HAITI AGROFORESTRY RESEARCH PROJECT

South East Consortium for International Development

and

Auburn University

July 1990

This work was performed under USAID Contract
No. 521-0122-C-00-7104-00

FINANCIAL ANALYSIS OF SELECTED TREE OPERATIONS IN HAITI'S NORTHWEST AND CENTRAL PLATEAU

(Revised)

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SECID/AUBURN AGROFORESTRY REPORT NO. 14

ACKNOWLEDGMENTS

The authors wish to thank Greg Sommers and Pierre Rosseau for help with the Systat statistical package in data analysis. Alfredo Unda of the Pan American Development Foundation was always helpful in advising on growth data and history of the project. Steve Gronski of Operation Double Harvest was called on several times for cost and returns information. Giovanni Caprio gave helpful suggestions on economic matters but in no way bears responsibility for assumptions included. Paul Campbell is to be thanked for finding a programming error in the previous interim report for this study.

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EXECUTIVE SUMMARY

The purpose of this work was to conduct a financial study of one tree border planting at Mirebalais in the Central Plateau and three tree farms located in the Northwest. This study entailed the computation of Net Present Values (NPVs) at a 30 percent discount rate for farms having a 90 percent survival rate. Charcoal and poles were the two products considered. The main part of the study included financial analyses in which seedlings were donated to the farmer and he and his family processed the charcoal. Another option showed arrangements in which the farmer paid a custom processor 45 percent of the farm-gate gross and kept 55 percent. Two sensitivity analysis options were included for the farmers paying either $0.25 or $0.50 for tree seedlings.

The farm located in Mirebalais had its three species of trees planted on the borders of the fields. The land is flat and has a good potential for agriculture. Poles showed the highest NPVs, with neem and cassia plantings on this farm being positive in all seedling costing options. Charcoal showed positive returns for the donated seedling option and for the $0.25 seedling cost option when the farmer processed the charcoal. Poles showed NPVs ranging from 1.8 to 4.0 times that for charcoal, depending on the species and seedling costing plan followed. The NPV for the borders of one hectare for poles was $120 for neem and $77 for cassia.

The first farm located in Bombardopolis was a leucaena coppice woodlot on steep land with low fertility at slightly over 400m altitude. Charcoal was the only product and yielded a NPV of $339 with the owner processing the wood. Under the $0.25 and $0.50 seedling cost options, this woodlot showed highly negative NPVs.

The second Bombardopolis farm had a mixed-species woodlot on steep infertile land at around 400m altitude. It showed high NPVs for pole production with a range of $1,123 for donated seedlings to $639 using a $0.50 seedling cost. Pole production ranged from 2.8 to 5.8 times the returns for charcoal with owner processing.

The third farm in Bombardopolis, a woodlot of eight species on arid land with a 55-percent slope at around 400m altitude, had positive NPVs of $313 in pole production with donated seedlings and $115 for charcoal with donated seedlings and owner processing. All the options with seedlings paid by the farmer showed negative NPVs except for pole production with a $0.25 seedling cost.

The following recommendations are made for the future:

1. Extension workers should stress increasing the survivability of the seedlings planted as a means to increase profitability.
2. Species selection should be tailored to the local area.
3. The feasibility of providing credit to farmers for seedling purchases should be studied.
4. More data should be obtained on the competitiveness of trees and crops for border plantings.
5. The present study should be expanded to obtain sampling data for making inferences in defined physiographic areas.

REZIME

Bi travay-sa li té yon étid finansiè pou yon lisiè pyebwa nan yon jaden ki nan lokalité Mirebalais, e pou twa fem nan Nodwes planté ak pyebwa. Etid-sa komprann kalkil valé net presante (VNP) pou yon to de 30 pou san pou fem ki genyen yon to de survi de 90 pou san. Chabon e poto sété pwodui consideré. Pati ki pli enpotan nan étid-sa sé yon analys finansié koté abitan resevwa ti pyebwa-yo e li mem ak famil-li ap fê chabon. Lot pati étid-sa, li genyen ka koté abitan ap péyè yon moun kap ramasé e fê chabon 45 pou san, pri vant chabon-sa. Tout resilta-sa yo té testé nan de kas: Yon ka kote abitan ap péyè $0.25 pou chak ti pyebwa-yo, yon lot ka koté lap péyè $0.50.

Fem ki sityé Mirebalais-a genyen twa espes pyebwa diferan ki planté sou lisiè jaden-an. Teren-an plat e tè-a gen yon gran kapacité pou pwodui e bay rendeman agrikol. Poto-an jwen VNPs ki pli ho, ak plantasyon neem e cassia ki pozitifs nan tout pri pyebwa ki konsidéré. Chabon li-menm, resilta yo pozitifs nan ka koté abitan jwen ti pyebwa-yo gratis oubyen si lap péyè $0.25 pou yo e ke li-menm ap fê chabon. Poto-an genyen VNPs ki superior depi 1.8 jis 4 a VNPs chabon, diferens-la depann de ki espes ki plantè ak ki pri wap péyè pou ti-pyebwa yo. VNP pou lisiè de yon ektar pou poto te bay $120 ak neem e $77 pou cassia.

Premiè fem Bombardopolis-la se yon jaden pyebwa leucena ki sityè nan yon teren ki genyen pant e ki pa kap donnen ampil. Chabon se sel pwodui ki étidiè nan abitasyon-sa, li te bay yon VNP de $339 si se femiè kap fê chabon. Si nan ka koté abitan ta dwe péyè oubyen $0.25 oubyen $0.50 te considérè, abitasyon-sa ta genyen

de VNPs ki tap trè negatifs.

Deziem fèm Bombardopolis-la se yon jaden plisiè espes pyebwa e ki lokalisé a 400m sou yon teren ki geyen ampil pent. Produksyon poto nan jaden-sa te jwenn yon ho valè pozitif ki alé depi $639 si abitan ap péyè $0.50 pou ti pyebwa-yo jiska $1,123 si li pa péyè pou yo. Kob ke abitan te kap jwenn nan produksyon poto te ent 2.8 a 5.8 fwa siperyè a kob produksyon chabon te kap ba li.

Pou twaziem fem Bombardopolis-la, jaden pyebwa gen uit espes sou yon mon arid ak yon pent ki pase 55 pou san. Abitan sou tè-sa nan ka koté li pa péyè ti pyebwa, jwen yon VNP pozitif de $313 pou produksyon poto e $115 pou produksyon chabon. Tout ka koté abitan dwe péyè pou ti pyebwa-yo ap bay yon VNP negatif, sof si abitan ap péyè $0.25 pou ti pyebwa e ke lap pwodui poto.

Men rekomandasyon ki fêt pou lavni:

1. Responsab extensyon-yo dwe ogmenté pousantaj survi pyebwa planté-yo kom mwayen pou ogmenté rantabilité pwoduksyon.
2. Kalité espes ki ap chwazi dwe adapté nan chak zon.
3. Meté kredi agrikol disponib pou femié-yo, sa va pemet yo an mesi pou achté pyebwa, se yon bagay ki dwe pran avek ampil konsiderasyon pou lavni pou yo kapab diminué efe negatif pri sou rentabilité.
4. Plis étid ta dwe fêt pou analize konpetisyon rekolt nan jaden ak pyebwa ki planté sou lisié jaden-an.
5. Etid-sa dwe kontinié nan lot zon diferan pou yo kapab jwenn plis infomasyon ki ka pemet yo fê rekomandasyon.

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I. INTRODUCTION

The present study is a complement to previous studies carried out in the Agroforestry Outreach Project (AOP) in 1988 and 1989. Before that time, cost and returns results in tree production in Haiti were based largely on results from ideal low-elevation plots which were flat in profile, had deep topsoil and were managed under experimental conditions. A need existed for data from typical farm conditions at the sites of tree planters cooperating with the programs in the Pan American Development Foundation (PADF) and CARE. The cooperating tree planters often have trees on steep slopes with low levels of topsoil interspersed with projecting stones and severely eroded patches. Cursory appraisal shows scant fertility on some of these sites. The present study attempts to survey on-farm production and financial returns for a more representative setting.

[1]Resource Economist, Agroforester and Economic Associate.

Purpose

The purposes of the study were:

1. To prepare exemplary financial analyses on tree production from selected areas where standing tree crops could be measured and
2. To make recommendations for expanding the study to allow a complete economic analysis of costs and returns in the future.

Methodology

This work includes mensurational data for 1989 from three woodlot tree farms at Bombardopolis in the Northwest and one farm with border trees at Mirebalais in the Central Plateau. Growth data were taken on all trees except on one of the woodlot operations, a pure stand of leucaena, under coppice management for charcoal wood. This woodlot had been cut twice previously during its six years. In this case, randomized sample plots were used to measure coppice stems and stump diameters used in volume calculations. In addition to species descriptions, tree heights, diameters outside bark at 0.3m and 1.3m above ground, and crown widths were taken to determine the probable production in terms of likely products from the trees, namely pole volume and charcoal volume.

The second Bombardopolis farm was a mixed-species woodlot which had been in operation for more than five years. The third woodlot was mostly leucaena and cassia, eight years of age. All of these stands were on typical steep-sloped low-fertility land amenable to little other than tree planting on a sustained basis.

The fourth farm had trees planted as a border on good land with low slope in Mirebalais. There was no interference between tree species on this farm since each species was planted on a different side of the border. This tree arrangement permitted an analysis for each species separately.

Tree measurements were used to calculate pole volume, main stem volume, crown volume, total volume, stem biomass, crown biomass, and total biomass. Biomass was also expressed as charcoal equivalent by using a conversion factor of 0.20. Mean annual increments were also reported for tree growth for the areas.

Physiographic data were obtained for the locations and included percent slope, aspect (exposure to the sun), elevation, mean rainfall, and soil fertility characteristics.

Prices of products were determined by asking questions of the respondents and by independent studies of transactions.

Financial costs and returns were calculated for the cooperating tree farmers. These analyses entailed the computation of the net present value (NPV) of the operations. Gittinger (1982) defined the NPV as "The present worth of the Benefits less the present worth of the Costs of a project." In order to compute the NPV in this study, the following procedures were used to determine income:

Numbers of charcoal sacks per hectare assuming a 4-year rotation = Mean annual increment per hectare of charcoal x 4 (years)/40

40 = 40 kg which is the average weight of a sack of charcoal found by Street (1989b).

Income from selling the charcoal in gourdes (G) = number charcoal sacks x 10 gourdes.

The study includes two ways for the farmer to produce charcoal. The farmer and his family may process and sell the charcoal themselves, keeping all the receipts. The other alternative is to have a custom processor make the charcoal. The proceeds of the sale will be split fifty-five percent to the farmer and the remainder to the charcoal processor.

The income generated by poles was computed as follows:

Income from selling poles = quantity of poles x 2 gourdes.

Income from selling charcoal coming from the wood of the crown.

Charcoal and poles were considered as the only products sold by the farmers. The values of these products can be correctly assessed and give a conservative estimate of the revenue of the farmer. For the coppice woodlot in the Northwest, charcoal was the only product studied since the farmer had cut trees before they reached pole size.

For the three woodlots the opportunity cost of the land used for tree growing was considered to be zero. Its physiographic characteristics were such that the land was not adaptable to ordinary field crops on a sustained basis. Kay (1981) defined the opportunity cost as "the income that could have been received if the input had been used in its most profitable alternative use." The zero oportunity cost assumption is consistent with the results of Street's study (1989) for border trees and woodlots. In Mirebalais an opportunity cost was computed for border plantings because of the competition of the trees with the sorghum and maize grown by the farmer. Based on field estimates, the yield of the area affected by border trees was reduced by 50 percent. This area was 3m x 97m on each side of a square hectare which equals a total area of 1,164 square meters per hectare. Allowing for border trees, crops occupy only 9,216 of the 10,000 square meters of a one hectare farm, so the affected area represents 12.6 percent of the crop space. Grosenick (1986) reported that a sorghum-maize association returns $218.23/ha/year in the Mirebalais region, which is equivalent to $201.12/ha for this farm. The lost income because of competition between trees and crops is:

$\$201.12 \times 0.126 \times 0.5 = \$12.67$/hectare/year.

Other costs considered were those for seedlings, planting and weeding.

The tree seedlings are distributed free of charge to the Haitian farmers; consequently, this cost was not counted in the tables of the main text for the financial analysis for the farmers themselves. In the Appendix a sensitivity analysis was made with two different arbitrary prices for seedlings, $0.25 per plant or $0.50 per plant, as a step in the direction of an economic analysis necessary for sustainability of the operations. These values are based on two studies which have covered the costs of seedlings. The $0.25 per-seedling amount is based on $0.125 per plant for direct expenditures to nurseries as reported by Goodwin, Street and Reid (1989). The nurseries were subsidized to a certain extent by buying plant-mix components at less than local market prices, and various overhead components of the grantee, the PADF, USAID, and the cost of money were not included. The $0.50 amount is an approximation of the cost per-seedling found by the AID Inspector General's audit (1984) of the agroforestry program for PADF and

CARE plantings. At that time there had been high start-up costs and a relatively low output of 7,000,000 trees planted by PADF and CARE. The 1986 End of Project Evaluation report of USAID/Haiti showed that more than 27,000,000 trees had been produced and distributed. The cost per seedling should have been reduced considerably by more production from facilities involving high fixed costs. Entry into various human capital building programs entailing extension services and other activities involves benefits to be reaped over a long time period in the future. Many benefits are reaped in areas which do not relate to the tree cost per se. It is impossible to separate the costs accurately to attribute the proper amount to the tree seedlings, but it seems unfair to burden the seedling cost by these outside activities. Further work must be done in this phase of the accounting before an accurate economic analysis can be made for each segment of the development projects.

Planting and weeding costs are estimated on a man-day basis at a value of one dollar. The planting cost is computed on the basis that this task must be completed in 48 hours after the distribution of trees to enhance survival. Weeding occurs three times a year and is not considered necessary after the second year. Some of the fieldwork of the Haitian peasant is done in a "Kombit"[2] and some is done by family labor alone. The Kombit allows the farmer to get a large amount of work done in a short time and he can participate in the process with others when he has idle time. Harvest costs were not included since harvesting generally is done with excess

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[2] A kombit is a group of peasants which rotates exchange work from one farm to another for the participants.

labor and the benefits from fodder, firewood from trimmings, leaves as green manure and other byproducts offset the harvest costs.

When the trees are cut and sold as charcoal or poles, the costs and benefits are as follows:

	Costs	Benefits
Year 0		
Year 1	Cost of planting and weeding	
Year 2	Cost of weeding	
Year 3	None[3]	
Year 4	None	Selling of charcoal or poles
Year 5	None	
Year 6	None	
Year 7	None	
Year 8	None	Selling of charcoal or poles
Year 9	None	
Year 10	None	
Year 11	None	
Year 12	None	Selling of charcoal or poles
Year 13	None	
Year 14	None	
Year 15	None	
Year 16	None	Selling of charcoal or poles

After consultation with Giovanni Caprio, AID economist, the authors chose to use a 30 percent discount factor in computing the NPV. This rate took into account a projected inflation of 20 percent and the opportunity cost of money (10 percent). Summing both rates is a normal procedure recommended by several authors such as Barry (1979). The benefits and costs were presented in the tables in current terms and were then discounted at 30 percent in order to establish their present values. The rates chosen were

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[3]For Mirebalais the opportunity cost of shadowing was counted.

arbitrary on the part of the authors since there was negotiation with the International Monetary Fund on matters which might cause a much lower inflation rate.

Since the data for this study were from selected farms in Mirebalais and the Northwest region, they are not necessarily representative of the average situation throughout Haiti. The farms examined in this study had a 90-plus percent tree survival rate compared with the 55 percent average survival rate that CARE and PADF were currently reporting. Since the growth rate for individual trees may be higher at the 55 percent survival rate than for the 90 percent rate, it was not possible to compare both rates in this study.

Certain benefits to the farmer, such as windbreaks, soil conservation, shading around the house and shading for livestock during excessively hot and dry periods, were not counted in this study. Other benefits of a social nature external to the farm, such as down-hill conservation to other farms, were not counted. Work is presently underway which attempts to measure soil saved by certain tree planting interventions.

Previous Work

A study of 62 tree planters in three different regions of the country (Street, 1989a) provided socio-economic data related to the enterprise and its setting. The respondents were approximately evenly distributed around Bombardopolis-Des Forges in the Northwest, Mirebalais-Belladere-Las Cahobas in the Central Plateau, and Vialet-Ti Goave in the South.

Although the cooperators had been planting trees for around four years on the average, with a range of one to six years, there had been few harvests on which to base economic returns analyses. Two-thirds of the planters had grown trees for four years or more, a very encouraging fact in view of skepticism concerning whether farmers would maintain trees properly or allow them to grow to maturity.

A preliminary assessment of the program can be given in terms of the owners' appraisal of the enterprise in attaining their goals of planting trees. Sixty of the sixty-two respondents reported satisfaction with the tree planting venture. Their motivation for planting trees centered around wood products for their own use and other direct and indirect income enhancements, including controlling erosion. One-third of the respondents reported erosion control as the primary reason for their planting trees. The farmer satisfaction with the tree operation was reinforced by the fact that 59 out of the 62 respondents expressed a willingness to plant more trees. Lack of land was the primary reason for not planting more trees. The trees were planted in woodlots, in mixed garden systems, on borders and in hedgerows. The tree hedgerow is a relatively new intervention in Haitian agriculture.

The farmers had an added means of income from under-utilized labor and other resources. There were few conflicts in the use of labor in the tree enterprises and the farmers' other cropping systems. These conflicts occurred in the peaks of planting and harvest seasons. Also, there were few conflicts in the use of tools and animals between the tree and garden crop enterprises.

Very few farmers hired any labor, and more than one-third reported no monetary expenses in maintaining their trees during the previous year. Data were collected on prices of the few tree products sold. The paucity of data in this part of the study necessitated a standing-inventory approach to evaluation of benefits as a follow-up.

Three additional studies (Street, 1989b), (Goodwin, Reid and Street, 1989), and (Street and Bellerive, 1989) are related to the present study. The first study covered the charcoal market in the Northwest and included farm prices as a check against the socio-economic data reported previously. Marketing margins to the Port-au-Prince sales area were also included to accompany a sampling process in which actual sacks of charcoal were weighed. The second study dealt with a cost analysis of tree nurseries where several infrastructure options were considered. The most expensive per-seedling cost was $0.1266 and the least expensive was $0.1244. These expenses included direct and indirect costs except for the cost of capital, part of the overhead of PADF, and certain overhead costs of USAID. The last of these studies dealt with the pole market from the Southwest to Port-au-Prince and was handled in a manner similar to the charcoal study. Samples of poles were measured in order to determine critical values emphasized in the trade. These studies are of importance since they cover two of the main uses of trees and the cost of producing the trees.

Grosenick (1986) computed the NPV for the AOP program. He found that 15 percent of the farmers in the program had a negative NPV. He explained the willingness of those farmers to continue to plant trees by the low opportunity cost of land and the low amount of labor needed for this operation.

II. RESULTS

Mirebalais Farm

The Mirebalais farm is located on flat land with good agricultural potential. The trees were planted on the border and included three species, chenn (Catalpa longissima), cassia (Cassia siamea), and neem (Azadirachta indica).

The mean annual total charcoal increment per hectare was 237 kilograms and the number of poles available after four years for each species is given in Appendix Table 1. Planting labor was estimated to be two man-days for a total of two dollars and weeding was three man-days three times a year for a total of nine dollars per year.

Neem Study:

The neem was the most successful species on the Mirebalais farm. Its production was the highest in terms of poles and charcoal equivalent and is reflected in the high NPVs obtained with neem only.

Charcoal production. Tables 1 and 2 show positive NPVs of $68.03 and $6.85, respectively, with the farmer doing his own processing or with a custom processor. Since charcoal is generally made with an excess of family labor, it is much more profitable for the farmer to do the processing himself.

Table 1. NPV at a 30 Percent Discount Rate for Neem Borders in Mirebalais for Charcoal as Product When Farmer Receives 100 Percent of Returns and with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0*	0	0	0	0
1	13.20	0	10.15	0	- 10.155
2	12.96	0	7.67	0	- 7.67
3	21.72	0	9.89	0	- 9.89
4	26.07	147.33	9.13	51.58	42.46
5	0	0	0	0	0
6	0	0	0	0	0
7	45.04	0	7.18	0	- 7.18
8	54.05	305.50	6.63	37.45	30.83
9	0	0	0	0	0
10	0	0	0	0	0
11	93.40	0	5.21	0	- 5.21
12	112.08	633.49	4.81	27.19	22.38
13	0	0	0	0	0
14	0	0	0	0	0
15	193.67	0	3.78	0	- 3.78
16	232.40	1313.60	3.49	19.74	16.25
				NPV	68.03

*In cases in which seedlings are not donated, year zero will have non-zero values at times. Some of the alternatives in the Appendix tables are non zero.

Table 2. NPV at a 30 Percent Discount Rate for Neem Borders in Mirebalais for Charcoal as Product When Farmer Receives 55 Percent of Returns and with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	13.20	0	10.15	0	- 10.155
2	12.96	0	7.67	0	- 7.67
3	21.72	0	9.89	0	- 9.89
4	26.07	81.03	9.13	28.37	19.25
5	0	0	0	0	0
6	0	0	0	0	0
7	45.04	0	7.18	0	- 7.18
8	54.05	168.04	6.63	20.60	13.97
9	0	0	0	0	0
10	0	0	0	0	0
11	93.40	0	5.21	0	- 5.21
12	112.08	348.44	4.81	14.96	10.15
13	0	0	0	0	0
14	0	0	0	0	0
15	193.67	0	3.78	0	- 3.78
16	232.40	722.53	3.49	10.86	7.37
				NPV	6.85

Pole production. Pole production entails a net income of $98 at harvest, which is the sum of $92 coming from the poles and $6 from charcoal from the crown of the trees. Table 3 shows a positive NPV of $119.60. The pole venture has a higher NPV than charcoal, and it also has the advantage of having a simpler production process. However, the market for poles was not as stable as the charcoal market, and for that reason most of the farmers preferred to produce charcoal, even if it entailed a smaller income.

Table 3. NPV at a 30 Percent Discount Rate for Neem Borders in Mirebalais for Poles as Product When Farmer Receives 100 Percent of Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	13.20	0	10.15	0	- 10.155
2	12.96	0	7.67	0	- 7.67
3	21.72	0	9.89	0	- 9.89
4	26.07	203.21	9.13	71.15	62.02
5	0	0	0	0	0
6	0	0	0	0	0
7	45.04	0	7.18	0	-7.18
8	54.05	421.38	6.63	51.66	45.03
9	0	0	0	0	0
10	0	0	0	0	0
11	93.40	0	5.21	0	- 5.21
12	112.08	873.78	4.81	37.50	32.69
13	0	0	0	0	0
14	0	0	0	0	0
15	193.67	0	3.78	0	- 3.78
16	232.40	1811.87	3.49	27.23	23.74
				NPV	119.60

Cassia Study:

Cassia production was less successful than that of neem. The difference was particularly important for poles, Appendix Table 1. The results for the charcoal increment are closer to those of the neem with a difference of only 40 kilograms per year.

<u>Charcoal production</u>. Tables 4 and 5 show a positive NPV of $27.91 when the farmer made the charcoal himself and a negative $1.25 when he used a processor.

Table 4. NPV at a 30 Percent Discount Rate for Cassia Borders in Mirebalais for Charcoal as Product When Farmer Receives 100 Percent of Returns and with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	13.20	0	10.15	0	- 10.155
2	12.96	0	7.67	0	- 7.67
3	21.72	0	9.89	0	- 9.89
4	26.07	131.38	9.13	46.00	36.87
5	0	0	0	0	0
6	0	0	0	0	0
7	45.04	0	7.18	0	- 7.18
8	54.05	272.44	6.63	33.40	26.77
9	0	0	0	0	0
10	0	0	0	0	0
11	93.40	0	5.21	0	- 5.21
12	112.08	564.92	4.81	24.25	19.44
13	0	0	0	0	0
14	0	0	0	0	0
15	193.67	0	3.78	0	- 3.78
16	232.40	1171.43	3.49	17.60	14.11
				NPV	27.91

Table 5. NPV at a 30 Percent Discount Rate for Cassia Borders in Mirebalais for Charcoal as Product When Farmer Receives 55 Percent of Returns and with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	13.20	0	10.15	0	- 10.155
2	12.96	0	7.67	0	- 7.67
3	21.72	0	9.89	0	- 9.89
4	26.07	72.26	9.13	25.30	16.17
5	0	0	0	0	0
6	0	0	0	0	0
7	45.04	0	7.18	0	- 7.18
8	54.05	149.85	6.63	18.37	11.74
9	0	0	0	0	0
10	0	0	0	0	0
11	93.40	0	5.21	0	- 5.21
12	112.08	310.73	4.81	13.34	8.53
13	0	0	0	0	0
14	0	0	0	0	0
15	193.67	0	3.78	0	- 3.78
16	232.40	644.32	3.49	9.68	6.19
				NPV	- 1.25

<u>Pole production</u>. The pole production with Cassia yielded a total income of $76.60 at harvest. Table 6 shows a positive NPV of $76.74. This NPV was much lower than the one with neem, since the production of poles from cassia was inferior to that of neem, Appendix Table 1.

Table 6. NPV at a 30 Percent Discount Rate for Cassia Borders in Mirebalais for Poles as Product When Farmer Receives 100 Percent of Returns and with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	13.20	0	10.15	0	- 10.15
2	12.96	0	7.67	0	- 7.67
3	21.72	0	9.89	0	- 9.89
4	26.07	156.76	9.13	54.89	45.76
5	0	0	0	0	0
6	0	0	0	0	0
7	45.04	0	7.18	0	- 7.18
8	54.05	325.07	6.63	39.85	33.22
9	0	0	0	0	0
10	0	0	0	0	0
11	93.40	0	5.21	0	- 5.21
12	112.08	674.06	4.81	28.93	24.12
13	0	0	0	0	0
14	0	0	0	0	0
15	193.67	0	3.78	0	- 3.78
16	232.40	1397.72	3.49	21.01	17.51
				NPV	76.74

<u>Bombardopolis Farm, Case 1</u>

The first farm in Bombardopolis is located at 430m of altitude, has a slope of 35 percent, and had a low crop production potential. The only crop grown on it was leucaena trees, and it was considered to have a zero opportunity cost. The mean annual total charcoal increment per hectare was 990 kilograms, Appendix Table 2. The planting cost was estimated at 20 man-days for a total of $20, and the weeding was estimated at 4 man-days for a total of $12 per year.

<u>Charcoal production</u>. Tables 7 and 8 show positive NPVs of $339.15 and $168.64, respectively, with the farmer doing his own processing or using a custom processor. There were no weeding costs after the first two years.

Table 7. NPV at a 30 Percent Discount Rate for Leucaena Woodlots in Bombardopolis, Case 1, for Charcoal as Product When Farmer Receives 100 Percent of Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	38.40	0	29.54	0	- 29.54
2	17.28	0	10.22	0	-10.22
3	0	0	0	0	0
4	0	410.57	0	143.75	143.75
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	851.36	0	104.37	104.37
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	1765.39	0	75.77	75.77
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	3660.71	0	55.01	55.01
				NPV	339.15

Table 8. NPV at a 30 Percent Discount Rate for Leucaena Woodlots in Bombardopolis, Case 1, for Charcoal as Product When Farmer Receives 55 Percent of Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	38.40	0	29.54	0	- 29.54
2	17.28	0	10.22	0	-10.22
3	0	0	0	0	0
4	0	225.82	0	79.06	79.06
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	468.25	0	57.40	57.40
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	970.96	0	41.68	41.68
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	2013.39	0	30.26	30.26
				NPV	168.64

Bombardopolis Farm, Case 2

This farm is located in Bombardopolis on a site with a steep slope at approximately 400m altitude and had little potential for crop production. Its opportunity cost for tree growth was considered to be zero. The farm had a woodlot with three species, cassia (Cassia siamea), eucalyptus (Eucalyptus comaldulensis) and leucaena (Leucaena leucocephala). The mean annual total charcoal increment per hectare was 1,110 kilograms, and the amount of poles produced was 1,309, Appendix Table 3. The cost of planting was estimated to be 10 man-days or $10 and the cost of weeding was estimated to be 4 man-days three times a year which represents $12.

<u>Charcoal production</u>. Charcoal on this farm yielded a total income of $222 at harvest. Appendix Table 3 shows that leucaena was the most successful species in that location, while eucalyptus performed poorly. Tables 9 and 10 show positive NPVs of $394.30 and $203.13. The returns were higher than the preceding case, in part from the lower number of trees, Appendix Tables 2 and 3, and a lower planting cost. If the farmer had produced only leucena the income would have been even higher. Diversification of trees could be an advantage in terms of loss to diseases, however.

Table 9. NPV at a 30 Percent Discount Rate for Mixed Species Woodlots in Bombardopolis, Case 2, for Charcoal as Product When Farmer Receives 100 Percent of Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	26.40	0	20.31	0	- 20.31
2	17.28	0	10.22	0	-10.22
3	0	0	0	0	0
4	0	460.34	0	161.18	161.18
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	954.56	0	117.02	117.02
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	1979.37	0	84.96	84.96
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	4104.43	0	61.68	61.68
				NPV	394.30

Table 10. NPV at a 30 Percent Discount Rate for Mixed Species Woodlots in Bombardopolis, Case 2, for Charcoal as Product When Farmer Receives 55 Percent of Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	26.40	0	20.31	0	- 20.31
2	17.28	0	10.22	0	-10.22
3	0	0	0	0	0
4	0	253.19	0	88.65	88.65
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	525.01	0	64.36	64.36
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	1088.66	0	46.73	46.73
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	2257.44	0	33.93	61.68
				NPV	203.13

<u>Pole production</u>. This farm had the highest pole production, 1,309 poles. The income from poles was calculated to be $523.60 plus $82 due to the selling of charcoal from residual wood for a total of $605.60. The NPV was positive at $1,123.07, Table 11. This high NPV was the result of high income due to high leucena production with low costs.

Table 11. NPV at a 30 Percent Discount Rate for Mixed Species Woodlots in Bombardopolis, Case 2, for Poles as Product When Farmer Receives 100 Percent of Residual Charcoal Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	26.40	0	20.31	0	- 20.31
2	17.28	0	10.22	0	-10.22
3	0	0	0	0	0
4	0	1255.77	0	439.68	439.68
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	2603.97	0	319.22	319.22
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	5399.59	0	231.76	231.76
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	11196.59	0	168.26	168.26
				NPV	1,123.07

Bombardopolis Farm, Case 3

The third farm is located at Bombardopolis at about 400m altitude on land which had a poor capacity for crops and a slope of 55 percent. This farm had a woodlot of the following species: casuarina (Casuarina equisetifolia), chenn (Catalpa longissima), cassia (Cassia siamea), eucalyptus (Eucalyptus comaldulensis), kapab (Colubrina arborescens), gliricidia (Gliricidia sepium), leucaena (Leucaena diversifolia), and leucaena (Leucaena leucocephala). The mean annual total charcoal increment per hectare was 381.4 kilograms, and the total number of poles produced was 439, Appendix Table 4. In this farm four species had results near zero in their charcoal and pole production. The costs of planting and weeding were estimated to be the same as in case 2, $10 and $12, respectively.

Charcoal production. Tables 12 and 13 show that both ventures were positive, with NPVs of $114.91 and $49.46, respectively. The results were inferior to the ones of the preceding Bombardopolis cases because of a low increment in charcoal, coupled with a relatively high density of trees. This situation resulted in low revenues and high costs. The low increment in charcoal was due to the fact that the area of the farm was particularly dry and many

Table 12. NPV at a 30 Percent Discount Rate for Mixed Species Woodlots in Bombardopolis, Case 3, for Charcoal as Product When Farmer Receives 100 Percent of Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	26.40	0	20.31	0	- 20.31
2	17.28	0	10.22	0	-10.22
3	0	0	0	0	0
4	0	157.59	0	55.18	55.18
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	326.79	0	40.06	40.06
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	677.62	0	29.08	29.08
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	1405.12	0	21.12	21.12
				NPV	114.91

species were planted, half of which had very low productivity. A simple alteration of the species mix could greatly increase the potential returns.

Table 13. NPV at a 30 Percent Discount Rate for Mixed Species Woodlots in Bombardopolis, Case 3, for Charcoal as Product When Farmer Receives 55 Percent of Returns with Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	26.40	0	20.31	0	- 20.31
2	17.28	0	10.22	0	-10.22
3	0	0	0	0	0
4	0	86.68	0	30.35	30.35
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	179.73	0	22.03	22.03
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	372.69	0	16.00	16.00
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	772.82	0	11.61	11.61
				NPV	49.46

<u>Pole production</u>. The total income with the pole enterprise was $179.60 of which $175.60 came from the poles themselves and $4 came from charcoal. The NPV with this system of production was a positive $313.16, Table 14. This result was considerably lower than the previous Bombardopolis case. In charcoal production, the non-performing species lowered the yield of the farm. Only half of the species planted produced poles, with eucalyptus representing

three-quarters of the production. Cassia had the highest pole-per-tree production.

Table 14. NPV at a 30 Percent Discount Rate for Mixed Species Woodlots in Bombardopolis, Case 3, for Poles as Main Product When Farmer Receives 100 Percent of Residual Charcoal Returns With Donated Seedlings (Values in Dollars)

Year	Cost	Benefit	P.V.Cost	P.V.Benefit	Net P.V.Benefit
0	0	0	0	0	0
1	26.40	0	20.31	0	- 20.31
2	17.28	0	10.22	0	- 10.22
3	0	0	0	0	0
4	0	372.42	0	130.39	130.39
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	772.25	0	94.67	94.67
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	1601.33	0	68.73	68.73
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	3320.52	0	49.90	49.90
				NPV	313.16

Summary of Results

The data obtained in this study can be summarized from Table 15 as follows:

1. At Mirebalais, under the actual conditions of tree planting with donated seedlings, all the options examined showed positive NPVs except for charcoal production from cassia with a paid custom processor. The highest NPV was

obtained with pole sales, a pattern which was followed on all the farms. Pole sales yielded a NPV of $120, which was 1.8 times that of the best charcoal option for neem and a NPV of $77, which was 2.7 times the charcoal value for cassia. Charcoal is known to have a more stable market than poles, however.

2. At Bombardopolis, Case 1, the farmer used a high-density planting system. This planting increased the cost of seedlings and was reflected in the NPV of the venture. A NPV of $339 was obtained from charcoal sales in which the farmer did his own processing.

3. At Bombardopolis, Case 2, production showed a NPV of $394 for charcoal with owner processing and $1,123 for poles because of the high yield with leucaena.

4. At Bombardopolis, Case 3, the mix of species biased the results downward. Some species performed well, while others showed a near zero productivity. The NPVs were $115 for charcoal with owner processing and $313 for poles, less than one-third of NPVs for the other two farms at Bombardopolis.

Table 15. NPVs Obtained for Pole and Charcoal Production for Tree Farms at Mirebalais and Bombardopolis in Haiti with Donated Seedlings (Values in Dollars), 1989.

Location	Species	Charcoal Share of Sale 100%	Charcoal Share of Sale 55%	Poles
Mirebalais	Neem	68.03	6.85	119.60
Mirebalais	Cassia	27.91	-1.25	76.74
Bombardopolis Case 1	Leucaena	339.15	168.64	NA
Bombardopolis Case 2	Mixed Species	394.30	203.13	1,123.07
Bombardopolis Case 3	Mixed Species	114.91	49.46	313.16

Appendix Table 5 shows additional alternatives of cost payment for the seedlings with one option for $0.25 to be paid by the farmer and another of $0.50 to be paid by the farmer. None of the NPVs were positive for charcoal production when the cost of a custom processor was imposed. In contrast, all of the pole production schemes, except the Bombardopolis Case 3 farm with $0.50 seedlings, had positive NPVs. The two Mirebalais options of neem and cassia with $0.25 seedling costs showed positive NPVs for owner processing of charcoal. Cases 1 and 3 at Bombardopolis showed negative NPVs at $0.25 and $0.50 seedling costs for owner processing of charcoal. With a $0.25 seedling cost, Bombardopolis Case 2 showed a positive NPV for charcoal with owner processing.

Sustainability of tree production in the future requires improvements in survivability of trees planted on farms and an improved efficiency leading to less costly trees on an economic basis from nurseries. The four case studies presented had a much higher rate of survivability than CARE and PADF generally report. More information needs to be gained to properly allocate various overhead costs and expenditures in order to determine what proportion covers various general extension programs and what proportion covers tree seedlings per se.

III. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

A wide range exists in the profitability of tree farming in terms of NPVs for the four case studies by the different cost and returns options. Improper matching of tree species and sites was a detriment to profitability in some cases.

At present, AID supplies seedlings to Haitian farmers free of charge, but sustainability questions demand that efforts be made to cover part or all of these costs over time. Support for payment for part of the cost of seedlings and tree planting may be justified on the basis of benefits to the public. To date, sufficient data have not been generated to quantify this support.

Species selection for a given site was found to have a profound effect on the profitability of growing trees. Eucalyptus had several times the production of leucaena or cassia on one site while the reverse was true on a different site in the same vicinity. These results illustrate the need for developing a set of site-species recommendations based on detailed site descriptions and tree growth studies. Meanwhile, where more than one tree species will be planted to a single site, trees should be grouped by species to prevent suppression of growth of one or more of them. A species which fails to grow can be replaced by one which grows properly.

The farmer retains more of the gross income when he makes the charcoal with his own labor. Previous studies (Street, 1989a) have shown a very low opportunity cost of labor for tree farmers in the Central Plateau and the Northwest of Haiti.

The present data should be complemented by additional studies to determine the benefits of additional tree products and to determine effects of soil conservation and other benefits to the public. A broader sampling base must be provided for generalizing cost and returns results to a specific population.

Recommendations

1. Extension workers should stress increasing the survivability of the seedlings planted as a means to increase profitability.
2. Species selection should be tailored to the local area.
3. The feasibility of providing credit to farmers for seedling purchases should be studied.
4. More data should be obtained on the competitiveness of trees and crops for border plantings.
5. The present study should be expanded to obtain sampling data for making inferences in defined physiographic areas.

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APPENDIX

Appendix Table 1. Yields per Hectare for Three Tree Species When Used Alone on Border of Mirebalais Farm.

Species	Number of Trees per Hectare	Number of Poles	Mean Annual Charcoal Increment (kg)
Neem	167	195	355.22
Chenn	174	0	40.29
Cassia	154	139	316.81

Appendix Table 2. Yields per Hectare for Leucaena on Woodlot of Bombardopolis Farm, Case 1.

Number of Trees per Hectare	Number of Poles	Mean Annual Charcoal Increment (kg.)
2,250	-	990.00

Appendix Table 3. Yields per Hectare for Three Tree Species on Woodlot of Bombardopolis Farm, Case 2.

Species	Number of Trees	Number of Poles	Mean Annual Charcoal Increment (kg)
Cassia	258	252	210.00
Eucalyptus	65	19	10.00
Leucaena	548	1,038	890.00
Totals	871	1,309	1,110.00

Appendix Table 4. Yields per Hectare for Eight Tree Species on Woodlot of Bombardopolis Farm, Case 3.

Species	Number of Trees	Number of Poles	Mean Annual Charcoal Increment (kg.)
Casuarina	98	0	9.90
Catalpa	43	0	1.70
Cassia	67	61	52.10
Kapab	25	0	4.60
Eucalyptus	563	312	222.70
Gliricidia	37	0	6.70
Leucaena	61	30	36.20
Leucaena	92	36	47.50
Totals	986	439	381.40

Appendix Table 5. NPVs for Tree Planters in Haiti by Location, Seedling Cost Payment and Species for Charcoal and Pole Production (Values in Dollars), 1989.

Location	Seedling Costs	Mixed Species	Charcoal Share of Sale 100%	Charcoal Share of Sale 55	Poles
Mirebalais					
	Donated	Neem	68.03	6.85	119.60
	$0.25	Neem	17.23	-43.15	69.60
	$0.50	Neem	-31.97	-93.15	19.60
Mirebalais					
	Donated	Cassia	27.91	-1.25	76.74
	$0.25	Cassia	14.56	-39.75	37.99
	$0.50	Cassia	-24.19	-78.25	0.76
Bombardopolis Case 1					
	Donated	Leucaena	339.15	168.64	NA
	$0.25	Leucaena	-285.85	-456.36	NA
	$0.50	Leucaena	-910.85	-1081.36	NA
Bombardopolis Case 2					
	Donated	Mixed	394.30	203.13	1,123.07
	$0.25	Mixed	152.30	-38.87	881.07
	$0.50	Mixed	-89.70	-280.87	639.07
Bombardopolis Case 3					
	Donated	Mixed	114.91	49.46	313.16
	$0.25	Mixed	-158.84	-224.29	39.41
	$0.50	Mixed	-432.59	-498.04	-234.34