cedrela odorata	7.0 (1)				15.0 (1)							

Species	Rafter Pole	Roof Lattice Pole	Stakes	Packet of Wattle	House Post	Kitchen Post	Joist	Cross Beam	Mast	House Board	Charcoal	Wood for Lime Kiln
Colubrina arborescens	11.0 (3)							41.3 (3)			13.0 (1)	
Eucalyptus camaldulensis	11.1 (5)	15.0 (1)	0.4 (1)		18.3 (5)		83.9 (4)	42.3 (19)	150.0 (1)	15.0 (2)	14.3 (5)	
Grevillea robusta								50.0 (2)		13.2 (6)		
Leucaena leucocephala					7.9 (6)						21.5 (57)	
Senna siamea	5.0 (6)	3.0 (1)		12.5 (1)	6.3 (8)	2.5 (1)	15.3 (3)	15.2 (9)		14.6 (2)	20.6 (49)	

Table IV. Difference between reported and inventory estimates of harvested wood products for 35 sites. Reported estimates are based on the approximate equivalent wood weight of the reported wood product. Inventory estimates are based on stand measurements, weight tables for the respective species and weight shares for each product. Differences (column 10) are measured on the basis of the inventory estimates.

Site Number	Wood Equivalent of Charcoal	Roof Lattice Board	Kitchen Post	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Difference (kg) (Est.- Rep.)
Unit Weight (kg)	197.5	0.55	1.1	1.65	4.4	7.15	12.65	55	
1 Reported[1]	198						50		
1 Estimate	826						212		-790 (24%)
2 Reported								880	
2 Estimate								2,411	-1,531 (36%)
3 Reported	4,345					193	51	220	
3 Estimate	4,820					214	57	244	-526 (90%)
4 Reported	2,442				198		76	165	
4 Estimate[2]	2,783				226		87	188	-403 (88%)
6 Reported	2,173								
6 Estimate	8,774								-6,601 (25%)
7 Reported	2,963						38		
7 Estimate[3]	2,228						29		+741 (133%)
8 Reported	4,543						304		
8 Estimate	9,064						607		-4,824 (50%)
9 Reported	1,975							495	
9 Estimate	6,324							1,585	-5,439 (31%)
10 Reported	2,370				31			825	
10 Estimate[4]	2,167				28			754	+277 (109%)
11 Reported					97		506	550	
11 Estimate					179		933	1,014	-973 (54%)

Site Number	Wood Equivalent of Charcoal	Roof Lattice Board	Kitchen Post	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Difference (kg) (Est.- Rep.)
12 Reported							100	274	
12 Estimate[5]							917	2,496	-3,039 (11%)
13 Reported	99							55	
13 Estimate	125							69	-40 (79%)
16 Reported							13	468	
16 Estimate[6]							8	285	+188 (164%)
17 Reported							63	231	
17 Estimate							171	624	-501 (37%)
18 Reported	593		4	3			152	440	
18 Estimate	890		6	5			227	660	-596 (67%)
19 Reported	1,284						101	110	
19 Estimate	1,978						156	169	-808 (65%)
21b Reported			187		26			440	
21b Estimate			614		85			1,446	-1,492 (30%)
23 Reported	2,568								
23 Estimate	3,361								-793 (76%)
24 Reported	5,530				35		63	220	
24 Estimate	8,669				55		99	345	-3,320 (64%)
25 Reported	1,975		12						
25 Estimate	2,046		13						-72 (97%)
26 Reported					10		13		
26 Estimate					26		36		-39 (37%)
27 Reported							633		
27 Estimate							3,691		-3,059 (17%)
28 Reported	593				22		89	220	
28 Estimate	2,297				85		343	853	-2,655 (26%)
29 Reported	4,148					36			
29 Estimate	6,737					58			-2,611 (62%)
30 Reported	1,975								
30 Estimate[7]	2,089								-114 (95%)
31 Reported	2,765						63	220	
31 Estimate[8]	5,811						132	462	-3,358 (48%)
32 Reported	4,740	11						439	
32 Estimate	6,430	15						595	-1,850 (74%)
33 Reported								33	
33 Estimate								49	-16 (68%)
34 Reported								37	

Site Number	Wood Equivalent of Charcoal	Roof Lattice Board	Kitchen Post	Roof Lattice Pole	Rafter Pole	House Board	House Post	Joist & Cross Beams	Difference (kg) (Est.- Rep.)
34 Estimate								42	-5 (87%)
35 Reported	889								
35 Estimate	3,777								-2,888 (24%)
37 Reported	1,185							125	
37 Estimate	4,020							424	-3134 (29%)
38 Reported	10,073								
38 Estimate	16,886								-6,813 (60%)
39 Reported	2,765		132				325		
39 Estimate	8,266		395				972		-6,410 (33%)
40 Reported	4,148			40	238		967		
40 Estimate	9,314			90	534		2,171		-6,715 (45%)
41 Reported	1,185		55		264		455	1,100	
41 Estimate	1,112		52		248		427	1,032	+198 (107%)
N	25	1	5	2	9	2	19	21	
REPORTED WEIGHT (mt)	67.52	0.01	0.39	0.04	0.92	0.23	4.06	7.55	80.73
ESTIMATED WEIGHT (mt)	120.79	0.02	1.08	0.1	1.47	0.27	11.28	15.75	150.74
DIFFERENCE	53.27	0	0.69	0.05	0.55	0.04	7.21	8.2	70.02
% OF EST.	44	27	64	55	37	16	64	52	46

[1] Site 1: only part of the reported harvest in proportion to the inventory sample. [2] Site 4: only one species, *Colubrina arborescens*, was inventoried and estimates are calculated for this single species. [3] Site 7: inventoried the site of a charcoal harvest; highly probable that all harvested stumps were not located. [4] Site 10: farmer had destroyed a significant number of *Leucaena* stumps - perhaps as many as 100, according to the reported 90% survival of the species. [5] Site 12: significant number of *Eucalyptus* stumps were destroyed or decayed. [6] Site 16: less harvested stumps were found than reported by farmer for *Eucalyptus* and *Casuarina*. [7] Site 30: farmer had destroyed a significant number of *Leucaena* stumps. [8] Site 31: less harvested stumps were found than reported by farmer for *Casuarina*.