AAN-330
Code 31864

CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) — PART I

Report Symbol U-447

1. PROJECT TITLE	2. PROJECT NUMBER	3. MISSION/AID/W OFFICE
Senegal Fuelwood Production	685-0219	USAID/Senegal 172

4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY)

☐ REGULAR EVALUATION ☒ SPECIAL EVALUATION

5. KEY PROJECT IMPLEMENTATION DATES	6. ESTIMATED PROJECT FUNDING	7. PERIOD COVERED BY EVALUATION
A. First PRO-AG or Equivalent FY 79	A. Total $ 4.0 million	From (month/yr.) May 1979
B. Final Obligation Expected FY ____	B. U.S. $ 3.434	To (month/yr.) December, 1983
C. Final Input Delivery FY 84		Date of Evaluation Review

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED
Decisions (recommended by evaluation and approved by AID/Senegal)		
1. Cessation of funding and of project as presently existing in the Project Agreement at the end of 1983, except for the continuation until termination of already committed scholarships and contracts.	AID/Senegal	December, 1983
2. Formulation of a plantation management plan by the American co-director.	AID/Senegal Roger Jones, American Project Manager	Jan.-May, 1984
3. Financing through the proposed Title III extension (for FY 1984) of plantation maintenance. of a continuation of on-going research on various aspects of plantation establishment and maintenance, and of an economic and management study of the plantation.	AID/Senegal Norman Rifkin	January, 1984

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

- ☐ Project Paper
- ☐ Financial Plan
- ☐ Logical Framework
- ☐ Project Agreement
- ☐ Implementation Plan e.g., CPI Network
- ☒ PIO/T Roger Jones (see Decision No.2)
- ☐ PIO/C
- ☐ PIO/P
- ☐ Other (Specify)
- ☐ Other (Specify)

10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

- A. ☐ Continue Project Without Change
- B. ☐ Change Project Design and/or
- ☒ Change Implementation Plan (See No. 3 Decision)
- C. ☐ Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

Peter Freeman, USAID/Senegal, Team Leader
Oscar Fugalli, Forester
Tim Resch, Forestry Support Program, AID/W
George Taylor, SDPT, Bamako
Theodore Wood-Stervinou, REDSO/WA
~~Jean F. Damon, Economist, AID/Senegal~~

12. Mission/AID/W Office Director Approval

Signature: [signature]

Typed Name: David Shear, Director

Date: May 10, 1983

AID 1330-15 (3-78)

PROJECT EVALUATION SUMMARY PART II

13. Summary

1550 hectares of a planned 3000-hectare, "fast-growing" fuelwood plantation have been established. Before the project ends in December 31, 1983, an additional 300 to 400 hectares will have been planted. Progress was less than expected principally because of organizational, management, and logistical delays in the project's first full year, 1980. Growth of the trees has been much less than expected due to a combination of lower than anticipated rainfall, lower than expected growth rates even after correcting for the rainfall factor, lesser density of trees in the plantation than was planned, and mortality. Instead of 10 cubic meters per hectare per year, the plantation is expected to produce only 1.5 m^3/ha/year. Costs have also been higher than expected.

14. Evaluation

The 3rd year evaluation was planned in order to make possible a determination of whether or not to continue the project into a second phase of 3,000 additional hectares. It was to have been carried out by AID staff, but an internationally known Sahelian forester was added to the team to provide needed expertise and weight to technical findings. He was Oscar Fugalli. Team leader/editor was Peter Freeman, USAID/Dakar. Other participants were: Jean François Damon, USAID/Dakar; Tim Resch, Forestry Support Program, USAID/Washington; George Taylor II, SDPT, Bamako; Theodora Wood-Stervinou, REDSO/WA.

The evaluation scope was set forth in the project paper. It was discussed with GOS Forest Service and project staff (project is known as PARFOB). Comments were incorporated into the design. Special data compilation work was carried out by PARFOB staff: financial records and plantation records. An energy analysis was added to the scope to test probable foreign exchange earnings from the project's contribution to Dakar's domestic fuel. Plantation growth was sampled.

The evaluation took place during November 1982 to April, 1983. The team was fielded during January and part of February, 1983.

15. External factors

GOS financial problems precluded their making the planned counterpart, contribution to project operating expenses, so AID paid for most of these, and particularly plantation labor.

Rainfall in the project area has been much less than expected; also growth rates in the area of eucalyptus have turned out to be less than was anticipated in the project paper.

Plantation output assumptions (10 m^3/ha/yr) are no longer valid. Actual output being almost an order of magnitude less (at 1.5 m^3/ha/yr) is so different that adjustments in the project aimed at rescuing its viability are not possible.

A heavy GOS commitment to plantation forestry as a way of supplying urban fuel needs, however, has put much attention on the project, which is viewed as a pilot experience from which important lessons should be learned.

16. Inputs

There were numerous problems with the timeliness, quality and appropriateness of project inputs. It is too late to change or otherwise remedy the matter.

17. Outputs

	Project Paper (Year 3)	Actual, Year 3 (end, Dec. 1982)
Plantation surface	2,250 has.	1,550 has.
Project headquarters at plantation site	constructed by year one	begun but not yet finished (to be finished in 83)
Six overseas training scholarships granted	granted	granted
Local training plan made and in implementation	accomplished	not accomplished
Plantation techniques learned and in practice	accomplished	accomplished
3rd year evaluation	done by end year 3	begun (finished in '83)

Other ouputs are measured on a 4-year time scale.

18. Through 20

Purpose, subgoal, goal, beneficiaries. Too early to make meaningful statements on these aspects.

21. Unplanned effects

None.

22. Lessons learned

Long term forestry research for species as well as cultivation techniques is indispensable, and its lack resulted in the over-estimation of Bandia Forest's productivity.

The organization and managerial novelties of this pilot project were seriously underestimated in terms of the amount of learning and institutional capacitation required. Also, the project document underestimated the amount of

technical assistance that would be needed to obtain, operate and maintain the project's heavy equipment.

U.S. Soil Conservation Service soil survey techniques resulted in hard-to-understand maps and reports, which made the information difficult to use.

The importance of plantation workshop and housing/office facilities cannot be over-stressed. The lack in this project prevented good supervision and adequate organization of project supplies and repair of vehicules. Similar projects should proceed in two phases. Start-up: build facilities, obtain equipment and supplies, recruit key staff. Estimate 1 year. Operation: 2nd year, etc.

23. Special remarks

Project growth and related cutting trials in the Bandia Forest corroborate the recent consensus among Sahelian foresters that it is not worthwhile to grow Eucalyptus below 800 mm of rainfall.

Natural forest management in the lower rainfall regions is the obvious alternative way to obtain more growth and production in forests in these regions.

Attachments:

. Chapter A. Summary (of the Third Year Evaluation of the Senegal Fuelwood Production Project.)

EXECUTIVE SUMMARY

PREPARED BY : Peter H. Freeman

DATE : April 1983

PROJECT : Senegal Fuelwood Production - 685-0219

COUNTRY : Senegal

COST : $3.34 million

PERIOD OF PROJECT: 1979 to 1983.

1. WHAT CONSTRAINT DID THIS PROJECT ATTEMPT TO RELIEVE?

The project attempted to relieve pressures on natural vegetation exerted by wood cutters and fuel gatherers, through the establishment of a fuelwood plantation.

A) Relieve projected shortages of fuelwood and stabilize or increase national fuelwood (charcoal, firewood) production potential.

B) Halt or reverse environmental deterioration due to inadequate national forest cover.

C) Increase the supply of available wood to meet basic human needs.

2. WHAT TECHNOLOGY (KNOWLEDGE, SKILLS OR PRACTICES) DID THE PROJECT PROMOTE TO RELIEVE THIS CONSTRAINT?

The project attempted to employ plantation forestry with mechanized land clearing and improved silvicultural and maintenance techniques.

A) Improved forest management techniques intended to increase wood production and utilization without causing environmental degradation.

3. WHAT TECHNOLOGY DID THE PROJECT ATTEMPT TO REPLACE?

The project attempted or was intended to replace in some measure the traditional wood cutting and charcoal making technologies employed in Senegal, to the extend that production from the plantation would substitute production by traditional harvesting methods from natural forests.

4. WHY DID PROJECT PLANNERS BELIEVE THAT INTENDED BENEFICIARIES WOULD ADOPT THE PROPOSED TECHNOLOGY?

The "intended beneficiaries" were essentially the urban populations of Dakar, who would benefit indirectly through the easing effect that would be generated by the output of the plantation on the charcoal supply to the city.

In fact, it is the GOS who would be adopting the plantation techniques undertaken in the project. The GOS has already stated its intention of employing plantation forestry to help supply the fuelwood and charcoal needs of the country, especially the large cities.

5. WHAT CHARACTERISTICS DID THE INTENDED BENEFICIARIES EXHIBIT THAT HAD RELEVANCE TO THEIR ADOPTING THE PROPOSED TECHNOLOGY?

The GOS commitment to forestry and the national recognition that existing supplies of fuelwood are inadequate.

6. WHAT ADOPTION RATE HAS THIS PROJECT ACHIEVED IN TRANSFERRING THE PROPOSED TECHNOLOGY?

(Question not applicable)

7. HAS THE PROJECT SET FORCES INTO MOTION THAT WILL INDUCE FURTHER EXPLORATION OF THE CONSTRAINT AND IMPROVEMENTS TO THE TECHNICAL PACKAGE PROPOSED TO OVERCOME IT?

It is highly likely that this is the case. However, any forces set in motion are only just beginning to be exerted (i.e. April, 1983), and partly as a consequence of a third year evaluation performed recently on the project. It is too early to discern what in fact might be the outcome in the GOS of the results of this project.

8. DO PRIVATE INPUT SUPPLIERS HAVE AN INCENTIVE TO EXAMINE THE CONSTRAINT ADDRESSED BY THE PROJECT AND TO COME UP WITH SOLUTIONS?

It would not seem to be so. Most lands eligible for forest plantations are within national forest boundaries, thus are controlled and managed by the GOS Forest Service. Secondly, these lands are generally not the best soils, hence would not respond as well to intensive husbandry as would agricultural soils -- which are in private hands. Note, however, that all charcoal and fuelwood are exploited and made by private individuals, not by the GOS.

9. WHAT DELIVERY SYSTEM DID THE PROJECT EMPLOY TO TRANSFER TECHNOLOGY TO INTENDED BENEFICIARIES?

Technical assistance in forest plantation establishment and management was planned for the project. To date however, competent and experienced dryland forest plantation specialists have not been provided to the project. None were available for the two year (or longer) contract slot as project co-director.

Training of Senegalese forestry personnel was planned and is in process.

10. WHAT TRAINING TECHNIQUES DID THE PROJECT USE TO DEVELOP THE DELIVERY SYSTEM?

A) Training of local nursery personnel in the production techniques required for efficient and timely seeding crops.

11. WHAT EFFECT DID THE TRANSFERRED TECHNOLOGY HAVE UPON THOSE IMPACTED BY IT?

Too early to determine.

EXECUTIVE SUMMARY

PREPARED BY: PETER FREEMAN
DATE: APRIL 1983
PROJECT: SENEGAL FUELWOOD PRODUCTION 685-0219
COUNTRY: SENEGAL
COST: $ 3.34 million
PERIOD OF PROJECT: 1979 to 1983

1. WHAT CONSTRAINT DID THIS PROJECT ATTEMPT TO RELIEVE?

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In fact, it is the GOS who would be adopting the plantation techniques undertaken in the project. The GOS has already stated its intention of employing plantation forestry to help supply the fuelwood and charcoal needs of the country, especially the large cities.

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(Question not applicable)

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Training of Senegalese forestry personnel was planned and is in process.

8

10. WHAT TRAINING TECHNIQUES DID THE PROJECT USE TO DEVELOP THE DILIVERY SYSTEM?

Two year scholarships were provided to six participants. None are specializing in plantation forestry per so.

A) Training of local nursery personnel in the production techniques required for efficient and timely seedling crops.

11. WHAT EFFECT DID THE TRANSFERRED TECHNOLOGY HAVE UPON THOSE IMPACTED BY IT?

Too early to determine

Acronyms

CNRF	Centre National de Recherches Forestières
DGEF	Direction Générale des Eaux et Forêts
GOS	Government of Senegal
GJ	Gigajoules
ISRA	Institut Sénégalais de Recherches Agricoles
PARFOB	Projet Autonome de Reboisement de la Forêt de Bandia
PP	Project Paper (Senegal Fuelwood Production Project)
SAED	Société d'Aménagement et d'Exploitation des Terres du Delta
SEEF	Secrétariat d'Etat aux Eaux et Forêts
SODEVA	Société de Développement et de Vulgarisation Agricole
WFP	World Food Program

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THIRD YEAR EVALUATION OF THE SENEGAL FUELWOOD PRODUCTION PROJECT 685-0219

Presented to the
Office of Agricultural Development
USAID
Dakar, Senegal

Evaluation Team:
Peter Freeman, USAID/Senegal, Team leader/editor
Jean François Damon, USAID/Senegal
Oscar Fugalli, Forestry consultant
Tim Resch, Forestry Support Program, USAID/Washington
George Taylor II, SDPT, USAID/Bamako
Theodora Wood-Stervinou, REDSO/Wa, Abidjan

April, 1983

Acknowledgements

The evaluation team wishes to express its appreciation for support from the AID mission in Dakar, and from the Government of Senegal during the course of its work. The team particularly appreciates the collaboration of the Direction Générale des Eaux et Forêts, the entire staff of the Projet Autonome de la Forêt de Bandia (PARFOB), and the Centre National de Recherches Forestières (CNRF).

Important contributions in the form of original data compilation were undertaken by the staff of PARFOB and CNRF for the evaluation. A sample growth mensuration of the plantation was carried out under the direction of Mr. Claude Bailly, CNRF, and labor and financial compilations as well as compartment histories for the PARFOB operation were developed by Mssrs. David Kingsbury, Elie Joseph Sambou and Abdoulaye Lo.

Acronyms

CNRF	Centre National de Recherches Forestières
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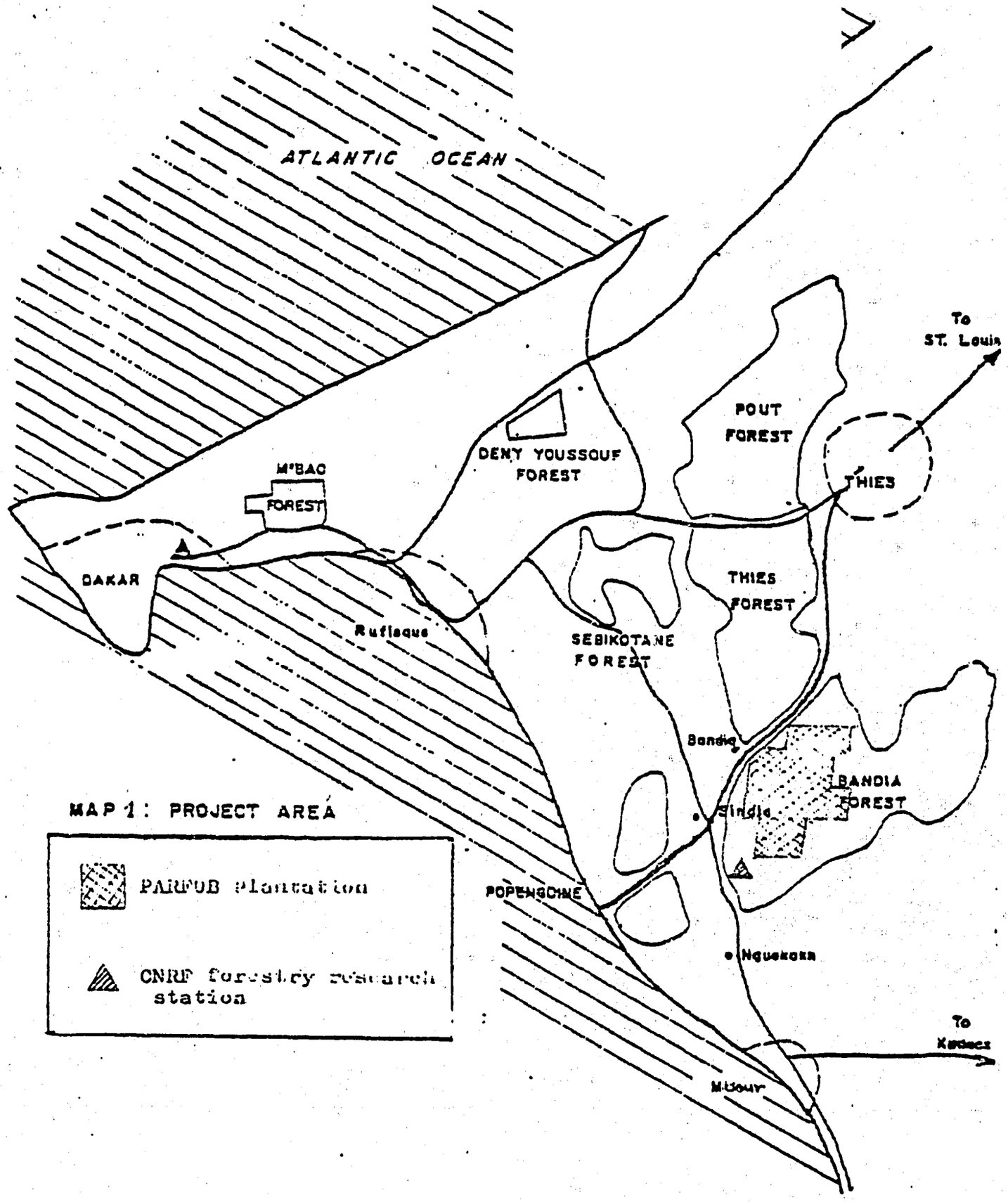

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A. SUMMARY

The design of the Senegal Fuelwood Production Project called for an evaluation in its third year to determine the advisability of continuing into a Phase II of 3,000 additional hectares. The present document reports on the evaluation effort which, including data compilation, field work and report preparation, took place between November, 1982 and April, 1983. The project will complete its fourth year at the end of 1983, when on the recommendation of this evaluation it would be halted, except for a low level of maintenance until the first substantial harvest (1987).

1.0 Progress as of end, 1982

By the end of the third planting season in 1982, a total of 1,550 hectares of trees had been planted in the Bandia Classified Forest, as shown in Table A-1 and Figure 2. The total is 700 has. less than was targetted in the project paper for the third year. The difference is largely explained by delays in the start-up period.

1.1 Start-up

Numerous delays in recruitment, procurement, and financial organization occured during the first year of the project. The agreement was signed in May, 1979, but the first American co-director did not arrive until May, 1980, well into the work of the 1980 planting season. Orders for the two D-6 Caterpillar tractors and the ten Massey-Ferguson tractors were not prepared until January, 1980. The D-6's were delivered in June, 1980 -- too late that year to be of effective help -- and the wheeled tractors did not arrive until January, 1981.

Table A-1 Plantation surface by year and species[a]

	Eucalyptus camaldulensis	Prosopis juliflora	Neem	Cassia siamea[b]	Other	Total[d]
1980	150					150
1981	617	12		26		655
1982	592	114	30	7	7[c]	750
	1,359	126	30	33	7	1,555

(a) Data supplied by the Division de Sylviculture, PARFOB.

(b) In association with eucalyptus

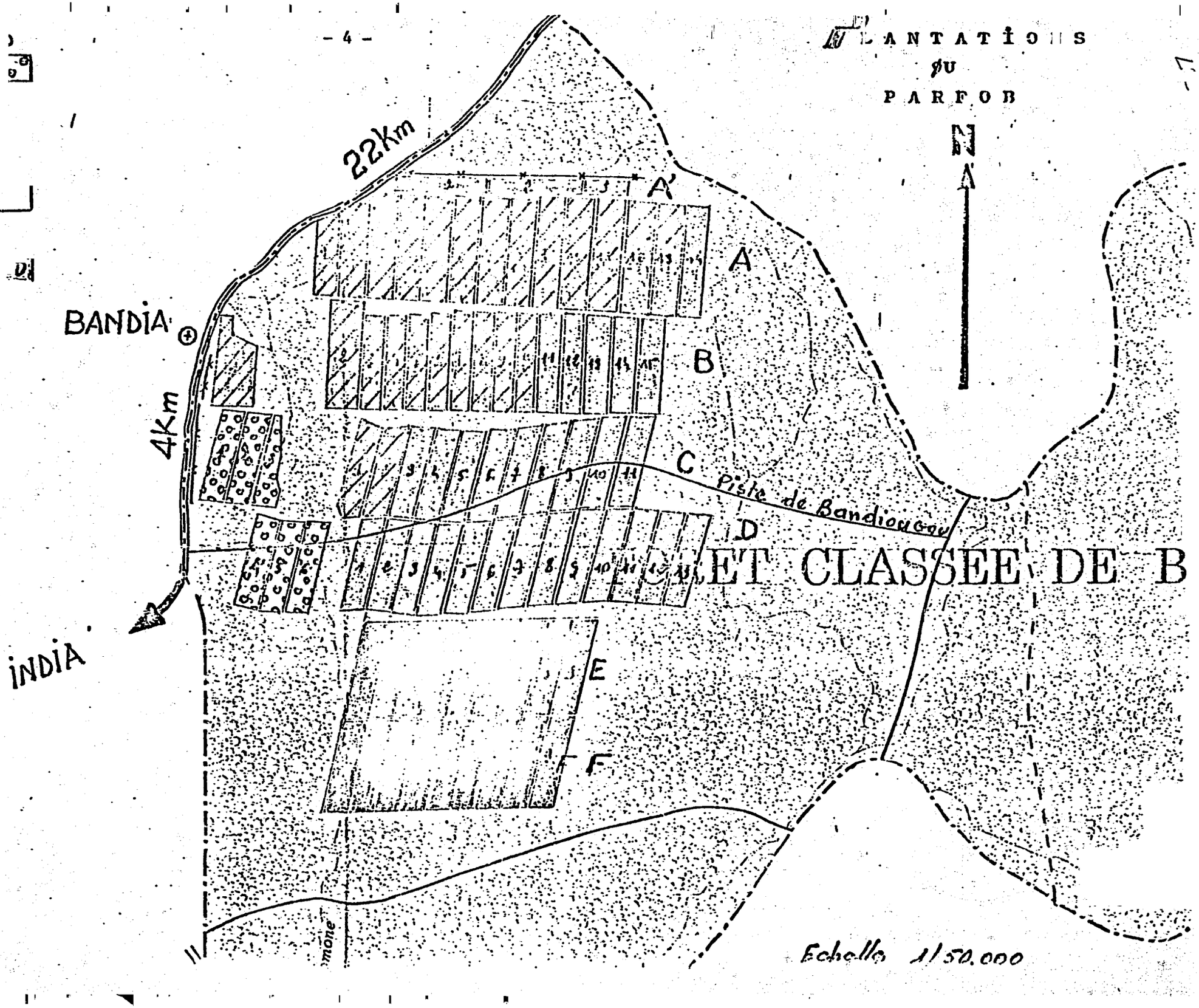
(c) Melaleuca (Niaouli)

(d) Totals do not include surfaces that were re-planted as follows: 1981 - 25 has. in 1980 compartments.
1982 - 50 has. in 1981 compartments and
75 has. in 1980 compartments

Table A-2 Technical assumptions underlying the project

Average annual rainfall:	500 - 700 mm
Plantation growth:	At least 10 m^3/ha/year
Plantation establishment:	750 hectares per year
Soil suitability:	Up to 8,000 hectares of suitable soils in the Bandia Forest.
Plantation costs:	Could be reduced by 40 to 60% over time, on the basis of cost-reducing research.

PLANTATIONS
DU
PARFOB



A number of difficulties and errors delayed the opening of a project bank account in Dakar until July, 1980, and in Thiès until October, 1980, rendering it difficult to purchase and pay for local goods and services.

GOS administrative procedures required for contracting the construction of the project buildings and the drilling of the well were slow and contacts were held up on a technicality concerning emergency bidding procedures. The time consumed in the preparation of invitations to bids, including prior reviews and approvals by AID and the concerned GOS agencies, and the awarding and drawing up of contracts, was greatly underestimated by the project paper.

After a false start by DGEF and invalidation of the bidding procedure on the project buildings, AID contracted out the building construction directly. It was not completed as of the end of 1982, whereas the project paper expected completion in March, 1980. Similar problems affected the bidding for the well at the nursery, but in this case the contractor who had been selected by DGEF proceeded to drill and complete the well without a contract approved by all the necessary branches of the GOS. The well was finished by March 7, 1981, after ten days of work, but has not yet been paid for, since a valid contract has not yet been executed. The Commission Nationale de Contrats et Marchés invalidated the emergency bidding procedure used for selecting the contractor.

1.2 Plantation Development

1980. Rainfall: 320 mm. Site clearing for the 1980 planting of 150 hectares was carried out with a borrowed D-7, which was contributed

by the GOS to the project. The D-6's arrived too late to provide much assistance, and moreover were not equipped with brush rakes. Also they are not powerful enough to remove baobab trees and level termite mounds.

Trees were raised in the nursery of the region at DGEF office in Thiès, for lack of facilities at the Bandia nursery site. Not all the trees provided were the recommended E. camaldulensis 8411. The soils of the 1980 plantation compartments were reconnoitered but the survey did not manage to avoid land with lateritic hard-pan at 1.0 meter below the surface, which subsequently has impeded root development. 100 of the 150 has. have had to be replanted with Prosopis juliflora. Weeding by disk harrow was accomplished with a tractor borrowed from DGEF in Thiès.

1981. Rainfall: 355 mm. The full 750 hectares were cleared in 1981, but due to an early cessation of the rains, only 650 hectares were planted. All trees were raised in the nursery at Bandia, from seed supplied by CNRF, and following procedures developed and specified by CNRF. Land cleared took into account a soils survey begun in October, 1980, and continued in 1981 by US Soil Conservation Service soils scientists, using 1:5,000 black and white aerial photography obtained in 1980.

Problems with the heavy equipment began to appear: wheeled tractors not heavy enough and disks not strong enough; tires too thin (6-ply) to resist sharp stumps left by wood-cutters and not up-rooted in the sub-soiling operation. Grasshoppers caused heavy damage in several compartments, which later had to be replanted. Grasshopper damage had not been anticipated in the project paper. Also, once wet by the rains

the terrain in the plantation becomes impassable to the heavy equipment, therefore requiring that plants be transported to the compartments prior to the rains and watered until planted out. These tasks reduced by two the number of tractors available for weeding at the beginning of the season.

CNRF harvests in 1981 of 6-year trials with Eucalyptus camaldulensis at their Bandia station revealed that growth was not higher than 4 m^3/ha/year during 1976-1981. A reconnaissance soils survey of classified forests to the south in the Sine Saloum was arranged in anticipation of the likelihood of moving further plantation work to this higher rainfall zone.

1982. Rainfall: 445 mm. A further 750 hectares of land was cleared and planted in this season of well distributed rainfall, including a "bonus" rain of 74 mm in October, which effectively extended the growth period. In addition 125 hectares of trees were planted in various parts of the 1980 and 1981 plantations which had suffered mortality, or which had not been completed. Thus a total of 875 hectares were planted.

This season used the greatest amount of labor (approx. 60,000 man days), at a cost of almost 100 million FCFA. The late rains and problems with tractors tires increased the need for manual weeding; both mechanical and hand weeding continued late into the season. Grasshopper attacks again damaged some 35 hectares in compartments near the borders of the plantation.

PARFOB assisted a number of villages surrounding the Bandia forest to plant woodlots, and also distributed free of charge some 43,000 eucalytpus and 1,000 mango seedlings.

In this year CNRF research in the plantation on water balance, crop/tree associations and bare root plantings has begun to yield results.

By the end of the project's third year, the techniques of raising and planting trees, and of clearing and preparing land for planting had become fairly well developed. A number of improvements remained to be worked out, however: more accurate spacing of trees; more timely weeding; the better maintenance of project equipment and the organization of routine and exceptional work on equipment; the better organization and more efficient use of labor; more timely and expeditious procurement of various products and materials, both imported and local; and better record keeping and reporting in all project operations, from the plantation to the accounting department.

1.3 Growth and productivity

A sample mensuration was undertaken by CNRF and PARFOB staff on the plantation in early 1983 in conjunction with the present evaluation. Plantation yields were estimated by comparing performance of PARFOB trees with the early performance (first three years) of the Eucalyptus harvested by CNRF in 1981, as well as by taking into account mortality and density of trees on the plantation.

Six-year old *Eucalyptus camaldulensis* trees on an experimental plot in the Bandia station of CNRF yielded between 1.5 m^3 and 4 m^3/ha/year. The total accumulated rainfall for the six year period was 2,600 mm or an average of 433 mm per year. The Bandia plantation has so far averaged only 373 mm per year.

The evaluation team's forestry consultant, Mr. Oscar Fugalli, estimates that the present PARFOB plantation will yield 1.5 m^3/ha/year. This very large reduction from the expected 10 m^3/ha/year essentially rules out the technical feasibility of fuelwood plantation in this rainfall zone. The natural forest is estimated to produce 1 m^3/ha/year, and could perhaps yield more by management measures such as excluding cattle and selective thinning.

The project paper estimates of growth rates turn out to be over-optimistic. Rainfall was estimated on the high side as well, with Mbour being used as indicative of the region's rainfall. Mbour has a coastal location with an anomalously high amount of rain. Rainfall at Bandia turns out to be, ironically, anomalously low, relative to Mbour and Thiès, as table D-5 shows.

There is no reason to propose that rainfall will become more abundant over time. A recent review for the Club du Sahel by Dr. Sharon Nicholson of various hypotheses that have been formulated for explaining climatic change in the Sahel has found no basis for any predictable periodicity of drought and abundant rainfall. All evidence supports a very great and unpredictable variability of rainfall in the zone (and a positive feed-back effect between de-vegetation and drought, linked to the influence of atmospheric dust).

Various yield enhancing improvements, i.e. closer tree spacing, more timely weeding, and planting, and perhaps faster-growing varieties, could increase output, but only by fractions of a cubic meter per hectare per year. The highest experimental plot yield recorded by CNRF

in Bandia of 4 m^3/ha/year is considered technically unattainable at present, and this judgement is consistent with the rule of thumb that plantation growth rarely achieves much more than 60% of experimental plot growth.

1.4 Costs

The direct costs of establishing the existing 1550 hectares of trees are calculated to average $808/hectare. Direct costs include all personnel, paid by AID as well as the GOS, office overhead, nursery and plantation supplies, equipment and various miscellaneous items not amounting to over 1% of the total.

Table A-3 Direct Costs of Plantation

	1980	1981	1982	Totals	%
Personnel					
DCEF agents (estimate)	$ 18,604	$ 22,641	$ 32,335	$ 73,580	6
Other personnel working for PARFOB	153,465	269,724	319,952	743,141	59
Overhead	4,479	12,166	8,625	25,270	2
Nursery & Plantation					
(plastic bags, pesticides, fertilizers, tools, fencing, etc)	31,874	4,909	24,682	61,465	5
Equipment Operation					
Fuel, lubricants	51,266	70,285	56,459	178,010	14
Repairs, maintenance	38,139	30,411	87,777	156,327	12
Miscellaneous	-	4,362	11,140	15,502	1
TOTAL direct costs				$1,253,295	99

Explanatory Note: Amounts summarized from tables D-13, D-14 and D-15. 1980 expenditures are estimates except for fuel and lubricants. Fuel and lubricants (grease, hydraulic pump oil, engine oil, etc.) are purchased directly by AID. Occasional purchases of fuel made directly by PARFOB, in 1982 on the CFA account are charged to the Overhead category. All other categories of expenses are made through the PARFOB account in Thiès, and have been developed from vouchers prepared on that account. CFA amounts have been converted to dollars at the following rates: 1980, 215; 1981, 265;

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By plantation year the direct costs per hectare have been:

1980	$297,827	150 hectares	$1,985/ha
1981	$414,498	650 hectares	$ 637/ha
1982	$540,970	750 hectares	$ 721/ha

The effect on average costs of the difficult 1980 start-up is obvious. If one includes in 1982 the additional 125 hectares that were replanted, the average cost per hectare declines to $618/ha.

Direct costs do not include depreciation for equipment and other investments. Equipment purchases total $941,200, of which $197,600, or 21% has been financed by the GOS. No additional equipment will be purchased in 1983.

Labor represents 65% of the direct costs. It should be possible to reduce this cost through better supervision and other measures to increase worker productivity. Compared to similar scale plantations in Mali and Upper Volta, PARFOB has used almost twice as much labor. In the operational plan it was projected that 44 man days per hectare planted would be required. This amount is similar to that expended in a plantation in Mali (43 man days/ha) and one in Upper Volta (41 man days/ha), neither of which had nurseries, however.

At PARFOB payroll records show that the man days expended per hectare planted in 1981 were 75 and in 1982, 78.

The technical records or fiches parcellaires that were prepared for the various operations in each compartment, for the purposes of this evaluation, indicate a lower per hectare labor input, on the order of

53 man days/ha in 1982. This figure includes nursery time (26 days), transport, planting (10 days), weeding (15 days) and pesticide application for grasshopper control. Up to 7 additional man/days per hectare planted could be attributed to weeding on previous years' compartments, re-planting, and guards (20 were employed during the 1982/83 dry period). The evaluation team judges that the 19 day difference between the 78 man/days per hectare from the 1982 payroll records and the 52.5 + 7 man/days/hectare derived from judgements and records of the technical staff is explained by low worker productivity, particularly during the months following completion of the planting work. "Ghost" workers are not suspected and nor have checks on the possibility revealed any "ghost" workers. On the other hand workers have been observed to leave the plantation early, or to take more than the alloted 1/2 hour for lunch, for the working day of 0800 to 1600.

1.5 Financial Analysis

The project's finances are difficult to analyze due to the lack, to date, of financial ledgers that are organized with appropriate detail and technical definition, by budget category relevant to forest plantations. An "analytic accounting" function foreseen in PARFOB's organizational scheme has not yet been implemented. Neither the GOS nor AID have a recommended scheme for financial record keeping specific to forest plantations.

The project must account to AID periodically as well as to the Ministry of Finance. In the latter case a detailed voucher is prepared as justification for a further advance of funds from PARFOB's Dakar account, (into which AID deposits money and which is controlled by the

Ministry of Finance) to the Thiès account controlled by PARFOB. At PARFOB all checks are co-signed by the Senegalese project director and the American co-director.

As yet no income has been generated by the project. An accounting of advances by AID to the PARFOB account and the use of the money for expenditures on the plantation is summarized in Tables D-22 and D-23. Between 1980 and the end of 1982 AID advanced a total of $1,090,456 to the PARFOB account. Fluctuating exchange rates and in general an increase in the value of the dollar relative to the FCFA (from 220:1 in 1980 to 360:1 at the end of 1982) make for imprecision in the conversion of FCFA expenditures into dollar equivalents. A comparison of advances and expenditures results in a discrepancy of between 8 and 12 million FCFA, representing between 2% and 3% of the total 313 million FCFA advanced in the first three years. There could be several origins of the discrepancy including, exchange rates, and imprecision in the itemization of project expenses (carried out for the evaluation). A reconciliation of this difference should be made.

Actual expenditures in the first three years have exceeded the planned level in most categories, even when the planned 10% inflation and 7% contingency are taken into account.

Table A-4. Selected planned and actual expenditures, 1980 through 1982.

	Planned	Actual	Difference
		(000's $)	
1. Plantation (3 years)			
Equipment	565.5	941.2	+ 60%
Personnel (Staff & labor)	564	816.7	+ 69%
Equipment operation	385	334.3	- 14%

	Planned	Actual	Difference
2. Technical Assistance (4 years)	500	593	+ 19
3. Training (4 years)	113	209.7	+ 85%
4. Research (2 years) (AID only)	129	94	- 41%

Plantation heavy equipment and vehicles were in general more expensive than was expected, and the GOS contributed a D-7 caterpillar tractor and three support vehicles, none of which were planned in the project paper. The D-7 has been essential; the two D-6's are too light for certain land clearing tasks.

Labor requirements were somewhat underestimated, but it is judged that much of the greater cost of labor is explained by low productivity of labor, in turn a function of insufficient supervision and inefficient organization. Technical assistance cost more because of the addition of two unplanned 2-year contracts. Training cost differences are principally a consequence of higher than expected increases in tuition and living costs in the U.S.

For the plantation operation only, in the first three years, the GOS has contributed a total of $271,200 to the project or $143,000 more than was planned for the period. AID contributed $411,800 more to the plantation operation than was planned. The total amount invested in the plantation as of the end of 1982 has been $2,260,000 of which slightly more than $1 million was spent on equipment and the garage and workshop.

The internal rate of return of the project was re-computed using the results of the sample mensuration of the plantation taken in January, 1983, together with the actual costs of plantation establishment.

A plantation surface of 1550 hectates with a 20 year life was used. Initially a direct cost of $890 per hectare was used. Initial computations using a yield of 1.5 m^3 per hectare per year, and a charcoal price of 40 FCFA/kg, resulted in a negative rate of return. Both higher yields and higher charcoal prices were then tested. A positive rate of return was not obtained until prices of charcoal are increased to 150 FCFA/kg and yield is increased to 3.0 m^3 per hectare per year.

Direct economic impacts of the project have been initially created through the payroll at the plantation site. The PARFOB salaries and wages in 1982 totalled almost 100 million FCFA, and during the months of peak activity amounted to approximately 20 million FCFA per month. During the project's first three years a total of 200 million FCFA have been paid as wages and salaries, 90% of which have been for equipment operators, mechanics and various categories of laborers.

The multiplier effect of wages paid is estimated to be 1.36 at the local level and 3.39 at the national level.

1.6 Energy analysis

One of the expected benefits of the project was that of conserving foreign exchange that would be spent on energy imports. An energy input/output analysis of the project was made to test this idea, as well as to know what the returns on "energy" investment would be. The analysis, presented in Annex C, compares inputs in the form of diesel and gasoline fuel consumed during plantation establishment and maintenance to expected outputs in the form of fuelwood and charcoal, by converting these into common energy units (Gigajoules).

The energy output obtained at a yield of 1.5 m^3/ha/year is 160% of the energy inputs. If the energy output is equated to butane gas, it is equivalent to 1,125.9 tonnes. If the money spent on the diesel and gasoline fuel during the plantation's life were instead employed to purchase butane gas (at 130,000 FCFA/tonne), 950 tonnes could be purchased, or an amount equal to 84% of the expected plantation output.

1.7 Research and training

The research component of the project is carried out through an agreement between National Forestry Research Center (CNRF), through a formal agreement between the State Secretariat for Inland Fisheries and and Forests (the Secrétariat d'Etat aux Eaux et Forêts (SEEF)) and the Institut Sénégalais de Recherches Agricoles (ISRA), which is CNRF's parent institution. Two full years of research results are now available.

Research carried out at the plantation has produced a number of interim findings of significance. The techniques for greatly reducing plantation establishment and maintenance costs at Bandia -- a principal research goal -- have not yet been developed, however, the research results will be of value to plantation efforts elsewhere.

(1) Techniques of barbatelle (stump) production have been refined and are being tried in actual plantation conditions for the first time in Senegal. Work continues on critical factors such as the time of planting. It is hoped that this technology will provide an important breakthrough in eucalyptus planting methods allowing for considerable savings on labor and more rigorous control of planting stock.

(2) Chemical weeding trials continue to test a variety of weed control agents again with a view to reducing the extensive labor demands of plantation maintenance.

(3) Intercropping trials have provided clear evidence that food crops can be grown together with eucalyptus during the initial years of the plantation.

(4) A windbreak trial, established in 1982, will provide data on the influence of windbreaks on plantation growth -- an influence expected to be particularly beneficial during the months of dry, desiccating harmattan.

Each of these trials serve to further refine the work that has been underway since 1975 in Senegal on the various aspects of eucalyptus production, plantation and maintenance.

Of greater overall importance is the research of long-term nature being funded under the project.

(5) Basic research is underway on the dynamics of the soil and water components in exotic eucalyptus and indigenous natural forest systems. One or two years of data provide initial indications of the potential of potassium to be a limiting factor for eucalyptus, of the degree to which eucalyptus litter contributes to increased soil acidity, of the apparent stability of the soil moisture profile under natural forest. This work should lead over the next few years to the development of silvicultural practices for eucalyptus and, perhaps, for the natural forest as well.

(6) Species trials have been initiated at eight sites spread throughout the country. These are an essential prerequisite to reforestation activities. Work of this sort, searching for the best combinations of species, site and climate - will provide a solid base from which planting programs can be developed in the years to come. Failure to wait for the results of such trials have led to the disappointing experience of the last three years in Bandia. At the same time, however, by funding an expansion of the species trials network, the project is contributing in an important way to ensuring that such a mistake is not repeated.

All the scholarships for technical level as well as advanced degrees in forestry have been funded. One recipient has returned after earning an M.S. in forestry economics from Syracuse. The two, one-year technical level scholarships to Morocco were not used; instead a single, two-year technical level training course was funded in the Ivory Coast. The remaining three scholarships were awarded for an M.S. in forest economics at Yale, an M.S. in Silviculture at U. of Arizona, and a B.S. in forestry at Utah A & M.

In-country training has fallen short of what was envisioned in the project paper. CNRF has offered a short course in nursery techniques to 20 PARFOB workers. The project director and accountant attended a one week course in financial management put on by AID in Dakar in late 1982.

Important training needs have become apparent during the first three years: routine maintenance and handling of heavy equipment; organization and operation of a workshop; plantation manpower organization; record

keeping and analysis; and financial analysis and management, including budget programming.

2.0 Discussion and Conclusion

2.1 Project Design

The project was over-optimistic as regards rainfall, yields and rate of plantation establishment in the first year. It correctly identified the pilot nature of the project, but did not build into the project activity the necessary data recording and monitoring activity that is essential to exploit such a pilot experience. Also, the managerial and organizational aspects of the project were underestimated, in terms of effort needed, even though the special need was recognized. Costs turned out to be underestimated, especially of labor and equipment. Equipment ordered was too light.

2.2 Performance to date

Despite a difficult start-up in which the first planting year had to be accomplished without a nursery facility or equipment planned for the project and with financing arranged only by July, 1980, the project has managed to establish 1,550 hectares of trees in the first three years. The cost however, has been high, averaging $808 per hectare established and maintained, to date. That figure does not include depreciation costs of approximately $1 million worth of equipment and installations.

Trees have been raised in a competent manner in general, although there is room for greater efficiency. The use and maintenance of equipment has become increasingly better organized, however, much remains to be done in terms of more competent and timely routine maintenance, and

in the purchasing of parts and mechanical services. These aspects will now have to be achieved without the benefit of a Peace Corps Volunteer mechanic, and it appears in retrospect that the in-service training aspect of the PCV mechanic's job was too ambitious a goal; equipment operation and repair took priority.

On the plantation, the inadequacies of the equipment (too light in general) have to some extent been compensated by organizing crawler tractor and wheeled tractor time somewhat differently than would be optimum. The result has been that the land is prepared in time for planting but not in the best manner. Three tooth ripping in two directions is not accomplished, thus many stumps remain, and the land is not loosened as thoroughly. The use of disk harrows for land preparation prior to planting as well as two tractors for watering plants set out in the compartments effectively reduced the availability of tractors at the crucial weeding period, namely just after the first rains. Weeding has been accomplished too late, and has been less effective than if done early.

Taking into account the various technical and other constraints it can be concluded that the project had the means to plant 500 hectares per year, and 200 hectares should have been the goal for the first year. It is judged that tree survival and growth rates would have been better had three-tooth ripping been accomplished in two directions, and weeding accomplished earlier.

Much better organization and supervision of labor is required if costs of planting and weeding are to be reduced.

If the rainfall in the project zone were more abundant it would be worthwhile to make an effort to solve these problems and inefficiencies so as to achieve a cheaper, better organized plantation effort. But the plantation's observed growth and expected productivity do not justify the investment, even after eliminating all costs not directly related to plantation operation and maintenance.

2.3 The replicability question

Although it can be concluded that the PARFOB experience represents a technical achievement --, the 1,550 hectares of trees do not fail to impress --, its "replicability" must be considered in light of the conclusion that it is not worth continuing to plant trees in such a low rainfall zone, and in light of the results of CNRF's cutting trials at their Bandia station.

What aspects of the project could be replicated in a similar scaled effort in a higher rainfall zone ? In fact almost every element of the project that was not a routine matter was beset by problems or unanticipated complications: AID financing, GOS financing, contracting of services, procurement of imported and local equipment and goods, short-term technical assistance, the second PCV mechanic, and the replacement for the first American co-director, to name few a salient events. One can and should analyze the reasons for the problems in order to avoid them in similar future efforts. The main report attempts to do this.

Nursery and plantation techniques were developed that could be replicated, although mistakes were made in plantation work that should be avoided. However, one must ask, what are the mechanisms for passing on

these lessons and capacities ? The present evaluation is one such mechanism. The experience gained by PARFOB's technical staff is another. Plantation labor is hired locally, and only the skilled labor,tractor drivers, mechanics and nurseymen are likely to move to another location to work. Elsewhere, local labor would be hired to undertake the unskilled work, and the experience of laborers on the Bandia plantation would not be "transferable" except for perhaps a few individuals.

Management experience at the PARFOB office, and the experience in DGEF and SEEF obtained during the course of the project should in theory comprise an asset for future, similar projects. However, it must be recognized that certain routine management aspects, especially procurement,contracting, financial transfers, and budget programming continued to be afflicted by problems throughout the project's first three years. Whatever the explanation, the doubt remains as to whether future projects would not be hampered by the same, time-consuming difficulties.

A special case is posed by the use of heavy equipment in this type of project. Presently DGEF has no administrative branch with competence in the procurement, organization, operation, maintenance and repair of heavy equipment. The fact that pick-up truck drivers and guards are paid as much or more than mechanics is indicative of the need.

In conclusion, the project cannot be readily used as a model for going about similar projects except in very clear-cut,isolated aspects. Throughout the project extenuating circumstances or unanticipated problems or events have created a continous, distorting effect that

renders virtually impossible the characterization of PARFOB as a model. This may be more the rule than the exception in development, of course, particularly with pilot projects. A concerted effort aimed at extracting all the lessons possible from the project will be necessary to capitalize on the experience.

2.4 Project profitability

The expected negative internal rate of return on the project's direct costs indicate the infeasibility of investing resources in fuelwood plantations in this rainfall regime, even if costs could be reduced and production increased, within reason, through better techniques and better management.

The net energy that would be produced by the project confirms the conclusions of the interim financial analysis. If the amount of money invested in fuel alone for the plantation operation could purchase 84% of the butane equivalent of the plantation's production, it is clear that the foreign exchange savings on imported energy would not be great.

3.0 Recommendations

Recommendations have been formulated for the Senegal Fuelwood Production project, and for fuelwood plantation and forestry sector assistance in general. The recommendations are addressed to AID, but should also be of interest to the Government of Senegal. The presentation here of the recommendations does not imply, however, USAID endorsement.

3.1 The Senegal Fuelwood Production project

(1) AID should not finance a Phase II of this project. Rainfall, and therefore growth, are too low in the project zone. National forests with adequate rainfall (800 mm annual average) to the south in the Sine-Saloum are too far away from the project infrastructure for it to be used in a Phase II planting operation.

(2) Plantation work should continue through the 1983 season. The work has been planned. The remaining money should permit at least 300 hectares to be planted, and PARFOB hopes to plant even more. There are no immediate, superior alternatives for using the money to support fuelwood production. The last year of the project should also yield additional experience that should be of use in future efforts.

(3) AID should provide financial support for plantation maintenance until the end of 1986. A total of approximately 35 million FCFA would be needed, largely to purchase diesel and gasoline for running project equipment in weeding and fire control work. After 1986, harvest revenue could, in principle, cover maintenance costs.

(4) AID should continue support for project research until the end of 1986. Due to delays only 2 years or less of research results have been obtained. They are judged sufficiently promising to justify the completion of the planned four years. Three areas of research should be supported : (a) the inventory and trials of species in eight different climatic and soils zones in Senegal, (b) research on soils changes under eucalyptus plantations, and (c) research on the water balance over time in the soil profile of a eucalyptus plantation.

(5) The American co-director of the project should be charged with developing a management plan for the plantation and surrounding forest. There should be adequate time for this following the 1983 planting season. The plan could be the basis for a more detailed justification of AID support for plantation maintenance.

(6) A wide-ranging economic analysis of the project should be undertaken. An appropriate moment for this would be 1986 or 1987. However, in the interim it is recommended that the internal rate of return analysis carried out in this evaluation be broadened with additional analyses, so as to develop a more complete view of the economic costs and benefits.

3.2 Assistance to Fuelwood Production and Forestry

Future support that AID may wish to provide for fuelwood production should, in the judgement of the evaluation team, be for plantations in zones with average annual rainfall of 800 mm or better, and in which no more than 500 hectares are planted per year, with the first year limited to one half that surface. Specific plantation support should not be designed until soils and climatic studies have been carried out for potential sites.

Natural forest management is a technical alternative to plantations for obtaining increased fuelwood production. AID should support research, inventories and management trials in natural forest management. Although the returns would not be immediate, the work is indispensable.

In addition to AID's on-going assistance to project activities in the forestry sector, the team recommends that AID provide support for (1) basic and applied research in forestry, (2) energy-conserving technologies, (3) macro-economic and regional analyses of fuelwood and

energy supplies and demand, specifically by perfecting the computerized fuelwood analysis model now being promoted by CILSS, (4) improvement of communication of information, and (5) additional support for forestry training.

B. INTRODUCTION

1.0 Background

The present evaluation is integral to the project design and was scheduled for the project's third year. The objective is to determine whether to proceed to a second, four year effort to plant an additional 3,000 hectares of fuelwood trees.

Funding for the second phase was planned through the Title III program, itself scheduled for a phased extension that was to have been planned in early 1983. (Planning was subsequently postponed a year). USAID had previously informed the Secrétariat d'Etat aux Eaux et Forêts of its intention to finance a Phase II fuelwood plantation effort through the Title III mechanism, depending upon the evaluation outcome.

2.0 Approach and methods

The evaluation was to have been done entirely with AID staff. However, because of already apparent, large discrepancies between the technical goals of the project paper and actual achievements -- and between expected and measured production potentials -- it was judged that the technical aspect of the plantation should be entrusted to an experienced plantation forester familiar with Sahelian conditions. (The project paper had foreseen the need for a forest economist to review the project towards the end of Phase I, but not as part of the 3rd year evaluation). Consequently provisions were made to contract such an individual (namely, Mr. Fugalli).

The utility of the evaluation exercise as a means of reviewing project performance with a view towards improvement was anticipated. Maximum involvement of PARFOB staff was therefore sought. Also, the evaluation

exercise was viewed by the DGEF in terms of its broader implications for plantation forestry in the future, many thousands of hectares of which are proposed in the long term strategy of the Plan Directeur de Développement Forestier (CTFT/SCET, 1982). DGEF personnel participated in the planning of the evaluation and made useful suggestions for improvements.

Government of Senegal personnel did not actively participate in the analyses and preparation of this preliminary report, however, excepting where noted herein.

2.1 Schedule

The specific aspects of the evaluation effort including the above-mentioned matter concerning composition of the evaluation team, were discussed internally in AID in October, after which the following sequence of events took place:

27 Oct	Meeting with DGEF PARFOB and CNRF to discuss the evaluation and elicit commentary. (A French language version of the preliminary evaluation plan was distributed).
28 Oct	Revision and distribution of the revised plan.
29 Oct	Planning meeting at PARFOB, in Thiès, to study tasks related to data compilation and to assign work.
November, December	Compilation of technical and financial data from project files, interviews.
7 Jan	Draft outline of evaluation report prepared.
13 Jan to 12 Feb	Evaluation team in Senegal (Thiès, Bandia, field trip to Sine Saloum and Dakar).
7 Feb	Presentation to AID of preliminary results and conclusions of the evaluation.
10 Feb	Presentation to SEEF and CNRF of the preliminary results and conclusions of the evaluation.

10 Feb to April 15	Preparation of complete draft of the evaluation.

2.2 The evaluation team and participation by the GOS

The evaluation team was composed as follows:

Peter Freeman	AID/Senegal	Team leader and editor of overall report.
Oscar Fugalli	Consulting forester	Senior forestry consultant in charge of the technical evaluation.
George Taylor	AID/SDFT Mali	Forester in charge of evaluating the research (recherche d'accompagnement) done by the Centre National de Recherches Forestières.
Tim Resch	Forestry Support Program, AID/Washington	Forester, responsible for reviewing the implications of the Plan Directeur de Développement Forestier pour le Sénégal, with regard to a possible Phase II.
Theodora Wood-Stervinou	REDSO West Africa Abidjan	Economist, in charge of the economic evaluation.
Jean François Damon	AID/Senegal	Economist, responsible for analyzing the regional economic impact of the project's payroll.
David Kingsbury	AID/PARFOB	Assistant to the American co-director, in charge of compiling financial, labor and fuel statistics, and a review of community forestry activities.

PARFOB staff devoted considerable time to the preparation of financial and technical data for the evaluation. In particular, Mr. Abdoulaye Lo, Head of the Division de Silviculture, developed fiches parcellaires or compartment histories for each of the compartments planted during the project's first three years. Mr. Elie Joseph Sambou, recently returned from a two year scholarship at Syracuse University in

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Forest Economics, assisted to prepare financial and labor tables.

The Centre National pour les Recherches Forestières undertook a growth sample of the entire plantation for the evaluation. Mr. Claude Bailly was in charge of this work, the results of which were used in the technical evaluation. Mr. Bailly also described the results to date of research during a field visit to the various research sites of the plantation.

Also, during the course of the evaluation, Mr. Moctar Niang of the Regional Inspection of the DGEF in Casamance, came to Dakar to make a presentation to PARFOB personnel, the evaluation team, CNRF, and DGEF staff on an international workshop in Brazil on charcoal making, which he attended in 1982 with AID sponsorship.

3.0 Issues and Problems

Lack of complete and precise technical and financial records, as well as errors in the original project design were principal problems. Since the evaluation consisted fundamentally of a comparison of project results to date with the original project design, these data problems and errors greatly complicated the effort.

3.1 Records and data compilations

Both technical and financial record keeping in the project had been inadequate. Financial records were intact but not analyzed or summarized. Compartment histories had not been kept. Consequently a considerable effort was expended during November through January in preparing and summarizing these data.

There is as yet no single system in use by the DGEF for compiling technical and financial data for plantations. Consequently, to bring together various technical notes and records, fiche parcellaire forms were developed based on the format suggested in the Ministère de la Coopération's Mémento du Forestier. Compartment histories were reconstructed from the notes and recollections of PARFOB forestry technicians, foremen, and workers.

Daily fuel allocation forms, employed by the project since 1981, were useful for estimating amount of time spent by bulldozers and tractors in different operations. However, records of operations by engine hours spent had not been kept. There was no way of reconstructing labour inputs for various nursery operations.

A system of comptabilité analytique had not yet been developed by the PARFOB project, nor has DGEF developed such a system for plantation forestry. The team attempted to use as a guide the Ministère de Coopération publication "Guide d'Evaluation Economique et Financière des Projets Forestiers" (Ministère de la Coopération, 1979), however the methodology of this publication is oriented towards private industry, with the interest of the government side being limited in the evaluation to a determination of the type of tax to be imposed on a particular project.

"Cost Accounting and the Maintenance of Records for Monitoring and Evaluating Plantation Projects" by J.B. Ball (FAO, 1981) was obtained and translated into French for use during the data compilation stage. The proposed method relies on a much more detailed record of labor and equipment use than has been kept in the PARFOB project. However, this publication served as a useful orientation to the work.

Before January, 1983, the evaluation team was unaware of a concurrent effort undertaken for the Club du Sahel to analyze recurrent costs in forest plantations (Morel and Pajor, 1982), in which the subject of data compilation and analysis is treated extensively. Similarly, we were unaware of the various record keeping forms developed in Mali for forest plantations (specifically forms developed by G.Ligney appearing in the abovementioned study). The study by Morel and Pajor for the Club du Sahel titled Politiques Forestières au Sahel was received in Dakar in January, 1983. It promises to be a most useful compilation for future reference.

A series of fiches for record keeping of various operations in PARFOB had been proposed in 1982 by Mr. Sambou Guèye of CNRF to PARFOB technicians. With one exception (Livre Journal des Engins) these fiches had not been adopted. Mr. Guèye undertook a first approximation of the economic aspect of the project in early 1982 and prepared a draft report that was made available to the evaluation team by CNRF in January, 1983, following an internal review by CNRF and DGEF.

3.2 The Project Paper as a Point of Comparison

Several discrepancies and mistakes were found in the project paper document, rendering it difficult to use as a point of comparison. There are errors in two key tables.Table A-1 Financial Plan (p.21) has numerous errors of addition. Secondly, on page 25, the annual operating expenses are totalled erroneously, resulting in an under-estimation by $70,000 per year of these costs.

An important discrepancy, discussed in greater detail in the technical analysis, concerns the use of rainfall averages for a historical period

of very favorable rains (1931 - 1960), as indicative of expected rainfall at the project zone.

The economic, financial and social analyses sections of the project paper were translated and distributed to PARFOB and DGEF collaborators during the first stages of the evaluation. Prior to the evaluation effort these important descriptions had not been available to the Senegalese project personnel in PARFOB and CNRF. The project is summarized in French in the Project Agreement, it should be noted.

C. DESCRIPTION OF THE PROJECT

Only the principal features of the project are summarized here, with emphasis on those aspects used as principal points of reference or comparison during the evaluation.

1.0 Project Document

The project was designed in 1979, at a moment in time when there was a great deal of official attention being focussed on the fuelwood crisis in the Sahel, and at the early stage, though not the beginning of a response by USAID and other donors to this problem. The project is unique in the Sahel in its emphasis on urban charcoal supply. Dakar stands out among Sahelian capitals for its high consumption of charcoal (1 million quintals of charcoal annually when the project was designed in 1979). Further, no significant experience with large scale fuelwood plantations had yet accumulated in the Sahel at that moment, while elsewhere in the world similar plantations were being grown under much more favorable rainfall (e.g. 1,500 mm or more in Brazil). Thus the project was (and is) viewed as a pilot project.

1.1 Project goals and related objectives

These are summarized in the logical framework analysis (Annex A).

Goals: To halt or reverse environmental deterioration due to loss of forest cover and to stabilize or increase national fuelwood production and reduce the susceptibility of national forests to drought and other weather variations. These broadly stated goals would be achieved through a realization of the project's purpose.

Purposes:

(1) Improve efficiency of firewood production for Dakar & Thiès.

(2) Provide employment, improve general environment and revenues for timbercutters and villagers in the Thiès region.

(3) Reduce pressure on forest cutting elsewhere.

These purposes would be attained if the following outputs were realized.

Outputs:

(1) Successful production of 3000 ha. of fast-growing tree species to produce 6% of local (Dakar) fuelwood needs.

(2) Employees of DGEF trained and capable of managing and developing fuelwood projects.

(3) A fuelwood production system which can be used as a model for other projects.

Inputs: The planned inputs are briefly summarized here. The total AID grant was $3,134,000. In addition to financing all equipment, 1/3 of the manpower, and 2/3 of the project overhead, the project inputs included:

(1) Technical assistance

Forest management specialist, four years.

Peace Corps Volunteer (mechanic), four years.

Short-term consultancies, 10 man-months.

(2) Training (local and abroad).

(3) Research.

(4) Soil surveys.

1.2 Technical analysis

These were based largely upon the results of three years of trials ('76 through '78) at CNRF's Bandia research station, particularly as regards plantation establishment and maintenance. Production estimates of 10 to 15 m^3/ha/year were "based on the CNRF trials at Bandia" (p. 10 Project Paper). In Annex A, Technical Analysis, it is stated that "... the (CNRF Bandia) data provide proof that on the two major soil types, when rainfall is about normal, (500 mm per year), Eucalyptus camadulensis can produce from 10-15 cubic meters of solid wood per hectare per year for four years, or over 20-50 times the production in natural forests in most areas of Senegal". (p.14 Annex A, USAID, 1979). The project paper does not reference any CNRF publication as a data source, however.

Rainfall registered at M'Bour during 1931-1960 and averaging 739 mm per year was taken as illustrative of the average for the "project zone".

It was assumed that 750 has per year could be planted, and that 8,000 has of soils suitable for planting could be found in the Bandia Forest.

A seedling production of 700,000 per year was projected. A deep well was to be drilled to provide estimated water needs of 100 cubic meters per day.

1.3 Economic Analyses

The economic analysis assumed a demand for fuelwood in Dakar growing at 7% a year, from a level in 1979 of one million quintals of charcoal and 41,000 steres of firewood, much of which was being provided by large

reserves of dead wood from trees that did not survive the drought. Charcoal was being provided to Dakar from an average distance of 400 kilometers.

Sensitivity tests on various production and rotation hypotheses were made to explore a range of internal rates of return on the project. In all cases the rate of return was positive, ranging from 4.8% to 19.4%.

Key parameters in the analysis were:

Production: 10 m^3/ha/yr for eucalyptus

6 m^3/ha/yr for other species (neem, Cassia sp.)

600 ha/yr harvested beginning year 5.

Note: considered to be on the conservative side.

Rainfall: 500 to 600 mm per year.

Costs: Would decrease over time to 1/2 or less of the total costs.

Benefits: Included a "savings" of 20 ha. of natural forest for every plantation hectare harvested (assuming 0.5 m^3/ha/yr. productivity in the natural forest); charcoal sale price of 22 FCFA per kg; wood sale price of 10 FCFA/kg.

Losses foregone (i.e. natural forest saved from cutting) amount to 44% of the total benefits, and range fr m 47.2 million FCFA to 174 million FCFA per year.

Ecological gains, foreign exchange savings and multiplier effects were not computed as quantifiable benefits. Licensing fees charged by DGEF to charcoal makers who exploit plots before conversion to plantation were not computed.

On a "conservative" estimate, it was projected that the project would begin in year five to yield 40,200 quintals of charcoal and 11,250 steres of firewood per year, with production increasing in year 9 to 72,600 quintals and 20,250 steres respectively.

1.4 Financial Plan

The project was conceived to be administered financially as well as technically as an autonomous entity (i.e. PARFOB).

Total cost of Phase I was computed to be $ 3,912,000 (assuming an accumulated inflationary increase over the first four years of 31%), of which the GOS would contribute $ 779,000. AID subsequently made a grant to the GOS of $ 3.134 million for Phase I.

The financial details of the planned expenditures are summarized in tables C.1,anticipated local personnel requirements, C.2, annual operating expenses and C.3, equipment.

Table C-1. Anticipated Local Personnel Requirements.

		Base Salary	Indemnity [a]
A.	Administration and General Support		
	1- Director	(120,000/mo)	+50,000
	2- Forestry technicians	(70,000/mo)	+30,000
	1- Administrative Assistant	(70,000/mo)	+30,000
	1- Accountant	(60,000/mo)	+15,000
	1- Secretary	(40,000/mo)	
	1- Mechanic	(60,000/mo)	+15,000
	2- Assistant mechanics	(30,000/mo)	
	10- Drivers	(35,000/mo)	
B.	Nursery		
	1- Head nurseyman	(60,000/mo)	+15,000
	6- Assistant nurseymen	(35,000/mo)	+15,000
	20- Full-time laborers	(22,000/mo)	
	40- Part-time laborers	(22,000/mo for six months)	
C.	Plantation		
	10- Full-time semi-skilled	(35,000/mo)	+15,000
	200- Part-time laborers	(22,000/mo for three months)	

(a) To be paid by GOS.

Table C-2. Estimated Annual Operating Expenses (planting year)

	FCFA
A. Administration and General Support	
1) Personnel	
. Administrative	5,640,000
. Skilled/semi-skilled	1,380,000
2) Equipment (all costs, excluding depreciation)	
. Bulldozer (1500 hrs X 2 X 5.000 CFA/hr)	15,000,000
. Pick-up (10.000 km X 2 X 30 CFA/km)	600,000
. 5-ton truck (8.000 km X 1 X 80 CFA/km)	640,000
. Tractors (1.000 hrs X 10 X 1.200 CFA/hr)	12,000,000
3) Overhead (electricity generation, building repair, communications, office space rentals, misc.)	4,300,000
Sub-total	39,560,000
B. Nursery	
1) Personnel	
. Skilled/semi-skilled	4,500,000
. Laborer (permanent)	5,280,000
. Laborer (part-time)	5,280,000
2) Misc. (minor repairs, renewal of local material)	1,000,000
Sub-total	16,060,000
C. Plantation	
1) Personnel	
. Skilled/semi-skilled	6,000,000
. Laborer	13,200,000
Sub-total	19,200,000
TOTAL	59,820,000 or
$ U.S.	271,909 @ 220 FCFA/ $1.00

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Table C-3. Equipment Purchases, Planned and Actual
(purchases directly by AID)

Item	Planned Cost[a]	Actual cost	Difference
2,D-6 Caterpillar tractors w/blades and rippers	$ 190,900	$ 195,800	+ $ 4,900
Brush rakes for D-6's	(not planned)	21,426	+ 21,426
2, Peugeot 404 Pick-ups	14,000	15,360	+ 1,360
1, 3-ton truck	15,000 (for 5-T truck)	27,600	+ 12,600
2, 78 hp tractors 8, 65 hp tractors 10, disk harrows 10, flat bed trailers 3, tank trailers 2, one-tooth sub-soiler rippers (not planned)			
Sub-total	268,600	319,857	+ 51,257
Meteorological instruments	1,500	22,628	+ 21,128
Mechanic tools	12,000	15,257	+ 3,257
Tools & surveying equipment	5,000	2,378	- 2,622
Massey-Ferguson (tractor) spare parts, disks	not planned	45,000	+ 45,000
Well drilled	50,000	45,000[b]	- 5,000
1, 8 kw diesel generator	8,500	not installed	- 8,500
Transformer (50 KVA) and installation for submersible electric pump	not planned	33,337	+ 33,337
TOTALS	$ 565,500	$ 743,643	+$178,143

(a) From the project paper

(b) 12,000,000 CFA. Bill not yet paid in December, 1982.

1.5 Social Analysis

This analysis focussed on beneficiaries of the project including Dakar consumers of charcoal, local inhabita [illegible] be employed, and local charcoal-making groups.

The analysis of consumption derived an average daily per capita consumption of charcoal in Dakar of 0.34 kg, projecting that the project's production would assist in "regularizing fuelwood supply and potentially price" for a target group comprising 85% of the urban population in Dakar and Thiès (Butane users were estimated to comprise 15% of the urban populace).Charcoal licensees who exploit the plantation would make a 34% profit, on Bandia plantation charcoal as compared to a profit of 26% from operations located in the Sine Saloum or Casamance. The analysis noted the creation of 50 permanent jobs and 200 to 300 part time jobs representing an outlay of 4.4 million FCFA per year in salaries. It was anticipated that a "large percentage of those hired will be women" (p.9, Annex C, USAID, 1979).

2.0 Discussion

The project paper was not translated into French, except for those portions that were summarized for use in the project agreement. The document was not therefore fully shared with the Senegalese persons who are involved in the project, especially PARFOB staff. At the onset of the present evaluation, however, the economic, social and financial analyses were translated and shared with Senegalese counterparts.
It would appear, nevertheless, that the project paper was of minimal value as a working document useful for coordinating project management and implementation.

D. PROGRESS AND RESULTS, 1979 TO DEC. 31, 1982.

This section summarizes and highlights certain major administrative actions events in the evolution of the project. It is based on bi-monthly progress reports by AID project management personnel, other internal AID documentation, joint reviews, and the observations of the evaluation.

1.0 Project Start-up and calendar of events

1979	
May	Project agreement signed.
Nov	Aerial photography taken (black and white).
Dec	Project director (Mr. Woyni) designated.
1980	
Jan	Orders for Caterpillar tractors and wheeled tractors prepared.
	Two Peugeot pick-ups ordered after waivers obtained.
Feb	Nursery development at the Bandia site initiated with equipment borrowed from DGEF.
March	Project bank account opened in Dakar, but done incorrectly. DGEF advances funds to cover start-up expenses.
April	Soils scientist and hydrologist arrive for short-term technical assistance.
	Soils reconnoitered and site preparation begun.
May	Second visit by soils scientists (Bowers and Brown). David Gibson takes post as American Co-director. DGEF advance funding runs out. Bank account still unopened. DGEF submits garage/atelier construction plans to AID. Project works with borrowed equipment. Problems with performance bonds and shipping delay ordered equipment.
June	D-6's delivered but without brush rake. Site preparation continues but with blades, and with borrowed D-7.

July	Bank account in Dakar opened and 20 million FCFA deposited. Bill payment slow and bills get lost at Min. of Finance.
Aug	Mr. Woyni is replaced by Mr. Sidibé as project director.
&	
Sept	Mr. Wilhelm, PCV mechanic arrives on project. 150 hectares planted. 1981 sites identified using soil survey results.
Aug	AID contracts architect to prepare plans for the garage/atelier.
&	ISRA/DGEF agreement made for complementary research.
Sept	Research plan submitted.
(cont).	Bank account in Thiès opened but done incorrectly. (in Idrissa Mbaye's name).
Oct	Soils scientists (Brown and assistants) return to continue survey of Bandia forest.
&	Garage/atelier plans submitted to Génie Rural for
Nov	appel d'offres.
&	Min. de l'Equipement Rural preparing appel d'offres
Dec	for the well at the nursery.
<u>1981</u>	
Jan	Tractors & accessories (except trailers) delivered. D-6 brush rakes delivered. Well drilling begun and reaches 157 m. Funding for CNRF research being processed.
Feb	Mechanics tools arrived. Bids received for garage/atelier construction.
to	Nursery set up and fenced. Well functioning with diesel generator.
April	Land clearing of 700 hectares proceeding, but 400 has. not exploited by charbonniers due to delays.
June	650 hectares planted, 50 less than planned (due to early termination of rainy season).
to	
Dec	Excess seedlings given to PVO's and other GOS entities (AFRICARE, CRS, DGEF, SODEVA). Site preparation for '82 parcels begins. Transformer to permit hook-up of well pump to power line has not yet arrived.
	Emergency bidding procedure used to contract for well drilling rejected by Commission Nationale des Contrats et Marchés, making it impossible to pay for the well (which was finished and functioning).

	Many cattle invaded the plantation and grasshoppers damaged several compartments.
1982	
Jan	Transformer for well connected.
	Emergency bidding procedure used for garage/atelier contract is rejected by the Commission Nationale des Contrats et Marchés.
March	Site preparation and nursery set up proceeding.
April	Final field trip by soil surveyors. Tax waiver for Massey Ferguson spare parts requested. Parts ordered.
June	Spare parts arrive but cannot be delivered; no waiver. AID unsuccessful in finding replacement for Gibson. Joint review of project takes place (June 30). AID proposes Freeman as interim co-director, with
to	assistant, David Kingsbury, for village forestry.
	Gibson departs end June.
July	Tractor tires waiver requested and tires ordered. Bierle, Wilhelm's replacement as PCV mechanic, arrives for language training.
	Garage/atelier contract passed to AID for execution, and AID draws up PIO/T for the work.
	Planting starts late July; 6 villages around Bandia Forest plant trees.
Aug	Wilehlm (PCV mechanic) departs. Massey Ferguson spare parts waiver obtained and parts delivered, including replacement disks (heavier duty).
Sept	Total of 750 ha. planted; 40,000 seedlings distributed to SODEVA, etc. Bierle, unable to learn French, returnsto USA. Delay of project financing supplement results in cash flow problem in Thiès.
	5 km of fence installed on north and east.

	$600,000 funding to end of project received.
Oct	Mechanical and hand weeding continuing.
Nov	Third year evaluation of PARFOB planned and data collection begins.
&	Interim, 3-month funding approved (Nov '82 through Jan '83) to allow PARFOB and CNRF to adjust programs
Dec	to available resources for '83 (80 million FCFA).
	Contract with Roger Jones (Gibson's replacement) was delayed, and his arrival rescheduled for early 1983.
	A replacement PCV mechanic candidate not yet been found.

1.1 Discussion

Principal administrative problems have been delays in recruiting long-term technical assistance experts (forest management specialist); administrative problems related to financing procedures; delays and apparent confusion related to procedures for import tax waivers; delays and confusion concerning contracting procedures (affecting both the well and the construction of project buildings); and delays related to initial procurement of heavy equipment by the project, in turn a result of AID procurement procedures (the performance bond question).

The total impact of these difficulties is most clearly expressed, although not with precision, in terms of time lost. The consequences have been inordinate amount of management time spent in trying to remedy or rectify situations created by errors, confusion and undue delays, and -- in the first year -- a plantation surface of only 150 hectares.

While a certain amount of time is usually lost in the start up phases of any project, and especially a "pilot project" such as this one, the continuing difficulties experienced in connection with contracting, financial and procurement procedures indicate that a more fundamental

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weakness is involved. This appears to have been a general inability in the DGEF and other branches of the government involved (Ministry of Finance in particular) to expeditiously and accurately process administrative actions.

2.0 Organization of the Project

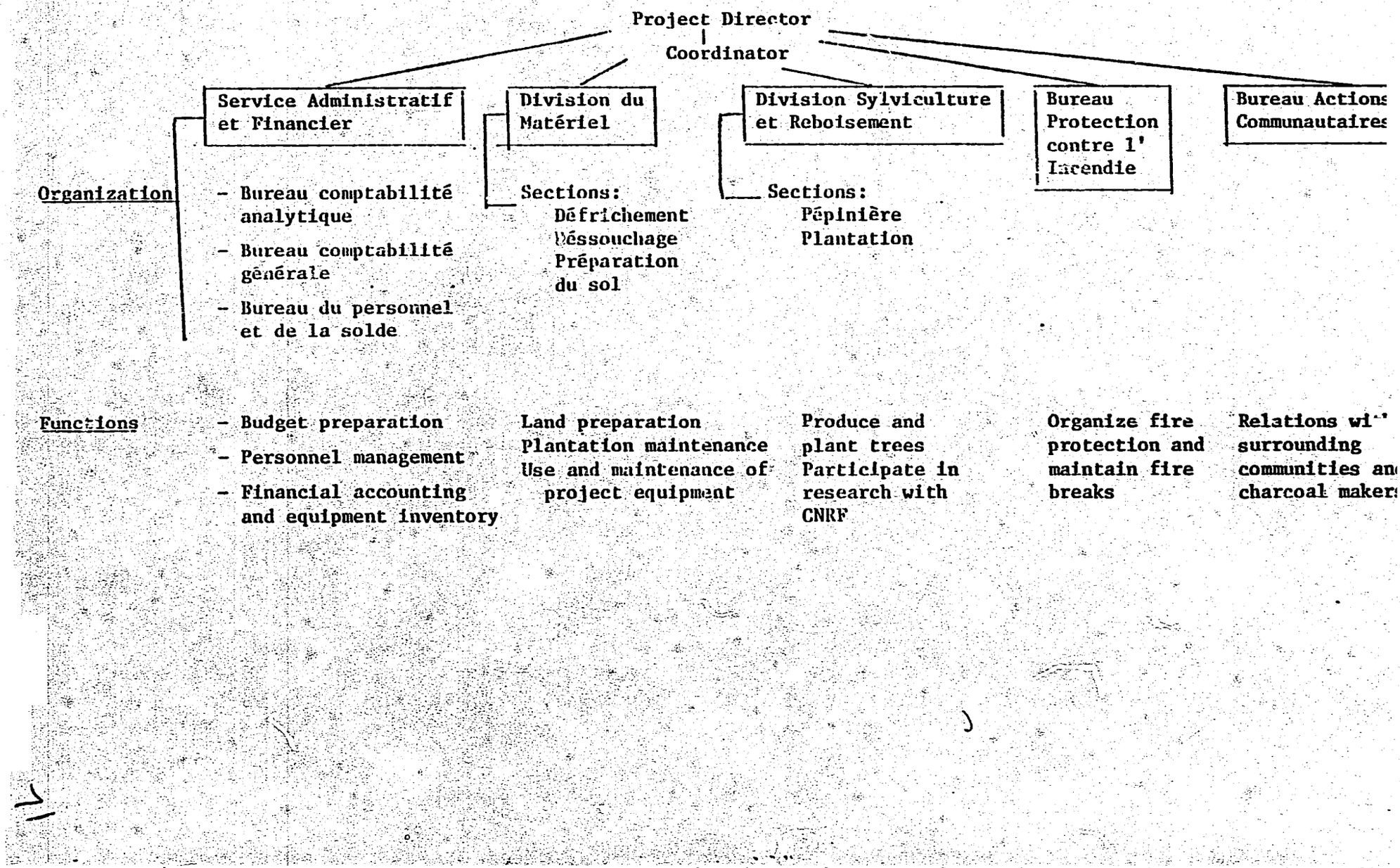
Except for the research, the project is managed entirely by the Projet Autonome pour le Reboisement de la Forêt de Bandia, PARFOB. This was provided for in the Project Agreement. Decree No. 006236 of June 21, 1982, of the Secretariat d'Etat aux Eaux et Forêts (SEEF) sets forth the attributions and functions of PARFOB. Research carried out within the project is executed by CNRF as established in a formal agreement between ISRA, CNRF's parent institution, and the DGEF.

2.1 PARFOB

Figure D-1 shows the organization of PARFOB. The abovementioned decree established a supervisory committee (Comité de Surveillance) for PARFOB with representatives from the Ministries of Finance, Plan, Rural Development, l'Hydraulique, Promotion Humaine, the DGEF, the regional governor, the President of the Conseil, the Project Director, the regional DGEF inspector and representative of the funding source. It is to meet at least twice a year. It is supposed to undertake technical and financial evaluations, stay up to date on progress, and propose measures for improvement as needed. The Comité de Surveillance has to our knowledge not been constituted nor has it met yet.

A Comité Technique is also set forth in the decree creating PARFOB, comprised of the Directeur, DGEF, the Inspecteur des Affaires Techniques, SEEF, a representative of SERST and one from the Ministry of Rural

Fig D-1. PARFOB Organizational Chart



Development, the Project Director, a donor representative, the regional Inspecteur of DGEF, and representatives of the ministries of Promotion Humaine and l'Hydraulique. It appears that this committee has never been constituted or convoked.

An important administrative function that has not yet been accomplished is the establishment of the Analytical Accounting Bureau.

Except for the project accountant, all of the upper level management personnel have been seconded to the project by the SEEF, namely;

The project director	Mr. Boubacar Sidibé	
Coordinator	Mr. Idrissa Mbaye	ITEF
Chief Div. Matériel	Mr. Abdoulaye Sy	ITEF
Chief Div. Sylviculture	Mr. Abdoulaye Lo	ITEF
Head,Nursery	Mr. Corka Diallo	ATEF
Head, Bureau Protection contre l'Incendie	Mr. Aly Seck	ATEF
Head, Bureau Actions Communautaires	Mr. Lasana Djiba	ATEF

The first American co-director, Mr. David Gibson, evolved a role as "co-director in charge of equipment", and he worked closely with Mr. Sy and Mr. Wilehlm, the Peace Corps mecahnic, in purchasing and maintaining the project equipment, as well as in land preparation. Mr. Gibson worked with Mr. Sidibé in developing the yearly work program and budget projection. He developed an informal liaison with the CNRF researchers working on the project (an effective formal communication arrangement between CNRF and PARFOB did not exist). Mr. Gibson also worked closely with the U.S. Soil Conservation Service surveyors and aided in translating this work into

information of use to the plantation operation, particularly in the matching of tree species with soils types.

The second American Co-director, Mr. Peter Freeman, worked on the project in an interim capacity and on a part-time basis, out of the AID offices in Dakar during the second half of 1982. He was less involved in operational aspects of the project, and concentrated almost exclusively on procurement questions (tax waivers, purchase orders, etc.). He also planned and lead the present evaluation.

2.2 CNRF Complementary Research

Research on a number of problems, some of which were identified in the project paper, has been carried out through a special agreement (Protocole d'Accord) between the DGEF and ISRA, the parent agency for the Centre National de Recherches Forestières. Mssrs.Bailly and Russell have been the principal researchers involved in the project. A separate bank account was established and managed by CNRF for this purpose.

Research problems were defined in general terms in the project paper, and one of the first short-term technical assistants focussed on the more precise definition of a water balance study that has been undertaken. By 1981, when research activities began, a four part program had been defined.

(1) Research aimed at reducing costs

(2) Species trials in alternative sites

(3) Soil changes under eucalyptus (sub-contract with ORSTOM)

(4) Water balance under eucalyptus

Two full years of research had been accomplished by end of 1982.

2.3 Technical assistance

(a) Project management

Project management has been more expensive than was envisioned and not without problems, especially in finding qualified managers acceptable to the GOS.

An experienced forest management specialist was called for in the project paper, to work as the American counterpart to the PARFOB director. However, none could be found who united all the qualifications, especially those of speaking French and having experience in arid zone forestry (a degree program which has not been offered anywhere in the USA, it may be noted. The University of Arizona in Tucson initiated in 1983 a study program in arid land forestry). An ex-PCV (Ivory Coast) with a B.A. in forestry and French-speaking ability, Mr. David Gibson, was eventually engaged as project co-director for a 2-year contract during May, 1980 to June, 1982.

Six months prior to Gibson's departure, a search began for his replacement. Only a year later (February, 1983) did Mr. Gibson's replacement finally arrive. The delay was a result of GOS demands for a "mature" project co-director and the impossibility of finding one. Also delays in project funding approval held up contracting. (It is generally known in AID that in the entire U.S. there are only 4 or 5 French-speaking foresters with experience in Sahelian forestry even though there are many less experienced foresters, usually ex-PCV's. Mr.Roger Jones, Gibson's replacement is a few years older and an ex-PCV from Tchad, where he worked of small scale reforestation efforts for three years).

Project management in the AID offices at Dakar has changed hands four times. The first manager, Jim Procopis was replaced by Tom O'Dell in mid-1980. In March, 1981, Carol Ulinski was contracted with project funds to manage this project and several others. She devoted about 1/4 of her time to the project. In March, 1983, at the expiration of Ulinski's contract, management passed to Daby Diallo, who had been Ulinski's assistant.

The GOS authorized use of project funds to hire the AID mission's environmental affairs advisor (Peter Freeman) on what was to have been a temporary basis, but which continued for the entire two years of his contract. Freeman worked as the PARFOB co-director for six months in 1982, following Gibson's departure, on a part-time basis. He had no previous experience in arid zone forestry or plantation establishment.

Finally AID personnel management costs were funded in part by the project, which contributed $60,000 to finance a contract between the Development Assistance Corporation and AID for logistical support and other management services to personal service contractors.

(b) Etude de Bilan Hydrologique

A water balance study was contracted by the AID mission through short-term consultant, Dr. Ervin Berglund. Dr. Ervin Berglund travelled to Senegal for three weeks in April, 1980; reviewed the situation at Bandia; and proposed a methodology for the study. Berglund's proposals were reviewed by CNRF and others and modified somewhat. Among the more important changes: a third treatment (the natural forest) was added, buffer strips between plots were eliminated, and the number of tubes used for making measurements with the neutron probe reduced. In addition, Berglund's

suggestion that two of the eight weather stations to be provided under another research component be installed on water balance study plots was deemed infeasible.

(c) Aerial Photography

This work was contracted out to Teledyne Corp. who were in Senegal taking aerial photography of the Senegal River Valley for AID. Black and white panchromatic photos at 1:5,000 were taken in late 1980 of the Bandia forest. Color infra-red photos at the same scale were taken in July and August of 1981. Prints and negatives of the panchromatic photos were delivered in late 1980, but negatives of the color infra-red photos were lost in shipment from California. Contact prints were delivered, however.

The contract did not include the preparation of photo mosaics, a serious omission in view of the fact that the photos were obtained for soils survey work. As a consequence there was no adequate base material on which the photo-interpreted soils information could be transferred.

The work was however, less costly than the originally budgeted $25,000, costing only slightly over $8,500.

(d) Soil Survey

In early 1980, prior to the planting of the first 150 hectares, CNRF technicians assisted PARFOB personnel to reconnoiter the terrain. Soil samples 80 cm deep were taken at a 250 m intervals. Subsequently American soil scientists undertook a soils survey of the entire Forêt Classée de Bandia. This work was carried out by means of a Participating Agency Service Agreement with the Soil Conservation Service of the U.S. Department of Agriculture. The work proceeded in two phases -- reconnaissance and detailed -- under the direction of James Brown and his co-

workers, and in a series of relatively short technical assistance missions.

The reconnaissance phase entailed to short-term consultations in April and again in May, 1980. Existing maps, studies and field trips were used to compile and later publish a 1:50,000 color map of the soils associations of the Bandia Forest. These were classified according to site potential. This map was delivered to the project in 1981.

The detailed survey was begun in October and November, 1980, by Brown and his co-workers: 2,700 hectares were surveyed and classified using black and white aerial photography, taken in late 1979. Color infra-red photography had been taken in the summer of 1980, at the time of maximum foliage but delivery had been delayed, and it was therefore not available to the survey team. The survey team commented that the work would have been easier with the latter photography, since at the time they were in the field the foliage of the previous rainy season still remained, while it was absent in the black and white photography being used.

An additional 3,200 hectares was surveyed and compiled on black and white photography in April and May of 1982. The soils series were re-classified at this time in terms of their forestry potentials.

During the 1982 visit, the soils team also reconnoitered several <u>forêts classées</u> to the south, to obtain a first appreciation of the soils in this zone of higher rainfall. The Velor, Sangako and Baria classified forests were visited. Only the Velor forest was considered to hold potential for plantation forestry.

A map of the 1:5,000 detailed (series) soil survey had not yet been delivered, as of the end of 1982. In order to guide the selection of soils for plantations sites in 1981, 1982 and 1983, tracings with the approximate locations of compartments were made over an uncontrolled mosaic of the aerial photographs that had been used in the task of photo-interpretation. There is as yet no base map of the project on which the information can be portrayed. Still to be delivered by the Soil Conservation Service was a printed map of the detailed survey. Computerized techniques are to be used to compile and prepare the map for publication at the 1:30,000 scale.

Discussion: The soils survey field work appears to have been carried out competently. Preparation of the maps and reports has been less satisfactory, however. The printed, 1:50,000 preliminary map of soil associations suggested more accuracy than was the case, precisely because it was printed and, moreover, printed in color. Multiple copies were delivered, after the more accurate 1:5,000 soils series work had begun. This remained a source of confusion to the Senegalese personnel at PARFOB as well as the American staff until early 1983. In essence, the more detailed work invalidated the information on the published 1:50,000 maps. These should not have been published and delivered (or they should have been recalled). The 1:5,000 scale series survey, on the other hand, wasn't compiled even in a working map form, and it existed only as an uncontrolled mosaic of interpreted black and white photographs, assembled on a plywood board.

The lack of an appropriately scaled base map of the Bandia Forest prevented the preparation of a map of the detailed soils survey. Had uncontrolled photomosaics sheets at the 1:10,000 or smaller scale been

ordered as part of the Teledyne contract this problem would have been handily solved.

A second impediment to the full use of the soils survey work was the fact that the reports were not submitted in French, and it was only in 1982 that AID/Dakar translated into French the second of the trip reports.

The reports submitted by the soils survey teams would have been more useful if presented as a single professional monograph at the end of the survey work, rather than as trip reports with annexes. Several reclassifications of the soils taxonomies in terms of plantation potential were, in particular, sources of confusion. The entire matter was finally clarified in a long distance telephone call to James Brown in January, 1983.

3.0 Plantation Development

This section describes and discusses the various aspects entailed in the development of the plantation, since 1979.

3.1 Facilities

(a) Project administration

The administrative offices of the project are located in Thiès, in a large house 20 kilometers by unpaved road from the plantation site. This house is rented by the GOS and paid with counterpart funds. Rent has remained unpaid, however for lack of counterpart monies. Nearby a house for the American co-director has been rented through the PARFOB account supported by AID. Housing for the PCV mechanic was also in Thiès. Although there is as yet no replacement for the mechanic who left in August, 1982, the house has been retained by DGEF to temporarily store some $45,000 of spare parts for the ten Massey Ferguson tractors and their accessory equipment. These will be eventually stored in Bandia when the garage and storage building has been completed (in May,1983).

(b) Nursery facilities

The nursery is located opposite the town of Bandia (see map, Figure 1) about 80 km southeast of Dakar, in the site of a small plantation of Khaya senegalensis established about 40 years ago. An existing well equipped with a hand pump was deepened to about 25 meters for the 1980 nursery. That year, a hand pump and watering cans were used to draw and distribute the water.

In early 1981, a well was drilled to approximately 200 meters and installed with an electric submersible pump. During 1981, a rented diesel

cD

powered generator supplied power to the pump. In January, 1982, a 50 KVA transformer was installed, making it possible to utilize the SENELEC power line which passes by Bandia. A pressure tank was installed and distribution lines with faucets were laid out to the nursery. Also a branch line was extended to the village of Bandia on the opposite side of the road, to furnish potable water for the village.

The installed pump and transformer are much more powerful than the project paper had proposed. The project paper had recommended an 8 KW diesel powered electric generator costing $8,500 and a 2 h.p. deep well electric jet pump, which together with the pressure tank and distribution system would cost an additional $15,500. The purchase and installation of the 50 KVA transformer alone has cost more than $33,000. Moreover, during the first six months of 1982, a transformer had to be rented until the supplier could import the one purchased by PARFOB. In the judgement of the AID engineer, the installed transformer and pump are considerably over-dimensioned relative to the technical requirements.

The project paper called for the construction of a garage and workshop building with storage space, and the refurbishing of an existing house to serve as a residence for project staff. The development of construction plans for these facilities was delayed continuously. The most significant delay was caused by the rejection by the Commission Nationale de Contrats et Marchés of the emergency bidding procedure (15 days published notice as opposed to 30 days) used to solicit bids. The USAID mission finally undertook in July, 1982 to let and administer

the contract. A local engineering firm was hired to monitor the work, which began in September, 1982. Since work began there have been many additional delays, including work stoppages to protest delays in payment of salaries by the contractor. Delays have also been incurred in procedures for obtaining duty free materials used in the construction. Total cost of the work will be 20,088,000 CFA, which at the exchange rate of 350 CFA/ $1 is slightly less than the amount budgeted in the project paper ($63,800 or 22,330,000 CFA at 350/$1).

(c) Discussion

Delays in the construction of the buildings at the nursery site have been particularly inconvenient. Proper organization, storage and care of equipment and supplies has been seriously hindered. Work on engines, requiring cleanliness, has been particularly affected. Storage of lubricants in areas free of dust and sand has been virtually impossible. Storage of pesticides has been inadequate, with the products being left in the open air, where sun's rays slowly deteriorate the plastic sacks.

The well drilled in early 1981 has not yet been paid (as of March, 1983), because as in the case of the contract for the garage and house, the emergency bidding procedure used by DGEF to let the contract was invalidated by the Commission Nationale de Contrats et Marchés. However, that decision was not taken until December, 1981, after the well had already been drilled and completed (work on the well was done during Jan. 20 to Feb. 7, 1981).

PARFOB cannot pay the contractor, because the Ministry of Finance would not approve the voucher, therefore the transfer of funds to the

PARFOB account at the Union Sénégalaise des Banques in Thiès. AID will not pay for the well for similar reasons, that is lack of normal contracting procedures. Despite a number of meetings in 1982 with the concerned parties and a letter from Mr. El Hadj Sene Directeur of DGEF to the Prime Minister requesting a reversal of the invalidation decision, the matter had not been resolved so as to make payment possible. The outstanding bill is 12 million FCFA.

3.2 Procurement and management of equipment

A number of problems have beset this aspect of the project, however, the over-riding problem was the under-estimation of the power and weight of the machinery needed in the project. Procurement delays and complications from overseas suppliers have also been vexing.

(a) Procurement

During the first plantation year, 1980, the project had to borrow equipment from the Département des Travaux Publiques and from the Direction Régionale des Eaux et Forêts. Whereas the purchase orders for the 10 wheeled tractors and the two D-6's were initiated in January 1980, the D-6's were not received until June and then were not equipped with brush rakes, while the Massey Ferguson tractors and accessory equipment (trailers, water tanks) were not received until January, 1981. The performance bond requirement delayed selection of the supplier. Suppliers in both Canada and the USA had to be used. Table C-3 summarizes AID procurement actions for the project's heavy equipment and other items.

(b) Management

The Division du Matériel manages the project equipment although the project accountant is administratively responsible for the entire inventory. In practice, during the first two years, the PCV mechanic who was on the project took on the responsibility for managing and maintaining the heavy equipment. He personally performed all routine maintenance and repair tasks on the Caterpillar tractors and the Massey Ferguson tractors. The local Caterpillar Tractor representative in Dakar, Manutention Africaine, undertakes major repair jobs.

Two mechanics assisted Mr. Wilhelm. When he departed in August, 1982, a third mechanic was hired. Now all maintenance and minor repairs are done by the Senegalese mechanic team who have available to them a pick-up. Assignment of tasks to the equipment is done by Mr. Sy, the head of the Division du Matériel, who establishes a plan for disposition of the equipment at the onset of the land-clearing period.

Diesel fuel is provided on a daily basis, that is, tanks are not filled up. Daily records are made of the distribution of diesel fuel and the the work being done by each piece of equipment.

Vehicle log books for the caterpillars and wheeled tractors have not been kept in the past. In November, 1982, Mr. Sy was organizing and systematizing the maintenance and repair work for this equipment, including the matter of log books (carnet de bord).

Identification and purchase of tires, tubes and spare or replacement parts had in the past been done exclusively by Mr. Wilhelm. Now it is done by Mr. Sy and his head mechanic, with the assistance of the American co-director.

Diesel fuel has been purchased twice a year, directly by AID. Consumption in a 750-ha planting year is approximately 140,000 liters. Gasoline was supplied by both the GOS and AID, but mostly by AID. The project director received an allotment of gasoline from SEEF in 1980, 1981 and part of 1982, until the time when USAID undertook to pay counterpart costs (as per the November, 1981 agreement reached in Paris between the GOS and various donors).

Support vehicles for the project are shown in Table D-1 .

Table D-1 Project Support Vehicles

Number	Type	Assignment	Contributed by AID	Contributed by GOS	Remarks
1	Peugeot station wagon 305	Director		X	
1	Peugeot station wagon 504	American Co-Director		X	Not serviceable as of Nov. '82 because of accident
1	Peugeot pick-up	Head, Div. du Matériel	X		
1	Peugeot pick-up	Head mechanic	X		
1	Datsun pick-up	Coordinator	X		
1	Peugeot pick-up	Head, Div. Sylviculture		X	
	5-ton IH truck		X		Used very seldom kept in Thies
4	Mobylettes	ITEF's at the plantation site	X		

Vehicles bought by USAID have TTA (Admission Temporaire) license plates and have insurance policies. GOS-provided vehicles have Service Officiel license plates and are not insured. (The Government of Senegal assumes expenses entailed in accidents in which it is found at fault).

AID policy requires that AID-purchased vehicles have vehicle logs and that these be regularly filled. This policy has not been followed. All the odometers are broken on the pick-ups and none carried vehicle logs, despite frequent reminders by the American co-director.

Routine maintenance and repairs of support vehicles are done in Thies at a local garage. The total cost has been high, adding up to $32,000

for the two years of operation ending in 1982. Most of the repairs have been for the four pick-ups, which are rapidly wearing out.

For the Caterpillar tractors and wheeled tractors total local costs for repairs and parts have also been high: $31,000 by the end of 1982. To this can be added $45,000 worth of spare parts, an anticipated $15,000 to $20,000 for replacement of tractor tires, and an anticipated $15,000 for major repairs for the two D-6's and the D-7 that were underway in late 1982.

The need for this major work on the Caterpillar tractors had been anticipated and programmed for the latter half of 1982. However, a combination of events delayed completion of this work and the equipment was not back on the plantation site until January, '83 (D-7) and March, '83 (the D-6's). The principal causes of the delays were, first, the lengthy process of obtaining a review and estimate of the work needed, including the large number of replacement parts to be ordered from the USA, and secondly the process of obtaining a tax waiver for the spare parts (without which the work could not begin).

In the case of the D-7, the tax waiver was processed through GOS channels, beginning September 30, and ending on Dec 7. The work on the D-7 was completed on January 7, 1983. For the D-6's USAID processed the replacement parts tax waiver. Nevertheless, the GOS' SEEF had to approve the PTO/C for the parts. It was submitted to the SEEF in early December but was lost. It had to be re-done and was re-submitted on December 24.

(c) Discussion

Many problems and expenses have been incurred in the operation of the project's equipment.

The heavy equipment was in fact not heavy enough. The D-6's are too light for removing termite hills and baobab trees. The GOS had to contribute a D-7 for this aspect of land preparation. Only two of the wheeled tractors are 4-wheel drive. The Massey Ferguson tractors came equipped with 6-ply tires, which lasted only two seasons, due to the slashing and puncturing action of stumps remaining in the plantation. These stumps, usually of the Acacia seyal, have a sharp, spear-like aspect due to the diagonal cuts made by the [illegible] bonniers. Many emerge intact even after being passed over by the D-7 and D-6's and after the ripping operation.

The light weight of the tractors rendered them less effective and hard to control. One hundred liters of water had to be added to each of the large rear tires to increase weight in the rear (but also probably aggravating the damage to the tires by stumps).

The disks were not strong enough, and the center portion of 70% of them had broken by the middle of '82. Heavier replacement disks received in August, '82 (but ordered in Jan '82) have solved the problem. However, much time was spent in the first half of '82 in welding broken disks. Welds would last only a few days before breaking.

Systematization of equipment and vehicle maintenance was only beginning towards the end of 1982. The competence and adhesion to routine that is required for preventive maintenance had not yet been developed.

It seems that the PCV mechanic Mr. Wilhelm either did not have the time or the capacity to teach the Senegalese mechanics and drivers the needed skills.

Procurement of replacement parts is an aspect of the project that has been especially troublesome. The problem is two-fold: on the one hand inexperience among field as well as office staff in procurement procedures, especially for imported goods from English-speaking countries; on the other hand cumbersome and lengthy administrative procedures for tax waivers which have frequently been faulty.

Finally the lack of adequate facilities at the project site for storing tools and supplies and for performing maintenance and repairs has hampered the good organization of the equipment and its care.

3.3 Organization and management of labor

(a) The situation

Labor needs are anticipated a year in advance in the annual operating budget, submitted for approval to the SEEF and AID. However, the project's director makes all decisions concerning labor and has not consulted with the American co-director on the hiring of labor.

The workers at Bandia are members of a labor union and have been since the inception.

The project adheres to Senegalese labor law regarding pay scales, indemnities, sick and annual leave (one month per year for permanent workers), raises, lay-off procedures, etc. Differences in AID's policy on indemnities, implemented in March, 1981, and that of the GOS have generated continuous friction between Senegalese staff at PARFOB and AID project managers.

The recruitment of seasonal laborers has been a delicate and complicated task. In 1981, a general notice was made to the effect that the project would be hiring 300 seasonal laborers, and that candidates should appear at the nursery site on a certain day. Over one thousand candidates arrived, and in the end more than two thousand sought the positions. In 1982, this unmanageable problem was resolved by sending a PARFOB representative to surrounding villages, each of which was given a quota beforehand, and speaking with the Chef de Village, who in turn presented the candidates. The distribution of workers by village or regions is shown in Annex B.

In 1982 many laborers were given raises, additional permanent laborers were employed, and the wage scale was increased somewhat. These events resulted in a very large increase in the numbers and costs of laborers on the project. Table D-3 shows the trend in the labor bill.

A time keeper is in charge of logging daily attendance. However, instead of seeing each man come and go to the work site, as is normal practice, he assumes everyone is on the job until he is told differently by the various crew chiefs. In essence, it is the crew chiefs who are responsible for work attendance. The time-keeper justifies this practice by the fact that many workers gather at the work site in the plantation and would waste their time coming first to the plantation.

Sick leave is granted only by written attestation of a medical doctor. One month per year of paid annual leave is accorded to permanent laborers. Workers are given malaria suppressant in the rainy season.

Workers living more than 5 kilometers from the work site are paid a global transportation allowance of 4500 FCFA per month.

The mechanics and equipment operators are organized and managed by the Chief, Division du Matériel. From the beginning of land clearing, normally in November, until the completion of compartment preparation prior to planting in July or later, the drivers work long hours. Various bonuses have been paid in the past as an incentive to achieve more, and the drivers earn over-time for hours in excess of the 8-hour day. The somewhat curious custom of furnishing a can per day of milk to the Caterpillar operators has been established by the project, as a bonus for working in dusty conditions. Assistants to the bull-dozer and tractor drivers accompany them during land clearing and ripping, and remove large stones and logs or stumps that are turned up. The assistants to the Caterpillar operators also do some of the greasing.

The laborers in the nursery and the seasonal laborers are under the Division de Sylviculture. The numbers of laborers by month during 1980, 1981 and 1982 by various categories are shown in Table D-2. Nursery laborers form a core of experienced labor that is retained year around, although at the end of the 1982 planting season many additional permanent workers were retained from the ranks of the seasonal laborers. Nursery laborers were assigned the title of "nurserymen"or pepinierists, following a short course on nursery techniques taught at Bandia by the CNRF.

Laborers are organized on the plantation or nursery according to the task at hand. In the nursery the task of filling plastic pots with an earth sand mixture is assigned to a crew who make their own internal arrangement for work partitioning and who by prior agreement with the Silviculture

Table D-2. Total Workers[a] at the Plantation site by month, 1980-1982

	1980	1981	1982
Has. Planted	150 has.	650 ha.	755 has.
Has. Weeded	150	800 has.	1550 has.
Jan	-	70	77
Feb	15	72	81
March	16	84	121
April	81	136	124
May	108	137	128
June	107	158	131
July	107	158	151
August	199	460	560
September	182	454	579
Oct	177	101	169
Nov	165	87	161
Dec	67	69	153

(a) Includes: nurseymen, time-keepers, tractor drivers and assistants, mechanics, and various categories of laborers.

Source: PARFOB monthly payroll records.

Table D-3. PARFOB monthly salaries, 1980 - 1982
(000's CFA)

		1980	1981	1982
Jan.	Admin Staff[a]	-	443	554
	Plantation workers[b]	-	2053	3879
	Total	-	2496	4433
Feb	Admin staff	-	440	516
	Plantation	298	1898	2648
	Total	298	2338	3164
Mar	Admin	-	460	633
	Plantation	390	2518	4008
	Total	390	2978	4641
Apr	Adm	-	664	590
	Plantation	2633	4307	4560
	Total	2633	4971	5150
May	Admin	37	501	569
	Plantation	2196	4291	5041
	Total	2233	4792	5610
June	Admin	218	537	651
	Plantation	2500	4368	4669
	Total	2718	4905	5320

(a) Administrative staff: project accountant and assistant, secretraries, guards, chauffeurs for support vehicles. Upon first arriving to work on the project DGEF engineers have occasionally been paid from this account on a temporary basis, until DGEF resumes payment of their salaries.

(b) Plantation workers: equipment operators, mechanics, nurseymen and laborers.

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Table D-3. PARFOB monthly salaries, 1980 - 1982 (Continuation)

		1980	1981	1982
July	Admin.	237	532	789
	Plantation	3040	4999	5984
	Total	3277	5531	6773
Aug	Admin.	352	554	882
	Plantation	3624	11345	20418
	Total	3976	11899	21300
Sept	Admin.	205	588	1108
	Plantation	5011	14194	21234
	Total	5216	14782	22342
Oct	Admin.	347	478	1064
	Plantation	4301	3674	6284
	Total	4648	4152	7348
Nov	Admin	316	648	705
	Plantation	2382	3762	6488
	Total	2698	4410	7193
Dec	Admin.	393	608	1038
	Plantation	1841	3468	7897
	Total	2234	4076	8935
Yearly Totals		30322	67328	102211

Source: PARFOB monthly payroll records. Amounts are net salary payments and do not include per diem payments, or taxes witheld.

Division Chief have a certain daily quota. At the time of planting and weeding the nurserymen become chiefs of 20 to 24 man crews.

It has become a practice to transport laborers to and from surrounding villages to work in trailers pulled by tractors.

(b) Discussion

The American co-director observed in 1982 and the evaluation team observed during their visits to the plantation many workers who were on the job but not working. Also it was observed on several occasions that in the early afternoon workers had already left the work site, as much as 1 1/2 hours before quitting time. These observations corroborate statistics analyzed below which show that worker productivity at Bandia is very low.

The hiring in late 1982 of more permanent laborers than appear to be necessary was a point of contention between the American co-director and the project director that remained unresolved at the end of the year.

3.4 Land Clearing and Site Preparation

(a) Delimitation

Upon completion of the planting and weeding operations in the year P-1, and sometimes even earlier, the compartments to be planted in the year P are identified on the ground jointly by the Chief of the Division du Matériel, responsible for subsequent land clearing and site preparation operations, and the Chief of the Bureau d'Actions Communautaires et Coopératives, responsible for liaising with and overseeing the charcoal-maker cooperatives.

Site potentials for trees are taken into account in locating new compartments. In 1981 and 1982 the 1:5,000 soils surveys information was transferred from the aerial photographs to large sheets of tracing paper on which the approximate location of compartments was plotted. For 1983, the precise location of the compartments has been plotted on 1:5,000 mylar overlays of the same soil information. In 1982, sites with lower potentials were planted in Prosopis juliflora, and some low-lying sites were planted in Melaleuca.

Once delimited on the ground, plots sufficiently wooded to attract charcoal-makers are licensed to them by the Inspection Régionale des Eaux et Forêts in Thiès. Charcoal-making continues until approximately the end of the year.

Most of the plots are 1 Km long but their width has varied, so that there are plots of 20, 25 or 30 ha.

As soon as delimitation has been done, the D-7 crawler tractor starts cutting 8-meter wide firebreaks all around the area to be planted, as well as 4-meter wide firebreaks around each plot compartment; these also to serve as access roads. This operation requires almost 4 hours per compartment. Between the compartments [illegible]-meter wide strips of natural forest are left, with the objective of providing some amount of wildlife habitat.

(b) Discussion of delimitation

Due to delays in Teledyne's delivery schedule, the aerial photography was not available for site selection in 1980. Despite the digging of holes in a 250 m X 250 m grid, the choice of 1980 sites did not avoid

areas with laterite, impeding root development at one meter or more. (The sample pits were only 80 cm deep).

Compartment delimitation seems to require well over 2 man-days/ha, which is somewhat on the high side in comparison with other projects elsewhere in the Sahel region.

The compartments had not been accurately mapped or located on the soils map as of the end of 1982, although in early 1983, this was being remedied. This work has been hampered primarily by the lack of an appropriately scaled base map. This is turn resulted in uncertainty about the potentials of the compartments. In general, however, the plantation is expanding south into areas of better soils, and the shallow lateritic soils to the east have stopped expansion in that direction.

(c) Land clearing

Despite the initial hopes that charcoal makers would leave behind them land sufficiently cleared (including windrowing) for sub-soiling to start, PARFOB has had to complete land clearing and windrowing in the plots exploited by the cooperatives. Land clearing operations occasionally begin in the autumn of the year P-1 but mostly are carried out in the period March to May of the year P. Both the D-6's and the D-7 are used. First, the two D-6 tractors are employed to remove remnant vegetation in plots where charcoal has been made, or all the natural vegetation from the other plots, except baobab trees. The brushwood and other larger wood are windrowed and eventually burnt. Some of the wood is collected by the local population before burning. In 1982, charcoal makers, exploited vegetation windrowed in 1981.

Data could not be obtained indicating the difference in actual inputs required in the cases of plots exploited by charcoal makers and plots cleared entirely mechanically. Guèye estimated 2 hours/ha of D-6 time in the first case and 5 hours/ha in the second case (Guèye, 1983). The PARFOB plot compartment records show slightly more than 5 hours/ha of D-6 time for 1981 (when 2/3 of the area planted had to be cleared mechanically) and slightly over 3 hours/ha for 1982 (when reportedly 4/5 of the area planted was exploited by the charcoal makers). According to PARFOB's Chief of the Division du Matériel, 2.2 hours/ha of D-6 time were used in 1982 for clearing land, most of which had been exploited by charcoal makers.

Once a plot has been cleared by the D-6's, the D-7 tractor knocks down and windrows the smaller baobab trees and levels the termite hills. It is PARFOB's current practice to knock down baobab trees when it is estimated that it will not take more than 1 hour and to knock down no more than 1 or 2 baobab trees per hectare. The levelling off of one termite hill takes about 5 minutes of a D-7 and there are 10-12/ha. The time devoted to these two operations is comparable to other projects.

(d) Discussion of land clearing

The compartments to be cleared have not been as fully exploited for their wood and charcoal as was expected, especially in 1981. About 400 ha had to be cleared entirely mechanically in 1981 because of delays in issuing licences to the cooperatives; the situation improved substantially in 1982 with these cooperatives working over more than 500 ha. Charcoal makers do not always respect the timeframe for exploiting the plots, thus placing severe time pressure on PARFOB staff to complete follow-up

operations in good time before the commencement of the rainy season. Furthermore, wood set aside for the cooperatives on some parcels that where mechanically cleared in 1981 has rotted due to delays in production operations. Charcoal makers do not cut and convert all vegetation. Much of the brush that has to be removed by the D-6's could be exploited for its firewood value if timely arrangements could be made with wood cutters in the surrounding area.

Use of the D-6's and the D-7 for land clearing appears to be comparable in efficiency with projects elsewhere in the Sahel (Table D-4a).

Table D-4a. Land Clearing Time in Upper Volta and Mali

Upper Volta	Hours per hectare
UNDP/FAO project:	
Dagonma 300 ha in 1975	2 hours 1 min, D6
Dagonma 100 ha	1 hour 57 min, D6
Bobo Dioulasso 300 ha in 1976	2 hours 54 min, D6
Wayen 1977	2 hours 18 min, D6
Gouse	3 hours, D7
AVV 1979	1 hour 44 min, D7 + 38 min, D6
AVV 1980	1 hour 41 min, D7,+1 hour 03 min, D6
MAF 1979	3 hours 30 min, D6
Mali	
OAPF (1977/80)	5 hours 8 min, D6
1981	4 hours 47 min, D6 + 09 min,D7

AVV = Aménagement des Vallées des Voltas
MAF = Mission Allemagne Fédérale

It should be noted that the above figures relate to areas which have not been exploited by charcoal makers, and that the isohyets of Gouse, Dagonma and Bobo Dioulasso are respectively 800, 900 and 1,100 mm : natural vegetation is therefore denser than in Bandia and more time consuming in its disposal. The Bandia forest, on the other hand, is characterized by a high number of baobab trees and termite hills.

All in all, it can be concluded that the efficiency of land clearing operations as carried out by PARFOB in 1982 is of acceptable standard: it can be of course be further improved, but no more than marginally.

(e) Sub-soiling by 3-tooth ripper

Once land clearing has been accomplished in four plots, one of the two D-6 crawler tractors is detailed to start 3-tooth sub-soiling to a depth of approximately 50 cm. When the D-7 crawler tractor has finished with the baobab trees and termite hills, it will also do sub-soiling, to a depth of about 60 cm, and so will the second D-6 crawler tractor once it has finished with land clearing. All 3 crawler tractors eventually carry out 3-tooth sub-soiling.

The purpose of this operation is to uproot stumps still left in the ground, to bring remaining roots to the surface and to loosen the soil in order to enhance water infiltration as well as root development and penetration.

This operation could start as early as February - March of the year P but is mainly concentrated in the period April to June, unless unduly delayed.

In reality, a good deal (if not most) of the 3-tooth sub-soiling is done in PARFOB by the two D-6 crawler tractors, and the compartment records show that about 4.5 hours/ha were used for such a purpose in 1981, and less than 3 in 1982. The Chief of the Equipment Division maintains that only 2 hours/ha were required for this operation in 1982 (to a depth of 50 cm when D-6's were used, 60 cm when the D-7 was employed).

Equipment performance elsewhere provides a point of comparison (Table D-4b).

Table D-4b. Time spent sub-soiling

Upper Volta/AVV 1979	2 hours 6 min of D7 + 22 min of D6
1980	2 hours 15 min of D7
/MAF 1979	1 hour 14 min of D6 or 1 hour 32 min of D7
Mali/OAPF 1977-80	1 hour 11 min of D6
1981	40 min D7 + 6 min of D6
Senegal/CNRF Bandia 1980	2 hours 21 min of BULL 977 h

PARFOB's efficiency in 3-tooth sub-soiling is similar to that of other projects in Sahelian countries.

(f) Disk harrowing

Meant to break the big soil lumps and thus facilitate subsequent site preparation and tending operations, pre-planting harrowing is performed in the direction contrary to that of the sub-soiling. Heavy duty discs are now used(since August, 1982). The harrows are drawn by wheeled tractors.

Most of the work is done in May to June but a substantial portion is carried on in March and April.

This operation is not currently done much elsewhere in the Sahel (but is performed in savanna country, in Northern Nigeria for example).

The PARFOB compartment records indicate almost equal time consumption of the time of a wheeled tractor for this operation in 1981 and 1982, around 2 hours/ha. The Chief of the Equipment Division estimates that it took less than 2 hours/ha (1.7) to do pre-planting harrowing in 1982. In Northern Nigeria, a 65 HP wheeled tractor with 3-0 m disc harrow takes about 1 hour to harrow 1 ha.

Efficiency of the disk harrowing operation has been adversely affected by the lightness of the Massey-Ferguson tractors and the original disks, an inherent weakness (perhaps under-design) in the hydraulic pump and line system resulting in many frequent breakdowns (especially of the flexible lines), and original tires too light (only 6-ply) for the rough conditions in the field. Remnant stumps not up-rooted by the sub-soiling operation destroyed over half the rear tires of the tractors by July, 1982. Complete replacement of all tires will have been done by mid-1983. These various problems have essentially reduced the number of tractors available for work at any one time.

(g) One-tooth sub-soiling

This is the last operation in land preparation with the equipment. It further conditions the soil for the trees by ripping the earth along lines on which the trees are planted. The Massey-Ferguson tractors perform this task. The operation is carried out first along the long

axis and then, if time permits, in the perpendicular direction. The intersection of the sub-soiled lines should indicate the place for the seedlings to be planted out, thus avoiding the need for staking out (which was done in 1980 and 1981). The resulting spacing should be 4 X 4 m.

Staking out to guide planting was abandoned in 1982 in favour of staking out every second line to guide 1-tooth sub-soiling. In addition, the decision was taken to cross the lines every 4.3 m in order to provide more space and thus avoid damaging the young plants while carrying out mechanized weeding. At a spacing of 4.3 m X 4 m, only 581 trees can be planted in one hectare instead of 625 as contemplated in the project paper. A 4.3 m X 4.3 m spacing results in 541 trees/ha.

This operation is meant, in addition to avoiding staking out, to enhance the effect of the 3-tooth sub-soiling which is carried out in one direction only and not crosswise. Practically all of this work is carried out in the period May to June.

One-tooth subsoiling does not seem to be currently done elsewhere in Senegal or in other Sahelian countries. This is perhaps due to the fact that preference is normally given to 3-tooth or 2-tooth subsoiling in perpendicular directions, which renders 1-tooth subsoiling redundant.

Guèye estimated at 0.8 hour/ha the time needed by a wheeled tractor to perform this operation (presumably in only one direction). The PARFOB compartment histories indicate very different figures for 1981 (1.1 hour/ha) and 1982 (almost 3 hours/ha), supposedly because this sub-soiling was carried out in one direction only in 1981, whereas it was in both

directions in 1982. The Chief of the Equipment Division estimates at 1.7 hours/ha the time employed in 1982 to perform this operation (55% for first passage and 45% for second passage). In 1978, CNRF did 1-tooth sub-soiling in a time comparable with the 1.7 hours/ha mentioned above (20 minutes/km at 4 m X 4 m spacing), but to a depth of 1 m.

(h) Staking out

Stakes to mark the tree planting holes were put out in both 1980 and 1981 to indicate precisely where seedlings should be planted. In 1982, every second line sub-soiled cross-wise by 1-tooth ripper was staked, with a view to reducing costs.

Whether intended to guide the planting crew or the driver of the wheeled tractor doing 1-tooth sub-soiling, staking out took around 1 man-day/ha, which compares well with the time spent on this operation elsewhere.

3.5 Production of Plantation Stock

(a) Germination and Potting

Eucalypts: The seed of the recommended provenance of *Eucalyptus camaldulensis* (8411) is received directly from the CNRF, and it is in accordance with their recommended procedures that seedlings are raised in the PARFOB nursery.

Sowing in germination trays is staggered over a period of 2 to 3 weeks starting in the last week of March, so that seedlings reach planting size over a period of time. The seed is sown in trays filled with gravel to about 5 cm, treated with Cuprosan or Cryptonol, and then with sand boiled in water for 3 to 4 hours and treated with Cuprosan. Seed is then covered with sand and the trays duly protected from birds and the sun as soon as the seed starts germinating (in 4 to 5 days).

Pricking out is done by those workers who have participated in a 2-week training course on nursery practices conducted by CNRF in 1981 in the PARFOB nursery (a 3-day refresher course was organized in 1982: another one hopefully will be organized in 1983). It commences approximately 45 days after sowing when the seedlings are in the second or third leaf-pair stages. The young plants are handled by their leaves, the roots are trimmed if necessary, and then the plants are inserted into a hole made with a little stick in the soil contained in a polipot; the stick (or a finger) is then inserted into the soil all around the plant to a certain distance, to firm the soil all around the roots. Pricking out normally terminates in the second part of May or early in June, which allows the plants to grow in the nursery for about 2 months. After pricking out the young seedlings are held in temporary shade until able to withstand the full sun. Bamboo crinting shade is employed.

The soil with which the poliplots are filled consists of a mixture of 6 parts of top soil from the adjoining forest and 14 parts of sand from the dunes near Thiès.

The poliplots used are white in colour, 12 X 25 X 8 cm in size, with 6 holes.

As access to the planting sites becomes very difficult, if not altogether impossible, after the rains have started, the potted seedlings are transported to the planting sites before the onset of the rains, placed in temporary (bamboo crinting), enclosures and watered once a day until the rains commence (3 mobile tank units are available for this purpose, though only one has a pump). Normally, 4 enclosures are set up for each 25 or 20 ha plot.

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Prosopis juliflora: Nursery practices for this species are generally similar to those used for raising eucalypts, except for the fact that seeds are sown direct into the polipot (2 seeds per pot). Due to its quick growth, sowing is delayed until the month of May. When more than one seed germinates, one of the two seedlings is pricked out. The pods are collected by PARFOB workers in the plantations existing at the Ecole Polytechnique de Thiès, and the seeds are extracted and cleaned by women of Bandia who are rewarded for the work with WFP food.

Melaleuca leucadendron (niaouli): Though slower in development than the eucalypt (2 weeks more in the seedling tray), niaouli is raised using the same nursery practices as those employed for eucalypt. Pricking out starts about 2 months after sowing.

Azadirachta indica (neem): The fruits are collected by PARFOB workers who clean them of their fleshy pulp and the seed is then sown in open beds a few days after collection. Normally, the seedlings are grown in the nursery for 2 years, at the end of which period they are planted out either as bare-rooted plants or as stumps. Only occasionally is planted neem when 1-year-old (family plantations).

Cassia siamea: The fruits of this species also are collected by PARFOB workers. The seeds are soaked in water brought to boiling point until they swell, normally after 15 hours. It is planted out when it is 1-year old, either as a potted seedling or as stump.

Other species: Mango seeds are sown directly in beds and held for two years, before distribution to villagers. The origins of the seed are diverse and not necessarily the best for root stock.

(b) Discussion

There is nothing new which needs to be known by the PARFOB supervisory staff to enable the PARFOB nursery to play the regional role often alluded to by many a speaker or writer. All that needs to be done to produce healthy, vigorous and sturdy planting stock is to see to it that what is already known is translated into practice timely, faultlessly and with the smallest possible combination of human and material inputs.

G. Guigonis, in his November 1979 report on PARFOB, estimated that 393.5 man-months of nursery staff would be needed to produce the required number of seedlings for one planting season. The project paper had estimated this need to 564 man-months. Assuming now, because of the dearth of pertinent data, that nursery men have had to spend 2/12 of their time outside the nursery during the peak of the planting season (August - September), and that 65% of the laborers' time (excluding the seasonal workers, but including the time keeper), is spent in the nursery or on work related to the raising of planting stock, then in 1982, 978 man-months were actually used by PARFOB to produce 666,000 plants as follows:

500,000 eucalypts	100,000 <u>Prosopis juliflora</u>
50,000 neem	10,000 <u>Cassia siamea</u>
5,000 niaouli	1,000 mango trees

Only about 521,000* plants, however, were actually needed by PARFOB to plant 745 ha in 1982, and the remaining 145,000 plants were used for other purposes. As overall it took 38 man-days to produce 1,000 plants

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* 700 plants/ha to allow for culling and losses.

(978 X 26 : 666,000), PARFOB's manpower requirement for raising planting stock in 1982 was 521 X 38 = 19,798 man-days or (: 745 ha) 23 man-days/ ha planted. This amounted to about 200% of the time estimated by G. Guigonis, and to 135% of the time estimated in the project paper. PARFOB's actual performance in 1982, however, compares fairly well with projects elsewhere:

		man-days/1000 plants
Mali/OAPF	1980	37
	1981	20
Upper Volta/AVV	1979	37
	1980	36

The above figures also indicate that is is possible technically to reduce cost considerably (See Mali ,1981).

As 1982 salary levels, including taxes, of 50,000 FCFA for the time-keeper, 48,000 for nursery men and of 39,000 of laborers, the impact of the cost of the manpower directly involved in plant raising is on the order of 60 FCFA per plant (10/12 of the 213 man-months of nurserymen, 65% of the 12 man-months of the time-keeper, 65% of the 1,220 man-months of laborers).

3.6 Planting and Tending

(a) Transport of planting stock

Approximately one month before the commencement of planting, potted seedlings are transported to places nearby planting sites, and deposited in bamboo crinting enclosures. Watering is done once a day until the rainy season is well established.

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No figures could be made available indicating at least the physical inputs required by such an operation, but Guèye estimates these at 0.5 man-day/ha and 0.5 hour/ha of a wheeled tractor, apparently without considering the inputs needed for watering until the rainy season has well established itself. In 1982, this required a tractor full time during much of July and August until the end of planting.

The quantitative impact of this operation on the cost of one hectare planted is less important, however, than on the availability of wheeled tractors at a critical time: that of weeding. The use of wheeled tractors for transporting and watering of planting stock in the enclosures, as well as for 1-tooth sub-soiling in perpendicular directions (pre-planting harrowing can be considered a weeding operation if appropriately timed) reduce the availability of wheeled tractors for weeding when this would be most effective, that is at the beginning of the rains and before seeding. Thus, in 1982, tractors were not available for weeding until July 25, when almost 100 mm of rain had already fallen.

Even after weeding began, two tractors continued to be used for watering trees not yet planted out. These delays in weeding render the operation less effective and more difficult, thus more expensive.

(b) Planting method

From the temporary enclosures in which planting stock is kept for about a month prior to planting, the potted seedlings are transported to the planting site,normally by 5 out of the 25 workers who constitute a standard planting crew (the other members are as follows: 8 men for pitting; 3 men for mixing Dieldrin to the soil that is used to fill the planting hole in order to control termite attacks; 8 men for cutting the

bottom few centimeters of the polipot, placing it in the pit, removing the remaining part of the polipot, and finally for filling the pits with the excavated soil and firming the plant; 1 foreman, normally one of the nurserymen, who also helps in the carrying of polipots to planting spots on in the carrying away of unused pesticide).

In principle, planting begins after 50 to 75 mm of rain have fallen, and preferably after a good rain which has soaked thoroughly the layer of the soil into which the plants will be embedded.

According to the fiches parcellaires (the only source of written information in this respect) some 10-man days/ha were required both in 1981 and 1982 to accomplish this operation. Although there is room for some improvement, this is comparable with the performance of similar projects in other Sahelian countries.

In 1982, planting started on 28 July, after almost 90 mm of rain had fallen; in 1981, and disregarding the early rain of 22 mm on 24 June, planting did not start until 2 August, that is until 114 mm of rain had wetted (so to speak) the ground (53 mm of which, however, fell on 1 August). All in all, an earlier start would have been better. All planting finished before the end of August, i.e. before the end of the rains, but three of the plots were planted less than one month before the end of the rains in 1982 (disregarding, the exceptional and unexpected rain of 74 mm on 14 October). In 1981, planting was completed in 4 plots from 5 to 11 days after the end of the rains, which that year ceased earlier, in mid August.

Despite the size of a planting crew mentioned above (25 men), there have been instances in both 1981 and 1982 of much greater numbers of

workers being employed in one single plot: 50, 60, and 79 in A-10 and 120 in C-1. It is clear that efficiency drops when the number of workers becomes too high: they cannot avoid getting in each other's way.

(c) Hand weeding

When planting has been completed on a 20-25 ha plot, hand weeding starts all around each plant and over a radius of 50 cm. Should there be a dry spell after planting has commenced, planting is momentarily stopped waiting for new rains and hand weeding initiates.

Normally, hand weeding around plants is done to complete mechanized weeding, and it takes some 4 to 5 man-days/ha. In principle, PARFOB does the hand weeding immediately after planting, that is, before mechanized weeding. According to the plot forms, it took about 12 man-days/ha in 1981 and 15 in 1982.

Weeding around each plant over a 50 cm radius is equivalent to weeding a total area of about 625 m^2. In 1978 as well as in 1979, it took CNRF in Bandia 10 man-days to weed manually one entire ha or 10.000 m^2. Such striking differences in output may be due to lack of supervision and/or to the fact that the operation is unduly delayed.

It is a fact that the later weeding is carried out, the more costly it becomes, in addition to becoming much less effective. According to the plot forms, the timing of weeding has differed widely. Weeding started in one plot even before planting was completed (presumably because of erratic rainfall); in other cases it is recorded to have started several days after completion of planting, or even weeks after. Most of the hand weeding was done in 1981 before the end of the rains according to the data available. In 1982, a good deal of it was done in October and even November, when it is most expensive and least effective or even

altogether useless. Furthermore, some of the plots were weeded over much too long a period, especially in 1982: from 20 August to 4 October (C-6), from 31 August to 11 October (C-7), from 30 August to 2 October (C-8), from 2 August to 30 September (B-13).

It should be noted that the relatively well distributed rainfall in the 1982 season favored continuous weed growth, and therefore compelled a longer period of weeding. However, at the same time, productivity of the weeding crews was low for lack of shovels. Inadequate provisions were made for equipping the laborers with shovels for weeding, and it was not until late September that each man had his own shovel. For a period of three weeks during late August and September, many crews had only 4 or 5 shovels, namely the number used for planting. (The shovel shortage was due to lack of suitable handles; the need was identified but there was no follow-up to actually buy the handles, until late September).

(d) Mechanized weeding

As early in the rainy season as possible, mechanized weeding begins, first in the plantations established in previous years because the recently planted areas are hand weeded immediately after planting.

Six, wheeled tractors are used, which since August, 1982, are equipped with heavy-duty disc harrows. This operation is performed in two directions at right angles.

Subject to the limitations of the data available at the time of writing, due to their incompletness and feeble reliability (and this remark unfortunately applies equally to all other operations) whereas

practically all the mechanized weeding was done in August - September in 1981, almost all of it was carried out in October - November in 1982. And some even in December.

The Chief of the Division du Matériel gives 1.3 hour/ha of wheeled tractors' time for the first passage and between 0.75 and 1.0 hour/ha for the second passage at right angle as an average for weeding with disk harrows. These figures compare well with those available from other projects in Sahelian countries and also with CNRF figures in Bandia. Relevant figures from the fiches parcellaires are similar for 1981 but very much higher (more than 5 hours/ha) for 1982 because of the clearly disproportionate time given in some of the compartments, in particular D-6, C-5 , D-8, D-9, D-11, and D-12.

If figures from these plots are disregarded, the average for 1982 drops close to, but remains higher than, the average for 1981, presumably because more area was weeded at right angle, in 1982 than in the previous year.

As for the timing, and due consideration given to the paucity of available information, it appears that most of the 1981 plantations were weeded, without delays. A considerable portion of the 1982 plantations were weeded only in November and some even in December. In some cases here again, plots were completed over much too long a period: C-9, from 11 October to 2 November; D-4 October 4 to 8, plus 30 November - 2 December; D-8, D-9, D-11 and D-12 from 11 October to 2 December (the identity of dates for these last four plots is of course suspect; also, these are the worst plots with regard to tractor time: 18 hours/ha).

It should be noted, moreover, that at any one time during July and most of August, 1982, one to four tractors were immobilized because of flat tires. Furthermore, in 1982, the original disks on the disk harrows being too light were breaking in the center portion because of excessive torque when encountering stumps not removed by the 3-tooth ripper. Seventy percent of the disks were broken and repaired by welding. But welds broke, too. Delayed tax waivers had held up the delivery of both new tires and heavier duty disks, until mid-August.

3.7 Protection

Termites, grasshoppers, rodents, and invading cattle are the principal threats to the plantation. Grasshoppers appear to be the principal problem. No fires have been recorded, and no diseases have been observed. In the nursery no serious problems of pests, parasites or diseases have arisen. These aspects are described in more detail below.

(a) Insects

Larvae of Agrotis in the nursery and grasshoppers and termites in the field, are the insect pests which have necessitated control measures thus far. Actidrin in liquid form, Soumifene* in powder form and Dieldrin powder are the insecticides which have been respectively employed with success (8-10 kg/ha for the last two). Application of Dieldrin is done, as mentioned earlier, at the time of planting.

Soumifene is the pesticide of choice in Senegal for grasshopper protection. It is applied when attacks occur, normally at the end of September to first part of October, about 10 days after the last rain. Grasshoppers gnaw bark or clip the young trees through, causing death

* Active ingredient Tetrachlorvinphos

or abundant side shoots. In 1981 and 1982,10 tons of Soumifene were purchased and applied to the newly planted trees. This took an average of 1 man-day per hectare. In both years a number of compartments were heavily damaged before treatment controlled damage.

The PARFOB staff observed in 1981 that attacks by grasshoppers originated in natural forests and that, therefore, plantations closest to the natural forests should be treated first. This was not effectively done in 1982, and in plots A-1, 2 and 3, 35 ha. have practically vanished and will have to be completely replanted.

Several minor problems in 1982 complicated the application of the Soumifene powder. Rainfall moistened the powder making it difficult to apply properly. A number of sacks split on being unloaded, thus exposing them to rain. The product was delivered by the supplier in 50 kg plastic bags with an outer, coarse weave, burlap type plastic sack. The outer sack is much appreciated by the rural folk, who remove them and carry them home. The inner sack is not strong enough to withstand rough handling, hence the damage to the sacks when being moved. Also, the late October rain fell during the grasshopper protection operation. Many sacks had been left open the day before and the product was thoroughly soaked.

(b) Rodents

Ground squirrels and rabbits dwell in the windrows between the plantations. The tend to gnaw on young eucalyptus stems shortly after planting, as well as late in the season, and even to shear them off at ground level. The problem was fairly serious in 1981, but less so in 1982, possibly because well distributed rains in '82 resulted in more food plants for rodents.

Control is difficult. Poisoned bait used in 1981 killed rodents but, also other wild animals including monkeys and bush deer. Repellants have not yet been tried.

(c) Domestic animals

Invasion by herds of cattle and goats has been a problem from the beginning of the plantation. The Bandia forest has in the past been browsed during the dry season, Acacia seyal being an excellent browse species (a circumstance which has no doubt reduced the natural regeneration and productivity of this same species for use as firewood). Guards must be posted on the plantation perimeters as well as inside the plantation. Cattle caught in the plantation are taken to a corral set up by PARFOB, where they are held until the owner pays a fine, usually a speedy process since there is no water at the corral, and the owners do not want to see their animals die.

In 1982, five kilometers of fencing was bought from a manufacturer in St. Louis (Senegal) at an installed cost of slightly over 400 FCFA per meter. It was erected on the northern and western edges of the plantation. This 2,000,000 FCFA investment should pay for itself in about 2 years, in terms of money saved by eliminating guards (approximately one per kilometer six months per year).

In 1982 there were 15 guards posted in other areas of the plantation (i.e. not protected by the fence).

(e) Fires

Within the plantation area fire risk is low thanks to the weeding and the fact that firebreaks around plots are also used as access roads

and, therefore, are kept clean by tractor traffic. Despite the existence of wider firebreaks all around the annual planting series, it is not to be excluded that fire may enter into the planted area from outside. The equipment available to PARFOB for active fire fighting is not specific (crawler tractors, tractor-drawn tanks) or very simple, mainly cultivation hand tools. Two vehicles of the Unimog type would increase considerably the possibility of keeping fires under check.

The visit paid by the Chief of the Bureau pour la Protection contre l'Incendie, together with the Chief of the Bureau d' Actions Communautaires, to four neighboring villages with a view to stimulating awareness of the forest fire problem and bringing about appropriate action at the village level, such as the establishment of village fire prevention and control committees, was a good initiative.

3.8 Growth and Productivity

Growth rates and expected productivity of the plantation have been estimated on the basis of rainfall data, experimental harvests and growth records at the CNRF research plantation in the Bandia Classified Forest, and measurements on the PARFOB plantation of plant height and density.

(a) Rainfall

Rainfall during the PARFOB plantation's first three years has been much less than was expected. The project paper had projected from 500 mm to 700 mm per year. Actual amounts recorded are shown in Table D-5 . The markedly higher rainfall at PARFOB in 1982, relative to the previous two years is largely due to an extraordinary single rain of 76 mm which fell in early October in the region.

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The considerable variability of rainfall at M'Bour is noteworthy this is probably explained by its coastal location. M'Bour's rainfall was taken an indicative of the region in the project paper, even though CNRF records for the period 1976 through 1978 should have indicated a pattern of lesser rainfall inland at the plantation site. PARFOB's records seem to indicate a further extension of this northward trend of declining rainfall. Three years of records are not adequate basis for discerning trends in the region. Nevertheless, PARFOB's first American co-director, David Gibson, observed that rain storms sometimes appeared to "detour" the plantation, and he postulated an influence of the low calcareous escarpment that borders the north edge of the classified forest.

It is also noteworthy that rainfall at Thiès has been more abundant than at the Bandia Classified Forest (CNRF station) during the period 1976-82. For that period Bandia received only 87% as much rain as did Thiès.

These data have obvious implications for rate of growth of trees and length of rotations. Tree growth will be slower than was projected and time before first harvest somewhat longer.

(b) Present growth

Trees in the PARFOB plantation were measured by CNRF and PARFOB personnel in January, 1983. A sample of between 7% and 8% was measured. Two double lines of trees in each compartment were measured, representing 51,742 observations. Absences (i.e. mortality) were noted; the height of trees was measured, (circumference is too small yet).

Table D-5 . Annual Rainfall at Bandia and other regional stations

	M'BOUR	BANDIA CNRF (a)	FOREST PARFOB (b)	THIES
Average for 1960-80	594	n.a.	n.a.	536
1976	518	350		408
1977	232	266		287
1978	738	615		606
1979	489	565		785
1980	371	401	320	416
1981	466	403	355	484
1982	n.a.	402	445	456

(a) CNRF established its rain guage in 1976, 7 kms directly south of the PARFOB nursery.

(b) PARFOB established its rain guage in 1980, at the site of the nursery, opposite the village of Bandia.

Table D-6 . Results of sample mensuration, PARFOB, Jan. 1983

	Mortality (%)	Height mean(cm)	Height s.d. (b)
1980 planting	40	260	32% - 41%
Considerable mortality over shallow soils with lateritic hardpan.			
1981 planting			
'A' compartments (a) on heavy sandy clays (dek)	25	193	30 to 53
'B' and 'C' compartments on lighter sandy soils (dior)	15	240	30 to 60
1982 planting			
'A' compartments	18		
'A1' compartments	75		
'B' eucalypts	5-32		
prosopis	5-32		
compartments	5-18		
'C' eucalypts	4-20		
prosopis	5-18		
compartments			
'D' eucalypts	3-31		
prosopis	8		
neem	37		
compartments			

(a) Compartments are arranged in east-west ranks, with A rank to the north and, successively, to the south B, C, and D. A^1 compartments are situated on the northern boundary of the plantation and are only three in number.

(b) s.d. - Standard deviation

Planting density has been less than envisioned in the project paper, namely 625 trees per hectare (on 4 m X 4 m spacing).

Table D-7. Planting density, PARFOB

1980 planting	550 trees/ha
1981 planting	560 trees/ha
1982 planting	490 trees/ha

(c) Projected growth

The evaluation team projects a growth rate for the existing trees on the plantation of 1.5 m^3/ha/yr. This is almost an order of magnitude less than was projected in the project design. It is unclear why the figure of 10 m^3/ha/yr was chosen for a "conservative" rate of growth at Bandia. Experimental cuts had not yet been made by CNRF at the Bandia station when the project was designed in 1979. At that time, the provenance trials with Eucalyptus camaldulensis, established in 1976, were only midway in the 6-year rotation envisaged. These were felled in 1981 and measured. The best provenance yielded 4 m^3/ha/yr; the second best, 3 m^3/ha/yr and the poorest 1.7 m^3/ha/yr. Total, i.e. accumulated, rainfall for the six years of the trials was 2,600 mm. (These results influenced the decision in 1982 to have the American soil scientists reconnoiter the soils of classified forests farther south in the Sine-Saloum).

A comparison of the mean heights at ages 1,2 and 3 years of PARFOB trees and those of the CNRF provenance trials in Bandia show that PARFOB trees are growing slower than did the lowest yield CNRF provenance. The rainfall at the two sites for the three first years of plantation has

been different, but the total, accumulated rain was almost the same.

	CNRF trials		PARFOB plantation
1976	350 mm	1980	320
1977	266 mm	1981	355
1978	615 mm	1982	445
TOTAL	1,231		1,120

The soils conditions are approximately similar, with the exception of the 1980 plantation, which in general is on poor soils (shallow, with lateritic hardpan in many places at 1.0 meter).

The CNRF provenance trials did not include E. camaldulensis 8411, however, raising the question of the appropriateness of this particular provenance at Bandia.

An interpretation of these measurements, and comparisons must take into account that the conditions of plantation and maintenance on experimental plots are invariably better than those on large scale plantations. Generally, one expects to achieve 50% of experimental results. Various small (one hectare) CNRF research plots located within the PARFOB plantation confirm this observation. These small plots receive better care than the surrounding 25 ha compartments (Table D-8).

Table D-8 Height and mortality of PARFOB trees and CNRF trees within the PARFOB compartments.

	Mean height (cm)		Mortality (%)	
Compartment	PARFOB	CNRF	PARFOB	CNRF
A3	211	331	10	8
A6	205	319	8	6
A5	191	310	22	26
B1	232	397	36	0
D1				
Eucalyptus	83	102	13	5
Proposis	72	96	8	0
Neem	-	-	37	26

The PARFOB plantation is not expected to attain from plantation establishment to the first harvest anything approaching the best experimental yield at CNRF Bandia of 4 m^3/ha/year. Rather, the data indicate that yields will be on the order of 1.5 m^3/ha/year or less. This is similar to the growth potential of the natural forest, estimated on the basis of past harvests to be at least 1.0 m^3/ha/year.

Between 1944 and 1953 the Bandia Classified Forest produced an average of 4.5 tonnes of charcoal per hectare or approximately 22 tonnes of wood per hectare at intervals of approximately 18 years. A later management plan envisioned as much as 30 tonnes of wood per hectare per 18 year rotation. Assuming a wood density of 0.6, these amounts are equivalent to between 0.6 and 1.0 m^3/ha/year of wood harvested.

In 1982, a forestry student from Germany, Miss Eva Muller, undertook sample cuts of the natural, A. seyal forest near the CNRF experimental plantation in a 9-hectare area. Her data indicate a yearly production ranging from 0.8 m^3/ha/year to 3.2 m^3/ha/yr, with a mean of 1.9 m^3/ha/year (David Gibson, personal communication, 1983). The forest sampled had been exploited for charcoal 6 years previous.

In considering the closeness between expected plantation yields and those of the abovementioned A. seyal forest it should be noted that to date we have no data on the productivity of eucalyptus coppicing after harvest. However, one would expect faster growth than that of seedlings, and CNRF has in fact observed this to be the case in one experimental plot at Bandia.

It can also be postulated that plantation productivity could be enhanced through refinement of techniques i.e. more effective planting and maintenance and protection, and faster growing species. Recommendations for improvements in planting and maintenance are presented in Annex C , below. If implemented they could at best increase per hectare output by a fraction of a cubic meter.

More adapted or superior trees are another possibility. For the moment, seeds of the best provenance of E. camaldulensis (No. 979-984-987) are not available for lack of seed production plots.

The species E. microtheca has shown considerable promise in plots near Bambey, where 5 different provenances yielded between 2.3 and 3.5 m^3/ha/yr over an 8 year period. Total accumulated rainfall for the period was 4029 mm. Soils were deep, agricultural-quality soils.

Prosopis juliflora is another fuelwood species which shows promise, but which has not been observed to produce more than 4 to 5 m^3/ha/yr when rainfall and air moisture are adequate. The Bandia site is drier than known Prosopis plantations in Senegal. However, cost of plantation could be perhaps much less than that of eucalyptus, inasmuch as it could be sown directly in the plantation and would shade out weed competition more quickly. Direct sowing has not yet been done on a large scale with Prosopis.

Cassia siamea is a fast growing tree initially, but it has been observed to slow or stop growth at about the fourth year, probably because of its high requirement for water (i.e. high evapotranspiration).

The overall conclusion that devolves from these observations of rainfall, growth, provenance trials and comparison between experimental plots

and field plots is that at present it is not technically possible to achieve more than 4 m^3/ha/yr, and that in the large scale PARFOB plantation, yields are likely to be on the order of 1.5 m^3/ha/yr for trees planted during 1980 to 1982, or 1983. In the computation of the internal rate of return the per hectare/per year figures of 1.5 m^3, 2.0 m^3, 3.0 m^3 and 4 m^3 have been used in order to explore the full range of technical possibilities.

3.9 Plantation Costs

Plantation costs have been compiled from AID and PARFOB financial records. Only direct costs, or operational costs, have been calculated. Table D-9 and D-10 summarize the direct costs of plantation establishment for the first three years. Tables D-12, D-13 and D-14 detail the costs by calendar year.

Table D-9 Direct Cost Summary, 1980 through 1982.

		%
Personnel	$ 816,721	65
Overhead	25,270	2
Nursery & plantation	61,465	5
Equipment operation		
fuel, lubricants	178,010	14
repairs, maintenance	156,327	12
Miscellaneous	15,502	1
Total	$1,253,295	99%

Except for the salaries of the project director and four technical staff, personnel costs have been borne entirely by AID, due to the inability of the government to furnish counterpart funds.

Depreciation of equipment, buildings and other installations is computed to be approximately $200/ha over a period of 10 years.

$$\frac{\$\ 1{,}253{,}295}{1550\ \text{ha.}} - = \$808 \text{ per hectare}$$

$$+ \text{ depreciation } 200 \text{ per hectare}$$

$$= \$1{,}008 \text{ per hectare}$$

Personnel costs represent a high proportion of the total costs. Maintenance and repair costs have also been high; they include a $45,000 order of tractor repair parts.

Table D-10. Direct Costs of Plantation-Summarized by years

	1980	1981	1982	Totals	%
Personnel					
DGEF agents (estimate)	$ 18,604	$ 22,641	$ 32,335	$ 73,580	6
Other personnel working for PARFOB	153,465	269,724	319,952	743,141	59
Overhead	4,479	12,166	8,625	25,270	2
Nursery & Plantation					
(plastic bags, pesticides, fertilizers, tools, fencing, etc)	31,874	4,909	24,682	61,465	5
Equipment Operation					
Fuel, lubricants	51,266	70,285	56,459	178,010	14
Repairs, maintenance	38,139	30,411	87,777	156,327	12
Miscellaneous	-	4,362	11,140	15,502	1
TOTAL direct costs	297,827	414,498	540,870	$1,253,295	99

Explanatory Note: Amounts summarized from tables D-13,D-14 and D-15. 1980 expenditures are estimates except for fuel and lubricants. Fuel and lubricants (grease, hydraulic pump oil, engine oil,etc.) are purchased directly by AID. Occasional purchases of fuel made directly by PARFOB, in 1983 on the CFA account are charged to the Overhead category. All other categories of expenses are made through the PARFOB account in Thiès, and have been developed from vouchers prepared on that account. CFA amounts have been converted to dollars at the following rates: 1980, 215; 1981, 265; 1982, 334. Exchange rates are the arithmetical averages of rates at which the various advances have been made by AID to the PARFOB account.

Costs per hectare to plant in 1983 are likely to be higher than in previous years. The remaining funds in the project available as of February 1, 1983, for disbursement to the PARFOB account were approximately 67 million CFA. AID in Dakar has ordered $45,000 worth of fuel and lubricants for the 1983 campaign, or an amount equal to 15.75 million CFA (at 350 to the dollar). To this can be added the PARFOB bank balance at the end of 1982 of 30 million CFA which was partly expended in January, 1983.

Table D-11. Estimated planting costs, 1983.

January, 1983 expenditures	19 million CFA
Account balance, Feb 1, 1983[a]	11
Advances to be made, 1983	67
Fuel and lubricants (AID), 1983	15.75
TOTAL	112.75
Requested counterpart budget	42
TOTAL	154.75 million CFA
at 350 CFA	$442,143
to plant 400 hectares =	$1,105 per hectare

(a) Balance as shown in PARFOB's budget proposal for Feb to Oct, 1983.

Given, however, the low probability that PARFOB will receive its counterpart budget (Budget d'Equipement), which was approved for the GOS fiscal year of July 1, 1982 to June 30, 1983, the per hectare planting costs would be lower if the same work is accomplished. They would then average $856 per hectare.

Table D-12. Expenditures for Direct Planting Costs, 1980

	PARFOB[a] (Thiès)		AID[b] (Dakar)	Totals $ $1 = 215 CFA[c]
	GOS	AID	$	
	(000's CFA)			
	(1)	(2)	(3)	(4)
Personnel				
DGEF staff	est.4,000 CFA			$ 18,604
All other[d]		32,995		153,465
Overhead		est. 963[e]		4,479
Nursery & Plantation		est.6,853[e]		31,874
Equipment operation				
fuel, lubricants			51,266	
repairs, maintenance		est.8,200[e]		38,139
Miscellaneous		-		-
Total expenditures	4,000	49,011	51,266	$297,827

(a) GOS expenditures in salaries and fuel (when available) have not been drawn from the PARFOB bank account, rather salary checks and gas coupons are sent directly from the SEEF in Dakar. Amounts shown are therefore estimates.

(b) AID/Dakar has purchased diesel, gasoline, and lubricants tax free through its own supply management office, and provided these commodities to the project.

(c) The conversion rate represents the arithmetic average of the various amounts advanced to the PARFOB account at different rates.

(d) Totals taken from monthly salary vouchers and other cash vouchers. Includes net salaries paid, taxes paid, per diem and indemnities where applicable (project director).

(e) Estimated values are taken from the 1980 operating budget submitted by PARFOB. Actual expenditures cannot be determined since records were not systematically kept during the first months of the project.

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Table D-13 Expenditures for Direct Planting Costs, 1981

	PARFOB (a) GOS	PARFOB (a) AID	AID(b) (Dakar) ($)	Total ($) $1.00 = 265 CFA(c)
	(000's CFA)			
	(1)	(2)	(3)	(4)
Personnel				
DGEF agents	est. 6,000			22,641
Project personnel		71,477		269,729
Overhead		3,224		12,166
Nursery & Plantation		1,301		4,909
Equipment Operation				
Fuel & lubricants			70,285	70,285
Repair & maintenance				
. Caterpillars, tractors		5,419		20,449
. Pick-ups		2,640		9,962
		(8,049)		
Miscellaneous		1,156		4,362
Total Expenditures		85,277	70,285	414,498

(a) Personnel totals are taken from monthly salary vouchers and other cash vouchers, and include net salaries, taxes paid, per diem and indemnities (where applicable). All other amounts are derived from records contained in vouchers submitted periodically by PARFOB to the Ministry of Finance.

(b) Direct purchases by AID. The commodity is delivered to PARFOB.

(c) The exchange rate represents the arithmetic average of the various amounts advanced to the PARFOB account at different rates.

Table D-14. Expenditures for Direct Planting Costs, 1982

	PARFOB[a] GOS 000's	PARFOB[a] AID CFA	AID[b] (Dakar) $	Total $ $1.00 = 334 CFA[c]
	(1)	(2)	(3)	(4)
Personnel				
DGEF agents	est.10,800			32,335
Project personnel		106,864		319,952
Overhead		2,881		8,625
Nursery & Plantation		8,244		24,682
Equipment Operation				
Fuel & lubricants			56,459	56,459
Repairs & maintenance				
. Caterpillars		2,418		25,203
. Pick-ups		5,870		17,574
. Spare parts			45,000	45,000
Miscellaneous		3,721		1,140
Total Expenditures	10,800	135,998	101,459	540,970

(a) Personnel totals are taken from monthly salary vouchers and other cash vouchers, and include net salaries, taxes paid, per diem and indemnities (where applicable). All other amounts are derived from records contained in vouchers submitted periodically by PARFOB to the Ministry of Finance.

(b) Direct purchases by AID. The commodity is delivered to PARFOB.

(c) The exchange rate represents the arithmetic average of the various amounts advanced to the PARFOB account at different rates.

3.10 Discussion

(a) Costs of plantation labor

A large proportion of the direct costs is labor on the plantation. Compared to the original estimates of labor needed, and to experiences elsewhere in the Sahel with similar scale plantations, the labor inputs at PARFOB are high.

Table D-15. Comparison of plantation labor inputs

	man days per year	man days/ha
1. Design estimates		
Project paper (750 ha)	28,000	37.5
Guigonis report (750 ha)	33,000	44
2. Plantation experience		
PARFOB 1981	49,000	75
650 ha planted 150 ha of '80 plantation maintained		
PARFOB, 1982	59,000	78
745 ha planted		
800 ha maintained, ('80, '81)		
Mali OAPF (without nursery)		43
Upper Volta, AVV 1979		39
1980		41
(without nursery, all weeding by hand)		

The total labor inputs computed from payroll records result in a higher number of man days per ha. planted (and maintained) than do the estimates given by PARFOB foresters or the records of the compartments: 75 to 78 man/days per hectare as opposed to 52.5 man days per hectare. Plantation records on labor inputs are summarized in Table D-16 .

Table D-16. Labor inputs per hectare planted [a], 1982.

	man days/ha
Nursery operation:	26
38 man days per 1,000 plants	
521,000 trees planted on 745 has.	
Transport	0.5
Planting	10
Grasshopper protection (pesticide)	1
Weeding	15
TOTAL	52.5

(a) Labor inputs to the nursery operation are estimated by O. Fugalli, based upon information from the 1982 campaign (See D.3.5.). Planting, weeding, and pesticide application inputs are taken from information contained in the compartment history forms (fiches parcellaires) that were prepared during the course of the evaluation. Transport inputs are estimates by Guèye (Guèye, 1982).

Total labor expended, (excluding personnel and highest level technical staff during 1981 was 49,000 man days and in 1982 was 59,000 man daya, according to PARFOB payroll records. This labor was in part expended on the weeding of plots from previous years, particularly the removal of vines and taller weeds not cut by the disk harrows. Thus in 1981, an additional 150 hectares of 1980 trees were provided some attention, while in 1982, 800 hectares of trees from the two previous years had to be looked after, in addition to the 750 hectares that were planted.

Table D-17. Total labor vs. computed labor inputs

1981	49,000 man days divided by 650 has	=	75 man days/ha
	Computed labor input per hectare planted (per 1982 statistics)		52.5 "
	Unspecified remnant equivalent to a total of 14,625 man days		22.5 "
1982	59,000 man days divided by 750 has	=	78.6 man days/ha
	Labor input per hectare planted		52.5 "
	Unspecified remnant equivalent to a total of 19,500 man days		26

The "remnant" man days could be accounted for in a variety of ways: weeding on previous years' compartments, guards during the period December to May, sick leave and paid vacation, and, finally, low productivity. Data on sick or annual leave exist for each worker but are not recorded in tabular form and are essentially unusuable at present.

Labor inputs on weeding in previous years' compartments have not been estimated, but cannot be more than 4 or 5 man/days per hectare at most. Guards are estimated to be posted for every 4 compartments, that is every 100 hectares (In 1983, twenty guards were posted for the 1550 has. of plantation). The resulting difference is small:

1981 "remnant" man days, total	14,625
- weeding of 150 hectares ('80) 5 X 150	- 750
- guards for entire plantation 5 mo' X 26 days/mo X 2	- 260
Unaccounted for remnant	13,407 man days
1982 "remnant" man days, total	19.500
- weeding of 800 has ('80,'81) 5 X 800	-4,000

- guards	
5 mo. X 26 X 8	-1,040
1 mo. X 26 X 20	- 520
Unaccounted for remnant	13,940 man days

These weeding and guard inputs are, it must be emphasized, only estimates and are by no means judgements that this level of labor input is needed or justified. Paid vacation and sick leave could not account for but a fraction of remainder: perhaps as much as 35 man months in 1981 (910 man days) and 50 man months in 1982 (1,300 man days).

The unaccounted for remainder probably represents the difference between actual hours worked and the 8 hour work day on which the payroll, computations, and all estimates are based. If so, it would appear that actual hours per day worked are on the order of 6 rather than 8, although this estimate is necessarily subjective. But if such were the case, that is, if effective man days were reduced by 25%, the "unaccounted for remnant" would be accounted for. Thus, 25% of 59,000 = 14,750 as compared to the calculated remainder of 13,940. This observation relative to worker efficiency as affected by actual hours worked is corraborated by our observations and the recognition by the PARFOB director that workers need closer supervision.

It seems evident that during the peak of the hot, humid season, it will always be difficult to get men to work under the sun between 1230 and 1500, traditionally a period of repose, except for farmers who are rushing to plow or to sow their millet or peanuts, or to undertake the first weeding so as to save their germinating crops.

It is equally evident that during the hot dry season, mid-afternoon heat is not less punishing even though less humid. (The cool dry season is the period of least plantation activity). Thus, in practice, workers work well during the morning hours but tend to not keep up the effort in the afternoon. The practice has been to allow the men to work a continuous shift, without a break for lunch, thus, from 0800 to 1530. On occasion, men have been observed to leave the plantation site early, around 1400. Many travel up to 10 kilometers to return home, and during the rainy season, they may well work in their fields in the late afternoon. It is common sense to take it easy during the hours of maximum daily heat, and not reasonable to expect farmers who have never held a wage earning position on a continuous basis to accept the discipline of an 8-hour day that is assumed of wage earners. The solution is probably that of adjusting the length of the work day to the season and the needs at the plantation, as well as having greater flexibility in the hiring and firing of workers. Whatever the ultimate management solution may be, however, much closer supervision would appear to be a necessary measure.

(b) The Mechanical weeding and other equipment problems

The inadequacy of the crawler tractors for the magnitude of the planting program has been dealt with above. But such inadequacy has had far-reaching repercussions. In order to try and accomplish the annual task of 750 ha.

PARFOB decided to depart from the site preparation techniques recommended less explicitly in the PP and more explicitly in the report by M. Guigonis (3-tooth sub-soiling in two directions at right angles).

It was thus decided to relieve the crawler tractors of some of the sub-soiling chore and to have the second 3-tooth passage replaced by pre-planting harrowing and by 1-tooth sub-soiling in two directions at right angles, the latter two operations to be done by wheeled tractors (the crawler tractors being employed also for knocking down vegetation and termite hills as well as for windrowing). The end-result of this option was to reduce the availability of wheeled tractors for the most important and narrowly time-restricted weeding operations, which consequently could not always be carried out in time and never replicated in the same year in the plantations established previously, as recommended by the PP.

The availability of wheeled tractors was also negatively affected by the difficult access to the planting sites during the rainy season, which was not anticipated in the PP, and which has necessitated using wheeled tractors for the transport of water for about one month, precisely when weeding could be done cheaply and effectively. Though it was not possible to have it confirmed, it is thought that the decision to weed manually all around each seedling immediately after planting, despite its very high cost in manpower, must be due to the same reason: the scarcity of wheeled tractors resulting from the scarcity of crawler tractors and from the land clearing and site preparation options chosen.

Departing from the recommended second passage of a 3-tooth ripper at right angle has had another negative effect in addition to preparing the site less efficiently, i.e. that of leaving many stumps in the soil (having escaped uprooting in between teeth of the ripper during the only 3-tooth subsoiling passage), sharply cut by charcoal makers and which have caused havoc to the tires of the wheeled tractors called upon to do

pre-planting harrowing and 1-tooth sub-soiling. Most of such stumps would have been uprooted by a second passage of the 3-tooth ripper.

It can also be concluded that (i) more than two 4-wheel-drive tractors could have been put to good use, especially because of the difficult access to planting sites during the rainy season; (ii) the other wheeled tractors, to be used mainly for weeding, could have been less powerful than those procured; (iii) the disc harrows should have been of the heavy-duty-type from the very beginning; (iv) though the service rendered by the PCV mechanic was indeed excellent for the wheeled, it was less so with regard to crawler tractors and, most important, he did not consider himself as an instructor but only as a doer; (v) the truck purchased is practically useless.

(c) Plantation establishment

Taking into account the various technical and other constraints, it can be concluded that the means available to the project were adequate for a 500-ha/year planting program at full scale operation. Two hundred hectares should have been the first year goal, 300 the second and thereafter 500 per year.

Land clearing, including windrowing, should have been done completely by the cooperatives of charcoal makers over the areas exploited by them, and by a low-powered crawler tractor over the remaining area. Baobab trees and termite hills should have been left standing, and areas with too many of them should have not been cleared. Site preparation should have consisted exclusively of 3-tooth sub-soiling in two directions at right angles. Weeding should have been done mechanically twice a year,

as early in the rainy season as possible. Had this been done, there would be today on the ground only 1,000 ha instead of the 1,500 planted sofar, but the 1,000 ha would be in better shape than the existing 1,500 ha despite the scarcity of rainfall since 1980.

4.0 Complementary Research

This work was entrusted to the National Forestry Research Center (CNRF) and has been carried out with a minimum of involvement by AID. In addition to the work described here that was funded by the project and undertaken at the plantation site, information has continued to flow from CNRF's research site 7 kilometers south of the PARFOB nursery. Both meteorological data and samples of growth at that site have been of great significance to understanding the potential of the Bandia plantation. In particular the harvest of 6-year old Eucalyptus camaldulensis trees of various provenances in 1981 at the Bandia research station yielded data that have greatly diminished estimates of growth potentials in the PARFOB plantation.

4.1 Objectives

The research component of the project was tied to the project goal of developing a replicable fuelwood production system in Bandia. The most important contribution of research was seen to be improving the likelihood of replicability by reducing costs and increasing the use of local materials and labor. In addition it was felt that a study was required to evaluate the effect of the project on local soil and water resources (Annex A, p. 12/13).

These objectives were mirrored in a paper prepared by Project Co-Director Gibson in November 1981 in which he noted: "A major emphasis of this pilot project is the development of readily replicable model which can be rapidly and successfully extended into other similar peri-urban areas. To assist in this goal of rapidly maximizing the project's spread effects... CNRF will assist in 1) reducing input costs at every implementation

level, 2) identifying urban centers with similar problems and determine their potential to successfully support a replication (site characteristics, monitor rainfall, ascertain land availability), and 3) performing basic research into ecological and hydrological effects of intensively managed forest plantations".

4.2 Research Problem Definition

The broad outlines of problem definition have been provided in the extract from Gibson cited above. In the Project Paper text itself there is only a general indication of what was to be undertaken. Mention was made of"directed experimentation" designed to reduce costs with examples such as living fences, alternatives to polyethelene sacks and the better organization and use of local materials (PP, P. 15). Some elaboration was provided in the Technical Annex A where it was noted that "interesting research possibilities" included nursery planting, organization of work teams, clearing techniques (labor vs. machines), seedling transport, living fences vs. barbed wire, and the best associations of livestock, agriculture and the plantation. CNRF proposed planting trials in different parts of the country.

Final details of the research program were worked out by CNRF in consultation with PARFOB. Formal agreement was reached between SEEF and ISRA in August 1980 on the recherche d'accompagnement to be carried out by CNRF. Four areas were agreed upon as shown in Table D-18.

During the course of project implementation, research results from earlier CNRF trials led to a changing definition of the problem to be addressed by forestry development in the Bandia area, at least as viewed

Table D-18. Recherches d'Accompagnement, CNRF

N°	Research Theme	Duration	Projected (cost CFA)
1.	Réduction des coûts de Production, des coûts de Plantation et des coûts d'entretien	4 yrs	14,100,000
2.	Inventaire des potentialités forestières des sols et climats Sénégalais	4 yrs	23,200,000
3.	Etude de l'évolution du sol sous plantation d'Eucalyptus */	4 yrs	9,700,000
4.	Bilan hydrique de peuplements forestiers	4 yrs	13,350,000
	Total		60,350,000

*/ Subcontracted to ORSTOM - Dakar.

by CNRF and project co-director Gibson. Initial production figures from CNRF research plots in Bandia coupled with high establishment costs of reforestation led CNRF to recommend in 1982 a reorientation of the project towards management of the natural forest. The first step in that reorientation was preliminary research needed to collect basic data on the possibilities of natural forest management.

A research proposal was generated by CNRF and proposed as a fifth theme for recherche d'accompagnement. Although initially accepted with funding of 16 million FCFA (Procès Verbal, 15 July 1982) this research will not now be carried out due to the financial constraints encountered by the project.

4.3 Results to date

(a) Theme No. 1 - Reduction des coûts de production, des coûts de Plantation et des coûts d'entretien

Objectives: These were to identify and perfect methods of reducing costs of plantation establishment and maintenance. It was suggested in the Project Paper that applied research of this type might reduce per hectare costs by as much as 40-60 percent (p. 10).

Methodology: This research component was an extension of a series of trials that CNRF had been undertaking since 1976 in nursery production, land clearing and soil preparation techniques, and plant protection measures. A wide range of research elements were included in the project-funded activity: stump planting of Eucalyptus (barbatelles), chemical weeding, a windbreak trial and an intercropping/agro-forestry trial.

CNRF expertise in the raising of Eucalyptus seedlings was used to produce planting stock for the project in 1981 and 1982, and guidance was available (sometimes sought and used, other times ignored) on a whole

range of technical questions related to the plantation. No methodology was established to monitor plantation costs and compare them on a systematic basis with research results to show whether the research objective of reducing costs had, in fact, been met.

Results: The evaluation team has identified no substantial reduction of cost in project implementation to date that can be directly attributed to the research. Moreover, the development of financial and technical supervision and monitoring techniques needed for implementing cost reducing measures was not envisioned or included in the research. Economist Guèye's work in early 1982 was a start in this sense. Guèye proposed a number of forms for recording various plantation and equipment operations on a daily basis, however, with the exception of the daily logs for caterpillar tractors, these forms were not put into use.

There are initial indications that the work on barbatelles may provide a cost reduction (particularly in the transport) of the trials currently underway prove successful.

The intercropping trials are of interest for village-level efforts, but not for large scale plantations in this zone (due to a lack of available manpower during the planting season). Food crops from the 1982 trials were recently harvested with respectable yields of millet (1.5 tonnes/ha) and pigeon pea (1.3 tonnes/ha).

(b) Theme No.2 - Inventaire des Potentialités Forestières des Sols et climats Sénégalais.

Objectives: to establish and monitor trial plantings of a number of both indigenous and exotic species with a view to assessing their production

potential and to the siting of future reforestation activities. It was noted in the Project Paper that these trials would be a pre-requisite first step to extending the fuelwood production system developed under the project.

Methodology: Eight locations were identified for the establishment of species trials. These were spread around the country from the Ferlo in the north to the Casamance in the south. In each case the site was located either in or in close proximity to a Forêt Classée. Six of the eight trials were started in 1982. In addition to the planting of a mix of indigenous and exotic species, a small weather station was installed so that the results obtained can be correlated with site-specific climatic data.

Results: Six of the eight stations were set up in 1982. The remaining two stations are scheduled to be installed in 1983. There are no results to report to date. Even preliminary results will not be available for a number of years. While this expansion of the CNRF network of species trials is important for future planning purposes, there is some concern over CNRF's ability to cover the recurrent costs of this expanded program.

(c) Theme No.3 - Etude de l'évolution du sol sous plantation d'Eucalyptus

Objectives: The primary objective of this study was to analyze soils changes under eucalyptus with a view to understanding the impact of tree growth on soil fertility and, as a result, identify silvicultural treatments that would enhance the long-term viability of multiple rotations of

Eucalyptus. The study is being carried out by Dr. Bernhard-Reversat of the Laboratoire d'Ecologie Végétale at ORSTOM, Dakar.

Methodology: Two sites were chosen for the study, each on a representative soil type - one at Bandia and the other at the CNRF station at Keur Mactar. In both cases Eucalyptus plots were paired with adjacent plots of natural vegetation. A wide range of parameters were selected relating to mineral cycling, the creation of organic matter and the evolution of soil fertility over time.

Although some of the analytical techniques are less than ideal (principal emphasis on *in vitro* rather than *in situ* studies, for example) practical considerations limited the analyses. In view of the increased use of *Prosopis juliflora* by the project, the possibility should be explored of establishing an experimental plot under this species at the Ecole Polytechnique de Thiès in order to begin collecting preliminary data.

Results: Research began in March, 1980. Results of the first years observations have been published in a series of three documents: "Les Cycles Biogeochimiques des Elements minéraux en Plantations d'Eucalyptus camaldulensis et en Forêt Naturelle a Acacia Seyal au Sénégal (1ère année de mesures 1980-81) (1981)", "Décomposition et Incorporation à la matière Organique du Sol de la litière d'Eucalyptus camaldulensis et de Quelques Autres Essences (1981)" and two papers on "Evolution des Substances Solubles de la Litière dans le Sol and Fractionnement gravilométrique de la matière organique du sol superficiel" (1982). These papers contain a wealth of initial observations on nutrient cycling, the decomposition and incorporation of leaf litter in the soil, various parameters related to the

production on the herbaceous strata and the evolution of soil organic matter.

Initial observations of note include the following:

(1) "Les réserves en K semblent être limitées et imposent une concurrence entre arbres et strate herbacée. Dans ces conditions il est possible que l'exportation de l'herbe, qui retirerait 50% du K mis en jeu dans le cycle, soit néfaste à l'équilibre de ce cycle".

(2) "L'absorption du P par l'Eucalyptus semble déficiente indépendamment des réserves du sol, et doit être liée à un problème physiologique peut être de mycorhizes".

(3) So far as organic matter in soil under Eucalyptus is concerned, the disappearance of leaf litter and its mineralization is relatively slow. The litter contains an important quantity of water soluble elements that are slightly acidic.

There is a predominance of mineralization and leaching of soil nutrients with little production of humus (as opposed to the situation under Acacia in which humus production is significantly higher). In addition it has been noted that the herbaceous strata makes an important contribution to soil organic matter (on the same order of magnitude as that provided by leaf litter) and that this is more quickly available than leaf litter due to its more rapid rate of decomposition .

Results from 1982 have not yet been fully analyzed and assembled. However, initial observations of interest include the following for a parcel of Eucalyptus camaldulensis harvested at Keur Mactar (Rapport d'Activité, 1982):

(1) L'exploitation et l'exportation des troncs représente un départ par hectare de 120 kg d'azote, 14 kg de phosphore, 175 kg de potassium, 700 kg de calcium, 22 kg de magnésium, soit respectivement 52, 70, 58, 83 et 88% du total immobilisé dans les parties aériennes des arbres.

(2) Par rapport à l'estimation des réserves en potassium échangeable du sol, la demande annuelle pour la croissance des arbres représente 10% et l'exportation du bois 76%. Bien que les réserves aient été estimées pour une profondeur de 60 cm et que les profils montrent une bonne exploitation du sol par les racines jusqu'à 1 mètre, on peut penser que le potassium risque d'être un facteur limitant dans l'avenir.

All of these results must be considered preliminary - providing initial indications rather than confirmed trends. Nonetheless, they begin to raise questions about the long-term viability of a fuelwood production system based solely on eucalyptus on sites where the use of fertilizer to replace soil nutrients lost through growth and harvesting is not considered viable due to low rainfall levels.

(d) Theme No. 4 - Bilan Hydrique de Peuplements Forestiers

Objectives: The primary objective of this research was to collect baseline data on soil moisture status and availability under Eucalyptus with a view to determining optimal silvicultural treatments. (In the original proposal planting density was singled out as being of particular importance). In addition, it was expected that the study would provide information on agroforestry possibilities as well as information on the effect of Eucalyptus on the water table (due to a fear that the large-scale planting of Eucalyptus would adversely effect well levels in surrounding villages).

Methodology: As noted in Section D.2.3. an initial methodology was proposed by Dr. Erwin Berglund following his consultancy in May, 1980. As a result of discussions with other experts and taking into account working conditions on the Bandia site, the recommended design was modified somewhat and now includes three treatments instead of two (plantation d' Eucalyptus, parcelle nue desherbée au même rythme que la précédente, parcelle de forêt naturelle) on three different soil types with soil moisture measured by neutron probe in a series of twelve tubes to a depth of three metres. Two of the three repetitions were installed in 1981 and data collection began in late 1981.

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Results: The following initial conclusions can be drawn (CNRF report, June, 1982).

a. there is a clear indication of the beneficial effect of weeding on tree growth.

b. it appears that the soil moisture profile under natural forest is stable over time and that it does not change as a result of evapotranspiration.

c. below a depth of 125 cm the soil moisture profile is the same under all three treatments. (CNRF report 30 June, 1982).

In addition, more recent results have shown a change in the soil moisture profile under eucalyptus indicating a decrease in available soil moisture in 1982 as compared with 1981. If this trend continues it will be used, in conjunction with the profiles from the bare and natural forest plots, to determine the optimum rotation age.

A thesis based on this research is being prepared by a CNRF research assistant as part of his training at Nancy (France). The preparation of this document will provide a valuable opportunity both to analyze the data collected as well as spell out the implications for Eucalyptus silviculture Due to the design eventually adopted, little will be able to be said about agroforestry possibilities and nothing about the influence (if any) of Eucalyptus on the water table of the surrounding area.

Due to the prevalance of hardpan at varying depths throughout the Bandia Forest, the impact of trees on the phreatic water table is considered to be insignificant, and this original research problem is not being pursued.

4.4 Use of the results

(a) Cost reduction

Two elements of this component are potentially of considerable importance. The results of the 1982 barbatelle/stump planting are being monitored with considerable interest as they may provide a significant breakthrough in establishment techniques for Eucalyptus, thereby reducing plantation costs. As with earlier estimates of Eucalyptus productivity, however, it must be kept in mind that results available to date are still of a preliminary nature and it is by no means certain that the technique will prove to be applicable under the highly variable and uncertain rainfall regime found in the project zone.

The intercropping component has provided interesting initial results that will need to be followed up on, particularly in the context of rural forestry activities. While in the plantation context this work was oriented towards reducing establishment costs and enhancing tree growth, in the rural forestry context the definition of the problem will need to be broadened with immediate attention to trade offs between the production of wood and food crops.

(b) Inventory/species trials

There are no results to date to be utilized by the project. With the trials only having been established in 1982, even initial indications of suitable species on the various sites are three to five years away. As a result, the objective of providing guidance for the siting of follow-on project will not be met. Nonetheless, the information gained from these trials will eventually contribute to long-term Senegalese forestry

planning efforts.

(c) Soil changes

As noted earlier, results from this work continue to be preliminary in nature. Research will need to be continued over a full rotation cycle and beyond to provide a basis for understanding the impact of Eucalyptus on soil fertility and its implications for the long-term viability of this type of forestry intervention.

While an important effort has been made to publish initial findings, there is an on-going need to (1) outline in more specific terms the implications of the research findings for plantation establishment and management and (2) discuss these implications with Eaux et Forêts and PARFOB staff on a systematic basis.

(d) Water Balance

The primary immediate utility of the results of this work is expected to be a determination of the length of the first rotation.

4.5 Discussion

(a) Validity of research objectives

The assumption that 'directed research' would help to assure the replicability of the project has not been borne out. Low rainfall and high costs of plantation establishment(relative to similar efforts elsewhere in the Sahel) have altered the productivity of the project to a degree that could not be solved by research. It was hoped that cost-reducing research could lower production costs by 40-60% but even this amount is too low to alter the situation found in this evaluation.

The evaluation found important needs for research or studies aimed at cost reducing measures of a managerial and organizational nature. The project's research was not foreseen to address these "non-technical" needs.

(b) Tested technical packages

The project is a dramatic example of the need for tested technical packages prior to moving into large-scale implementation. As such, it supports the case for attention to basic research prior to development, not simply accompanying it.

(c) The CNRF/PARFOB linkage

The working relationship between CNRF and PARFOB has not been as collaborative as had been hoped. Project personnel remain skeptical of the utility of much of the research currently underway. Although the Project Paper spoke about 'working cooperatively', there was no indication that the complexity of this was understood (the need to work through various levels between two different Ministeries, for example), nor was any institutional analysis carried out to ascertain whether it was realistic to expect such cooperation. The hurdles to be overcome in improving this relationship should not be underestimated.

Important strides can be made in opening up lines of communication through the regular discussion and review of research work plans and results by CNRF, ORSTOM, Eaux et Forêts and PARFOB. In addition, personnel from other forestry projects currently underway in Senegal should be encouraged to visit Bandia and vica versa. (It may be noted that CNRF proposed such an encounter to DGEF in early Feb. '83 without success).

(d) Unanticipated research spinoffs

There have been a number of unanticipated spinoffs to the research funded by the project. These include the economic analysis of the project

prepared by Samba Guèye, the study by Eva Muller on the productivity of the natural forest at Bandia, and the thesis on water balance currently being prepared by a CNRF research assistant (funded under a French scholarship). In addition, students from the University of Dakar have been studying the impact of the project on local charcoal cooperatives and there is a study proposed on fodder production in the plantation. The work carried out by Eva Muller is of particular importance as it provided a basis for identifying an alternative approach to forestry development in the project zone.

(e) Project-funded research/national research

While project-funded research is, in theory, recherche d'accompagnement, it is at the same time a substantial portion of the CNRF operating budget and, as such, is viewed in terms of national forestry research goals. The project has made an important contribution to the broader objective of strengthening the national research effort in a way that will contribute directly to ensuring that future reforestation activities are launched on a stronger technical footing.

(f) The need for increased forestry research

The results of the Bandia project to date provide a clear warning on the potential pitfalls of moving ahead with techniques or species that have not yet been adequately tested. In order for forestry development in Senegal to proceed on a firm footing, substantially increased attention and support will need to be given to forestry research. As the Plan Directeur notes" 'On ne peut manquer d'être frappé ... par la disproportion qui existe entre l'importance de ces programmes de recherches, pourtant réduits au minimum, et les moyens qui leur sont affectés, et entre la

modicité des crédits laissés à la Recherche et l'importance des investissements à prévoir pour les opérations de développement'.

Although the need for increased funding has been noted for some years now, including a proposal by the Minister responsible for scientific and technical research in 1980 that the percentage of the ISRA budget devoted to forestry be increased from 3 to 12.5 percent, funding has in fact been declining in both actual and real-value terms since that time.

(g) Research on natural forest management

CNRF identified this need some time ago (as evidenced in the preparation of proposed research theme No.5, for example) but this was not yet been reflected in Senegal's national forestry research portfolio due to the severe budgetary limitations noted above that have rendered the launching of new research initiatives all but impossible.

ISRA's Plan Indicatif National de la Recherche Agricole 1979-1984 prepared four years ago in February, 1979 included a substantial number of research proposals dealing with indigenous species, minor forest products and the natural forest. In addition, CNRF prepared a proposed 'programme complémentaire' to the recherche d'accompagnement during project design that was to include a study of minor forest product production and marketing (fruits, gums, medicinal plants, forage) in the Bandia forest with particular attention to possibilities for agriculture*. As such, what

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* ISRA/Dir. Eaux et Forêts, Avant-Projet, Programme Complémentaire aux Recherches d'Accompagnement du Projet Autonome des Forêts Périurbaines de Bandia - Financement USAID. s.d. (1979) 4p.

has been lacking is not an understanding of what needs to be done, but the means to do it. Had this research been started in 1979 we would now be in a position to better quantify the multiple products of the natural forest and assess the relative merits of management vis a vis reforestation. Based on indications from the Muller study on wood production alone, however, it is clear that natural forest management research will need to be started just as soon as possible.

5.0 Training

Five, 2-year scholarships were provided for in the project for study abroad. Local, on-the-job training was also envisioned, concerning the operation and maintenance of heavy equipment and various nursery and plantation skills.

5.1 Scholarships

Five scholarships for long-term overseas study have been funded by the project. Increases in the cost of university programs and the award of four rather than three two-year scholarships to the U.S. resulted in cost increases that exceeded the projected 17% per year contingency and inflation allowances. Total dollar cost of foreign training will amount to $ 209,730 as compared to the projected $113,000.

Table D -19. Scholarships in Forestry

Name	Program	Dates	Funds allocated
Elie Joseph Sambou (DGEF)	M.S.Resource management State University of N.Y. Syracuse	1981-82	$40,830
Abdoulaye Kane (DGEF)	M.S. Forest Economics Yale University	1981-83	26,000
Idrissa Mbaye (DGEF)	B.S. Forestry Utah A & M	1982-84	64,800
Ibrahima Thomas (CNRF)	M.S. Silviculture and forest management U. of Arizona	1982-84	60,000
Gora Ndiaye (DGEF)	Sylviculture and Nursery management Institut Agrocole de Bouaké, Côte d'Ivoire	1981-83	18,100
			$209,730

Enrollment in U.S. universities is preceded by three to six months of intensive English study. Only one person has returned, Mr. Sambou. He is now attached to PARFOB project but has not yet been re-hired by the DGEF. Consequently he is paid by project funds.

To date, only two persons originally attached to the project have received a scholarship, Mr. Idrissa Mbaye, formerly the PARFOB project coordinator and Mr. Gora Ndiaye. Two of the other recipients have been proposed, and awarded scholarships with the understanding that PARFOB would be "paid back" the scholarships it had loaned. Thus, the fields of study selected for the recipients do not all reflect PARFOB needs, rather are the needs as determined by other criteria.

5.2 Other training

A workshop in nursery techniques was taught at the PARFOB site in 1981 by CNRF technicians.

The project director, and the project accountant participated in a financial management workshop, given jointly by AID and the Ministère de Plan et de la Coopération, during September 13 to 24, 1982.

No other in-country training has been arranged, nor was an in-country training plan ever developed, as envisioned in the project.

5.3 Discussion

Even if long-term training were exclusively for PARFOB personnel, the benefits would not have been enjoyed until the later phases of the project. Nevertheless, it can be concluded that the long-term training has missed the general objective in several respects. Short-term training in Senegal, has fallen far short of that envisioned.

In the USA, no university provides a curriculum in arid zone forestry, although the U. of Arizona could come close to providing much of the course work. Consequently, the principal value of study in the U.S. would pertain to the more conceptual, theoretical and methodological aspects of different branches of forestry. The project envisioned more practical, that is technical, in-country training than has been the case. Study in Morocco for two persons had been proposed in the paper, but has not been funded. (Morocco has considerable surfaces of eucalyptus plantations and a forestry school).

The organization and technical skills required to run the project's heavy equipment were under-estimated. The PCV mechanic did not manage to impart the systematic knowledge that is required (even though he did convey much in the way of practical skills). Also the managerial and organizational techniques involved in running a large plantation project should have been identified for special training.

6.0 Village Forestry and Extension

A modest but encouraging effort has been made in support of small eucalyptus woodlot plantations in the surrounding region. PARFOB has also supplied free of charge thousands of eucalyptus seedlings in 1981 and 1982 to other organizations. Various extension type forestry activities were not explicitly budgeted, but they are envisioned in the project paper, on page 22:

> "The project will actively promote fuelwood production projects at the village level" and "attempt to establish village extension techniques for this type of activity which may be pursued in collaboration with locally recognized extension agencies".

An anticipated 150,000 surplus seedlings were proposed to be distributed to villages.

PARFOB's statutes do not specifically include the extension forestry, however, PARFOB's geographical mandate includes the departments of Mbour and Thiès.

6.1 Results

(a) PARFOB extension efforts

This activity began in 1982, when PARFOB, in collaboration with SODEVA, worked directly with several villages in the immediate environs of the Bandia Forest, and indirectly with other villages in the wider region by supplying trees to the regional development agency, SODEVA. To assist in this work, and to follow-up on its effectiveness, an ex-PCV (David Kingsbury) with experience in village extension work (Min. de la Promotion Humaine) was contracted to work at PARFOB during July to December, 1982. Kingsbury worked with ATEF, Lansane Djiba, PARFOB employee charged with "actions communautaires". A total of five hectares of communal woodlots

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were planted with direct assistance from PARFOB, including sub-soiling with a one-tooth ripper. Trees were delivered by PARFOB in August. Trees were planted on a 3 m X 3 m spacing.

Table D-20. Village woodlots established in 1982 with PARFOB assistance

Village	Dept.	Area ha	Sub-soiled	Survival (%) (Dec. 11)	Height (cm) (Dec. 11)
Sypane	Thies	1.0	X	60	25-30
Ngolfagning	"	0.5	X	90.8	80-100
Dakhar Mbaye	"	1.0		56	60-90
Thiombolodji	Mbour	1.0	X	89	60-80
Diogaye	"	1.0	X	74	40-60
Keur Massouka	"	0.5		70	50-80
Keur Bakary	"	0.5		80	80

PARFOB plantation laborers come from some of the villages, thereby favoring correct planting and maintenance of the woodlots. Dieldrin powder and, after grasshopper attacks occured, Feniotrothion powder were supplied to control termite and grasshopper damage. A plan to distribute WFP food to participating villages was announced after planting had already taken place, but the food had not yet been distributed at the end of the year. (WFP food was obtained by the project director outside the scope of the AID support for the project). Protection and weeding varied among the villages. In one case trees were planted in part of the woodlot among peanuts, without clearing space near the tree, resulting in stunted tree growth compared to neighboring trees on clear ground.

Only woodlots in clayey soils were sub-soiled with tractors. Trees grown on sub-soiled sites survived and grew markedly better than those on sandy soils that weren't sub-soiled. In Keur Bakary, part of the woodlot was "sub-soiled" with an oxen-drawn plow. Trees grew better in that portion.

Kingsbury's "Final report on the joint PARFOB/SODEVA village woodlot program in the Thiès region, 1982" draws a number of lessons from the experience.

(b) SODEVA village forestry

PARFOB supplied eucalyptus trees to SODEVA in 1981 and 1982.

In 1982, SODEVA in Thiès requested 33,800 eucalyptus and 2,450 mango plants from PARFOB for distribution in 35 villages in the Thiès Department. Joint visits with PARFOB personnel revealed that SODEVA extension agents are doing a competent job of preparing villages for woodlot assistance, but are not knowledgeable about how to plant and grow mangos. Lots no larger than 1.0 ha. are now promoted, since in previous years 2 to 4.0 ha. woodlots were observed to be poorly protected and maintained. Transport and delivery of trees is somewhat of a problem, because they are loaded and unloaded many times before reaching their destination.

(c) Distribution of trees outside of PARFOB

The PARFOB nursery is increasingly taking on an identity of a regional nursery. Surplus plants were supplied to a wide range of organizations in 1981 and 1982, and in 1982 there were more requests for eucalyptus than could be satisfied.

In 1981, PARFOB supplied the Bakel Small Irrigated Perimeter Project with 10,000 plants for windbreaks, and 100,000 to the PARCE project located in Kaffrine (to make up for tree shortages in that project). These represent unusual cases, and were possible in part because the PARFOB plantation in 1981 produced trees for 100 more hectares than were planted.

DGEF policy is at present to provide trees free of charge, however, PARFOB is in the process of requesting authority to sell trees.

Table D-21. Distribution of surplus plants, 1982.

SODEVA - Thiès region	33,815
SODEVA - Sine Saloum	1,500
Eaux et Forêts - Diourbel	2,000
Eaux et Forêts - Cap Vert	3,000
Eaux et Forêts - Louga	500
Peace Corps	1,000
Thiès Military Base	1,200
TOTAL	43,015

In addition, SAED had requested 25,000 plants in July, 1982, to serve as windbreaks on irrigated perimeters. However, a visit to the Fleuve du Sénégal region in August found that no program yet existed for the installation of these trees for technical assistance, or for the mobilization of villagers. In the end, 7500 trees were set aside at Bandia for eventual use by SAED, but were not used. A portion were eventually given to villagers, who came to the nursery to pick them up. Given PARFOB's restricted geographical jurisdiction DGEF questioned the appropriateness of PARFOB sending trees to the SAED.

6.2 Discussion

(a) The future of PARFOB in rural forestry

Given the large number of village woodlot efforts currently underway in Thiès and surrounding regions, there is little justification for the launching of another small program along the lines of what is already being tried. Once the experience gained from these other efforts has been distilled, another look at a possible continuation of this volet would be in order. In the meantime there may well be an expanded role for PARFOB to play in producing planting stock for other programs on a regional basis.

(b) The use of food for work to encourage/induce planting

Kingsbury was concerned that the use of food for work to promote village forestry was not justified given the villagers' motivation to work without food. This point is well taken. The use of food for work should be discontinued. Every effort should be made to establish a system that relies on local motivation and uses local resources to the maximum extent possible.

(c) The expansion of Bandia into a regional nursery: implications for rural forestry

It has been suggested that the nursery at Bandia be expanded into a regional nursery. Bandia could produce planting stock for many of these efforts. However, private nurseries and village-level mini-nurseries could also help supply rural needs.

(d) Plant pricing policy

A request has been considered but not yet made to Eaux et Forêts to allow for the sale of fruit trees and othe[illegible] from the Bandia nursery. If granted, this request will have initiated an important policy change that will enable some cost recovery at the nursery but, more importantly, place a market value on tree seedlings thereby encouraging increased care both in their planting and in post-planting protection and maintenance.

(e) The role of rural communities in natural forest management: broadening the definition of rural forestry

Production figures for eucalyptus at Bandia to date are only slightly higher than those recorded for the natural forest. As a result, substantially increased attention will need to be given to the management of the natural forest. Local communities should be closely involved in these activities. (A recent CILSS/Club paper by James Thomson provides important food for thought on how this might be achieved). Along with increased attention to natural forest management will come a broader definition of rural forestry - a definition that moves from a narrow focus on fuelwood or pole production to include the many non-wood forest products on which rural communities depend.

7.0 Financial Analysis

7.1 Management

(a) General

The AID contribution has been expended either as dollars through the use of various project implementation orders (PIO's) which in every case are approved by SEEF or ISRA, or as CFA francs deposited periodically in the two project bank accounts that have been established, one for PARFOB and one for CNRF's complementary research.

The GOS contribution is, from the standpoint of management, handled as (1) salaries and indemnities, paid directly by the SEEF to the personnel that have been seconded to the project and (2) an operational budget (budget d'équipement) which in the case of PARFOB is submitted once a year in June. The GOS fiscal year runs from July to June. Because counterpart funding has been restricted or not available during much of the project, it cannot be characterized in a systematic way. Financial records at PARFOB of the GOS counterpart contribution are not available; detailed records of the FCFA provided by AID are. A ledger shows expenditures by major budget category, as used in each year's budget propsoal.

(b) Budget programming

Until 1983, PARFOB made two separate operational budgets each year, one for the AID contribution and the other for the counterpart contribution. The PARFOB budget based on the AID contribution has been prepared once a year at the beginning of the year, with the participation of the project's American co-director, in the case of the 1981 and 1982 budgets.

In 1980, the CNRF assisted in making detailed budget projections, for AID grant money, which finally became available in July, 1980, when the project account was established in Dakar. Prior to then immediate expenses were covered by the GOS.

In early 1982, a $300,000 increase in the project's funding was requested from AID/Washington by AID/Dakar, and eventually authorized in November, however, only after a delay that created a temporary cash flow problem in the PARFOB account in Thiès. The delay was caused by a mistake in the wrote-up of the project in the Congressional Notification. The uncertainly over the ultimate authorization of the increase also held up financing and, therefore, the contracting of the replacement co-director, Roger Jones (whose contract was not consummated until February, 1983).

For 1983, shortages were forecast as a consequence of over-expenditures in various categories and the loss of most or all of the GOS counterpart funding for operational expenses in 1981 and 1982. The need to scale down both PARFOB's and CNRF's operational budget was foreseen and conveyed to by AID's project manager, Ulinski, as well as the interim co-director, Freeman, to the responsible persons in PARFOB and CNRF. To allow time to adjust the respective work programs to the reduced resources, funding at already programmed levels for the three month period, November through January, 1983 was proposed by AID. Three month budgets were correspondingly presented by PARFOB and CNRF letters of implementation for the amount requested were executed by AID.

(c) Financial records

The AID controller has worked with the accountants of the PARFOB and CNRF accounts in order to orient the keeping of adequate records. At PARFOB in Thiès, a senior accountant and an assistant accountant keep project records and prepare the monthly payroll.

Every three months PARFOB submits to AID a statement of all the expenditures, classified by budget category. The statement is prepared just prior to its submission, thus a running account of expenditures by budget line-item is not kept. Further, the statement prepared is not sufficiently detailed to permit a functional analysis of the various project operations. It is not, in other words, suited to the requirements of costs-benefits analysis and financial analysis pertaining to forest plantations. (On the other hand neither AID or the GOS has developed a format for forestry plantation cost accounting).

Records are nevertheless complete for funds provided by AID, and during the evaluation a more detailed analysis of project costs was carried out on the basis of existing records (Tables D-12, D-13 and D-14).

The PARFOB accountant must also periodically submit vouchers to the Minister of Finance for funds expended. Funds are not transferred from the PARFOB's Dakar account at the USB to the USB in Thiès without authorization of the Minister of Finance, based on the approval of the vouchers submitted. By the end of 1982, fifteen such vouchers had been submitted .

The Government of Senegal has adopted a standard accounting system, with corresponding ledger formats, however, no attempt has been made to

keep this up to date at PARFOB for lack of time.

7.2 Financial Analysis

The project has not yet generated income, and the financial aspects of the charcoal produced in the planted compartments have not been controlled by the project or analyzed here.

Planned and actual expenditures of the project are reviewed next for the direct costs of the plantation operation. These expenditures have been made either as purchases directly by AID on behalf of PARFOB or purchases made through the CFA account managed by PARFOB and periodically replenished by AID through advances.

As of November 27, 1982, eleven advances had been made to the PARFOB account in Dakar. These are summarized in Table D-22 . The table also notes the expenditures made on the PARFOB account, according to the detailed vouchers submitted by PARFOB to the Ministry of Finance, as a condition of transfer of funds from the PARFOB account in the USB in Dakar, to the PARFOB account at the Thiès branch (See tables D-12, D-13, and D-14).

The accounting presented in the table finds a discrepancy between the amount of money advanced to the PARFOB account in Dakar and the amount of money expended from the Thiès account. This may in part be explained by the fact that the last voucher for expenses in 1982 was not included in the expenditures analyzed for that year, since it was not available. It could account for up to 4 or 5 million CFA. Secondly, the analysis of the various vouchers submitted to the Ministry of Finance has not been double checked and there may be errors in the distribution of costs among categories. The use of average exchange rates could also account for some difference. The total discrepancy of between 8 million and 12 million CFA

Table D-22. Advances and Expenditures, PARFOB

1980 No.	Advance[a] Date	Exchange (CFA/dollar)	000's CFA	Dollar equivalent
1	May 22	208	20,000	96,131
2	Aug 20	208	13,649	65,605
3	Nov 8	225	16,481	73,200
	TOTAL ADVANCES		50,130	$ 234,930
	Expenditures on PARFOB account (Table D-12, col.2)		- 49,011	
	Balance		1,119	
1981				
4	April 4	248	50,000	201,613
5	n.d.	291	40,000	137,575
	TOTAL ADVANCES		90,000	$ 339,188
	Expenditures (Table D-13, col.2)		- 85,217	
	Balance 81		4,783	
	Balance 80		1,119	
	TOTAL BALANCE		+ 5,902	
1982				
6	Feb 2	294	19,540	66,641
7	May 10	299	30,000	100,334
8	July 12	348	19,000	54,598
9	Aug 20	348	22,000	63,218
10	Oct 13	352	22,272	63,273
11	Nov 27	361	35,000	96,952
	TOTAL ADVANCES		172,812	$ 516,038
	Expenditures (Table D-14, col.2)		- 135,998	
	Balance		36,814	
	PARFOB Bank balance Dec 31, 1982		30,344	
	Difference		6,470	
	Balance carried over (80 & 81)		5,902	
	TOTAL		12,372	

is important enough, however, to merit a review by the PARFOB accountant and the AID Controller. It should be noted that periodic statements of account submitted by PARFOB to AID have balanced income against expenses, but these are not presented in the same detail or for the same period as the vouchers presented to the Ministry of Finance.

Expenditures planned in the project paper for the first three years are compared with actual expenditures for 1980 through 1982 in Table D-23. Only expenses entailed in the plantation operation are compared. It can be noted here that the financial plan presented in Annex A of the project paper contains numerous discrepancies and does not seem to accurately summarize more detailed tables in the same annex of operating expenses and equipment costs. Therefore, the more detailed tables were used for the comparison.

A number of salient points emerge from this comparison. The GOS contribution to the project has been greater than was planned in the paper. Whereas much less of this contribution was for labor costs (with the total personnel contribution being limited to SEEF permanent staff), there was a very important unplanned contribution in the form of equipment, amounting to almost $200,000, 25 million CFA of which financed the D-7 caterpillar tractor that has been indispensable to the project operations. The total equipment costs have been far greater than was planned, exceeding the project paper estimate by $340,000, even after allowing for the expected 7% contingency and 10% inflation. A detailed comparison of planned versus actual equipment costs can be found in Table C-3.

Table D-23. Plantation Expenditures, First Three Years, Planned and Actual[a]

($000's)

tem	Planned				Actual			
	AID		GOS	Total	AID		GOS	Total
	as $	as CFA			as $	as CFA		
rocurement								
Equipment[b]	565.5				743.6		197.6[d]	
Air photography	25.0				8.5			
Garage/Workshop		63.8				57.4[e]		
Subtotal				(654.3)				
+ 17.7% Contigency/inflation				(11.5)				
Subtotal				665.9	752.1	57.4	197.6	1,007.1
perating Expenses[c]								
Personnel		438	126	(564)		743.1	73.6	(816.7)
Plantation/nursery		13.6				61.5		
Equipment operation		385			223.0	111.3		
Overhead		59				25.3		
Miscellaneous						15.5		
Subtotal		895.6		(1,021.6)				
+ 17.7%/yr contingency and inflation				(18.2)				
Subtotal				1,039.8	223.0	1,179.8	73.6	1,253.4
TOTAL				1,705.7				2,260.5
TOTAL AID				1,577.5				1,989.3
TOTAL GOS				128.2				271.2

a) Taken from the Project Paper

b) Taken from "Project Procurement", p. 23, 24, Annex A, Project Paper. Some minor purchases were omitted. Actual expenses from Table C-3.

c) Planned expenses taken from "Annual Operating Expenses", p.25, Annex A, Project Paper. Actual expenses from Tables D-12, D-13, and D-14.

d) Total cost of one D-7 Caterpillar tractor; 2 Peugeot station wagons; 1 Peugeot 404 pick-up.

) Only partially disbursed by Dec. 31, 1982. Expended directly by AID.

The plantation operating expenses have also exceeded the planned costs, by $213,600, after accounting for inflation and contingencies. The most significant increases in the operating expenses over those planned have been in the cost of labor -- a $250,000 difference -- and the costs of materials and supplies in the plantation and the nursery -- $61,900 spent versus $13,600 planned. The latter difference is explained largely by the high cost of plastic pots and pesticides. Other categories have cost less than planned.

Thus, for the categories of expenses analyzed, the expenditures exceeded the planned outlays by $555,000. The Government of Senegal spent $143,000 more than was planned and AID, $411,800 more than was planned.

AID has also spent more than was planned in the technical assistance and training categories, however, these amounts have not been analyzed for the three calendar years. However, the total contracted amounts (including obligations in 1983, and 1984) for technical assistance are $ 500,000 versus $ 593,000 in the project paper, while the training scholarships have exceeded the planned $ 113.000 by $ 96.730 (Table A-3).

7.3 Discussion

The evaluation team judges that the additional expenditures entailed in the purchase of equipment are in general reasonable, and that the project paper underestimated the costs in this category. On the other hand, the costs of labor are judged excessive, to the extent that similar operations elsewhere in the Sahel employ less labor to accomplish similar tasks. However, as pointed out in the analysis of the use of labor in Section D-3.3, the project paper underestimated to some extent the project's labor requirement.

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ECONOMIC ANALYSIS OF THE BANDIA PROJECT

Summary and Conclusions

This analysis uses the evaluation of costs and benefits which are easily quantifiable. Consequently we have not tried to estimate the impact of the project on soil conservation, climate or other ecological effects. These effects, although real, are too difficult to be evaluated given the data and methodology available.

The benefits which have been considered are :

. first the production of charcoal which has resulted from the cutting of the natural forest on the 2000 hectares of the project (4300 tons of charcoal which at the -undervalued- official price in 1983 represent 130 millions CFA or 360 000 $) ;

. second the differential between the yield of the project and that of the natural forest which was replaced.

It has been assumed that the best use of Bandia wood production was to transform it into charcoal since that was the object of the project.

For the costs, a distinction has been made between personnel costs and other costs. Personnel costs have been valued at the opportunity cost of labor in the project zone which is a farm area. The income foregone by the workers of the project has therefore been estimated by considering that most of this income is derived from agriculture. The other costs (investment, equipment,operation,overhead...) have been estimated at their real dollar or CFA value.

For the analysis of benefits, two important parameters were varied :

2

. The difference in yield between the planted forest and the natural forest which was removed : the 3rd year evaluation of the project has retained a figure of 1.5 m^3 - 1 m^3 = 0.5 m^3/ha/year ; we have also considered in our calculation a more optimistic figure of 1 m^3/ha/year.

. The economic price of charcoal (75 F/kilo in 1983): this price has been determined by establishing the economic value of the alternative energy sources for household cooking, i.e. butane gas. However since there is clearly a preference factor for charcoal, it has been assumed that Senegalese are prepared to pay a higher price for charcoal than for butane, we have therefore set a second charcoal price hypothesis 33 % higher than the basic one (100 F CFA/kg).

In addition it has been assumed that the price of energy will increase in constant $ at a rate of 2.5 % per year.

Our basic hypothesis takes a yield differential of 0.5 m^3/ha/year and an economic price of charcoal of 75 CFAF in 1983. The 3 other hypothesis are more optimistic and permit a sensitivily analysis for these factors.

The results :

Tables 1 and 2 gives the detail of the computation for the 4 hypothesis retained.

The following table summarizes the results in terms of internal rates of return and net present value.

Table 1 - COSTS AND BENEFITS OF THE BANDIA PROJECT : HYPOTHESIS 1

(Yield differential : 1m^3/ha/year)

$ ' 000	1980* 0	1981* 1	1982* 2	1983 3	1984 4	1985 5	1986 6	1987 7	1988 8	1989 9	1990 10	1991 11	1992 12	1993 13	1994 14	1995 15	1996 16	1997 17	1998 18	1999 19
Investment costs	503.5	503.5																		
Personnel costs	70.0	114.0	122.0	99.7																
Overhead costs	4.5	12.2	8.6	7.0																
Nursery and Plantation	31.9	4.0	24.7	20.2																
Equipment operation	89.4	100.7	144.2	117.9																
Miscellaneous	-	4.4	11.1	9.1																
TOTAL COSTS	699.3	739.7	310.6	253.9	102.0	2.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0
Hectares Planted/Harvested	150	650	755	400			150	650	755	400		150	650	755	400		150	650	755	400
Yields of dry Wood : Hyp. 1 = 0.5 m^3							450	1950	2265	1200		375	1625	1887	1000		375	1625	1887	1000
Tons of charcoal : (1m^3 wood = 720 kg ; 3,3 kg wood per kg charcoal	499	2288	955	595			98	425	494	262		82	355	412	218		82	355	412	218
Hyp 1 A. Price of charcoal 75 FCFA in 1983 per kg + 2.5 %/year	70	71	73	75	77	79	81	83	85	87	89	91	94	96	98	101	103	106	109	111
Hyp. 1 A. Benefits in $'000	*	*	*	124	-	-	22	98	117	63	-	21	93	110	59	-	23	105	125	67
Hyp. 1 A Benefits Minus costs in 1983 $	(629.3)	(601.4)	(108.7)	(129.9)	(102)	(102)	(15)	61	80	26	(37)	(16)	56	73	22	(37)	(14)	68	88	30
Hyp 1 B. Price of charcoal per kg 100 CFAF in 1983 + 2.5 %/year	93	95	98	100	102	105	108	110	113	116	119	122	125	128	131	134	138	141	145	148
Hyp 1 B Benefits in $'000	*	*	*	165	-	-	29	131	160	84	-	28	124	147	79	-	31	140	167	89
Hyp 1 B. Benefits minus costs in 1983 $	(586.1)	(12.2)	(32.4)	(88.9)	(102)	(102)	(8)	94	123	47	(37)	9	87	110	42	(37)	(6)	103	130	52

* See table n° 5

* In current dollars unless otherwise indicated

Table 2 - COSTS A[illegible]TS OF THE BANDIA PROJECT : HYPOTHESIS 2

(Yield differential : 1m^3/ha/year)

$ ' 000	1980* 0	1981* 1	1982* 2	1983 3	1984 4	1985 5	1986 6	1987 7	1988 8	1989 9	1990 10	1991 11	1992 12	1993 13	1994 14	1995 15	1996 16	1997 17	1998 18	1999 19
Investment costs	503.5	503.5																		
Personnel costs	70.0	114.0	122.0	99.7																
Overhead costs	4.5	12.2	8.6	7.0																
Nursery and Plantation	31.9	4.9	24.7	20.2																
Equipment operation	89.4	100.7	144.2	117.9																
Miscellaneous	-	4.4	11.1	9.1																
TOTAL COSTS	699.3	739.7	310.6	253.9	102.0	102.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0
Hectares Planted/Harvested	150	650	755	400			150	650	755	400		150	650	755	400		150	650	755	400
Yields of dry Wood : Hyp. 2 = 1 m^3							900	3900	4530	2400		750	3250	3875	2000		750	3250	3875	2000
Tons of charcoal : (1m^3 wood = 720 kg ; 3,3 kg wood per kg charcoal	499	2288	955	595	-	-	196	851	988	524	-	164	710	824	436	-	164	710	824	436
Hyp 2 A. Price of charcoal 75 FCFA in 1983 per kg + 2.5 %/year	70	71	73	75	77	79	81	83	85	87	89	91	94	96	98	101	103	106	109	111
Hyp. 2 A. Benefits in $'000	*	*	*	124	-	-	44	196	234	126	-	42	186	220	118	-	42	186	220	118
Hyp.2 A Benefits Minus costs in 1983 $	(629.3)	(201.4)	(308.7	(129.9)	(102.0)	(102)	7	159	197	89	(37)	5	149	183	81	(37)	5.	149	183	81
Hyp 2 B. Price of charcoal per kg 100 CFAF in 1983 + 2.5 %/year	93	95	98	100	102	105	108	110	113	116	119	122	125	128	131	134	138	141	145	148
Hyp 2 B Benefits in $'000	*	*	*	165	-	-	59	260	320	168	-	56	148	294	158	-	62	280	334	178
Hyp 2 B. Benefits minus costs in 1983 $	(586.1)	(12.2)	(32.4)	(88.9)	(102)	(102)	22	223	283	131	(37)	19	111	257	121	(37)	25	243	297	141

* See table n° 5

* In current dollars unless otherwise indicated

Table 3

	Yield differential	Economic price of charcoal in 1983	I. R. R. (%)	N. P. V. ($'000)
Hyp 1 A	0.5 m^3	75 CFAF	- 8.98	- 1014
Hyp 1 B	0.5 m^3	100 CFAF	- 2.21	- 601
Hyp 2 A	1 m^3	75 CFAF	- 0.42	- 740
Hyp 2 B	1 m^3	100 CFAF	+ 6.17	- 254

The net present value has been calculated using a discount rate of 10 %*. The IRR is negative in 3 hypothesis out of the four considered in this analysis. (A negative IRR has no meaning on a conceptual point of view, but it visualizes the unprofitability of the project). The net present value is negative in all cases. From an economic point of view, the Bandia project is therefore not profitable.

* A discount rate of 10 % could be considered as low for a project in a developing country. This corresponds however approximately to the present normal discount rate of the Central Bank (10.5 %).

1. COSTS :

1.1. Economic cost of labor for the project :

There are four types of workers on the Bandia project :

- Part time unskilled workers
- Permanent unskilled workers
- Permanent skilled workers
- Administrative staff

For each of these category, the opportunity cost must be computed :

1.1.1. Part time unskilled labor :

The opportunity cost of unskilled labor can be estimated as the income foregone by the worker in his normal activity, in this case farming. It is very difficult to find specific data on income in the project area. Those presented in annex B regarding the budget of a household in the Nguekokh area are probably not directly applicable to the project area itself since it concerns mostly fishermen, whereas on the project zone itself we are dealing with farmers..

In the study "Consumption effect of Agricultural policies : Senegal" by the Center for Research on Economic Development of the University of Michigan, the authors made a detailed analysis of a sample of 3 villages in the Djourbel area. In lack of more adequate information we have assumed that the income in the Djourbel farm family is comparable to that in the project area.

72 households were studied reprensenting 720 people. The average composition of the household was as follows :

Men over 15	: 1.9
Women over 15	: 2.9
Children below 15	: 5.2
Total	10

The average area cultivated was 4.3 hectares per household.

45 % of the farm area was planted in peanuts and 55 % in Millet ; we have assumed that the average yield for millet was 600 kg per hectare and for peanuts 800 kg.
The income derived from these crops by the household in 1982 is (price of peanut : 60 F ; price of millet : 50 F)

4.3 hect x 45 % x 800 kg/h x 60 = 92 880
4.3 hect x 55 ù x 600 kg/h x 50 = 70 950

Total : 163 830 CFAF

If we assume that the work force of a man is 1 while that of a woman is 2/3 of that of a man, and the average work force of children under 15 is 1/3 of that of a man, the total household work force in man equivalent would be :

Men	1.9 x 1	= 1.9
Women	2.9 x 0.67	= 1.9
Children	5.2 x 0.33	= 1.7
Total		5.5

Thus we establish the value of one man unit of labor during the crop season as : 163 830 : 5.5 = 29 800 CFAF

In practice, this income is created during the 3 months of the rainy season, i.e. the period during which the part time workers are hired by the project, therefore the daily income foregone is not the division of the annual income by the total number of days in a year, but a division of annual income by the number of days of the rainy season.

.../...

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Therefore the daily income foregone would be

$$\frac{29\ 800}{90\ \text{days}} = 331\ \text{CFAF}$$

In fact this figure is probably somewhat underestimated since only the income generated by millet and peanuts at official prices have been taken into account.

In reality a) millet is valued during some period of the year at a much higher price than the official one ;

b) groundnut straw is a basic food for cattle and is either sold or utilized for cattle feeding by the farmer generating extra income not taken into account ;

c) farmers are often engaged in miscellaneous activities creating some additional income which is very difficult to measure.

For these reasons, it seems more adequate to increase the above figure by about 20 % and we will consider that the opportunity cost of part time unskilled labor is 400 CFAF per man/day.

1.1.2. Permanent unskilled labor :

If the farmers hired by the project had no alternative but either to be hired by the project or earn their income as farmers the opportunity cost per man/day of permanent unskilled labor should be the annual income foregone by the farmers divided by 365 days. In practice this would underestimate the real income since

- farmers are engaged in miscellaneous activities which give them some additional income.
- At least some of the farmers take advantage of the dry season to go to town and try to work for a few months.

.../...

Given these considerations, it will be assumed that the opportunity cost of permanent unskilled labor is half that of part time unskilled labor, i.e. 200 CFAF/day.

1.1.3. Skilled Labor and administrative staff

The wage rate of skilled labor and administrative staff on the project will be considered as a good approximation of the opportunity cost of that type of worker.

1.1.4. Computation of the economic cost of labor

a) During the plantation years

The following table gives an estimate of the evolution of the average number of workers by qualification during the plantation years.

	1980	1981	1982	1983*
Permanent unskilled	67	60	95	80
Part time unskilled	114	361	350	150
Permanent skilled	12	16	20	20

* Assuming 400 ha will be planted in 1983.

Inflation :	between 1980 and 81	: 8 %
	1981 and 82	: 15 %
and estimate	between 1982 and 83	: 10 %

.../...

If we assume that the opportunity cost of labor varies from one year to the next in the same way as inflation we have the following opportunity costs for 1980 and 1981 and 1983

	1983	1982	1981	1980
Opportunity cost for part time unskilled workers	440	400	348	322
for permanent unskilled workers	220	200	174	161

for permanent skilled worker the wages will be estimated at

55 000 per month in 1983
50 000 " " " 1982
45 000 " " " 1981
40 000 " " " 1980

With this data and the cost of administrative staff given by table D 3 (page 70-71) it is possible to estimate the total economic cost of labor for the 4 planting years.

Table 4
Estimated economic cost of labor for the 4 planting years

(In 1000 CFAF)	1980	1981	1982	1983
Part time unskilled workers	3 304	11 307	12 600	5 940
Permanent unskilled workers	3 937	3 811	6 935	6 424
Permanent skilled workers	5 760	8 640	12 000	13 200
Administrative staff	2 105	6 453	9 099	9 000
Total	15 106	30 211	40 634	34 564
Exchange rate $/CFA	215	265	334	360
Total Cost in 1000 $	70	114	122	96

.../...

b) Cost of labor and maintenance after plantation period :

The maintenance costs for the years 1984 and 1985 have been estimated at 55 millions CFAF. 50 % of the annual maintenance costs represents personnel expenses. If we assume that the economic cost of labor is valued at about 1/3 of the real wage bill for the project, the economic cost of maintenance for years 1984 and 1985 would be 36.7 millions FCFA or $102,000 per year (in 1983 dollars). For the following years maintenance costs have been estimated at 20 millions CFAF per year or $55,600. Using the same assumption as for 1984-85 the yearly economic maintenance costs after 85 should be valued at $37,000.

1.2. Other costs :

The economic value of the project costs other than personnel costs will be considered as best represented by their effective dollar or CFA value.

Table D 23 estimates the total investment costs at $1,007,100.We will assume that this amount has been spent equally during the two first years of the project.

Table D 10 indicates for 1980, 81 and 82 the overhead costs, the Nursery and Plantation costs, the Equipment Operation costs and Miscellaneous costs.

For year 1983, it will be assumed that the overall cost structure will be the same as for 1982 adjusted for area planted. In 1982 the direct plantation costs were $5 0,870. For 1983 the planting costs are estimated at $442,143 (table D 11).

2. BENEFITS :

Two kinds of benefits of the project must be distinguished :

- Before the PARFOL trees were planted, it has been necessary to cut completely all the natural forest existing on the future plantation. Nearly all

the wood was transformed into charcoal. According to the "Direction des Eaux et Forêts", the yields in terms of charcoal have been as follows :

	1980	1981	1982	1983	Total
Charcoal yields	499	2288	955	595	4337

- Once the trees were planted, the benefit of the project is the difference between the yield obtained by the planted trees and that which would have been obtained if the natural forest has not been cut.

2.1. Hypothesis

Several hypothesis have to be chosen for this economic evaluation.

2.1.1. Harvest Rotation schedule :

It will be assumed that the first cut will be made 6 years after plantation, the second one after 5 years and the last one 5 years afterwards. Since plantation was effected on a 4 year period this determine the total life of the project : 20 years.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Planting years	x	x	x	x																
First harvest							x	x	x	x										
Second harvest												x	x	x	x					
Third harvest																	x	x	x	x

In practice, given the low yield, at least in the very first years of the project,it is probable that the first harvest will not be possible before the seventh year after plantation. This would decrease the benefits of the project.

2.1.2. Yields per hectare and per year

As indicated in the evaluation report (page 9) the PARFOB yields are estimated to be around 1.5 m^3/ha/year, while the natural forest yield are estimated at 1 m^3/ha/year. The difference between these two yields i.e. 0.5 m^3/ha/year will be our basic hypothesis for the economic evaluation. (hypothesis 1).

However, we will also retain a more optimistic hypothesis (Hyp. 2) which will assume a difference in yield between planted and natural forest of 1 m^3. Although optimistic this hypothesis can be defended by 2 arguments :

- a yield of 1 m^3 for natural forest might be optimistic : the World Bank in an evaluation of the Kaffrine Project* took an hypothesis of a yield of 0.5 m^3/ha/year for the first ten years and 0.4 m^3/ha/year for the following years.

- Eucalyptus yields are directly related to the amount of rain. For the first 3 years of the project, rains have been abnormally low. We can make the optimistic hypothesis that rains will return to a more normal level.

2.1.3. Economic Value of Charcoal

The existing retail price of charcoal does not represent the real economic value of this product in the Senegalese economy. In official calculations, the wood used to make charcoal is considered more or less as a free good, which does not reflect its increasing scarcity. In addition the official price of charcoal is maintained for political reasons at a low level, although in practice retailers sell at a price higher than the official price.

The economic value of charcoal is not easy to determine since there is no international market for it for the moment. An economist financed by the World Bank is now attached to the "Service des Eaux et Forêts" precisely to

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* Senegal : Projet forestier, Rapport d'Evaluation ; 15 janvier 1981.

determine the economic price of fuel wood and charcoal, by looking at the cost structure. In this analysis, since the results of this study are not yet available, another approach has been followed, looking at the cost of alternative sources of energy.

Charcoal is mostly used for cooking. In recent years, in order to reduce the consumption of wood, the GOS has followed a policy of subsidy of butane gas and introduced a cook stove adapted to the needs of Senegalese families called "Blip Banekh". Despite the subsidy which makes butane less expensive than charcoal, there has not been a sharp increase in the consumption of butane sufficient to have an influence on charcoal consumption. Two reasons explain this fact :

- many Senegalese consider that gas is dangerous, which is true if it is not used properly.

- the taste of food is not the same and the Senegalese have a clear preference for food prepared with charcoal.

If there was no constraints on the prices of these alternative sources of energy, the prices of useful kilocalories produced by both systems should be linked together, and it seems reasonable to assume that the price of useful kilocalories supplied by charcoal would be equal to those supplied by butane. This will determine our basic price hypothesis. However according to a World Bank study on energy problems in Senegal* the difference in the prices for butane and charcoal (using official prices) is to the advantage of butane by a factor of 5 or more.

This means that the taste preference is a very important factor, and consequently we will use a second price hypothesis arbitrarily set 33 % higher than the basic price. The price of energy will change over time and it is expected that the charcoal's value is going to increase, with the increasing scarcity of wood. A yearly increase of 2.5 % will be assumed.

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* Senegal : Problèmes et Choix énergétiques. Janvier 1983.

The following table computes the economic value of charcoal in 1983 with the assumption that the price per useful kilocalories is the same for butane and charcoal sources.

	Unsubsidized[1] Price/kg CFAF	Kilo/Calories /kg	Price per 1000 Kcal.	Thermal efficiency	Price per usefu 1000 Kcal.
Butane	285	10,800	26.48	0.55	48.1
Charcoal	75 ←	7,800 ←	9.6 ←	0.20 ←	48.1

1 The butane unsubsidized price per kilo is based on the price of liquified gas ex refinery plus bottling, distribution costs, m[illegible]n and an estimate of capital cost to take into account the cost of the necessary equipment and the deposit on the bottle itself.

3. INFLATION FACTOR 1980 TO 1983

It was decided to establish all the data in 1983 dollars. The expenses and benefits incured in the 3 first years of the project had therefore to be converted in 1983 dollars. Some of these expenses and benefits have been made in dollars, some others in CFAF. Table 5 details the conversion process from current dollar to 1983 $ and from current CFA to 1983$.

Table 5 : Conversion of current expenses into 1983 dollar

	1980	1981	1982	1983
United States consumer price index (Source International Financial Statistics	100.0	110.4	117.1	119.6 (April)
Conversion factor. Current $ to 1983 $	119.6	108.3	1.021	100
Senegal Inflation rate	8.4 %	8.0%	15 %	10 %
Conversion factor. Current CFA to 1983CFAF	134.6	124.0	115.0	100
Expense in 1000 $ (investment costs)	503.5	503.5		
Converted in 1983 1000 $	602.2	545.3		
Expenses in current CFA/Millions)	42.10	62.59	103.74	
Converted in 1983 CFAF	56.66	77.62	119.30	
Converted in 1983 $ (1 $ = 360 CFAF)	157.4	215.6	331.4	
Benefits in current CFAF (Millions) Hyp A	34.93	162.4	69.7	
Converted in 1983 CFAF	47.02	201.44	80.17	
Converted in 1983 $ (1 $ = 360 CFAF)	130.6	559.5	222.7	
Benefits in current CFAF (Millions) Hyp B	46.41	217.36	93.59	
Converted in 1983 CFAF	62.46	269.53	107.63	
Converted in 1983 $ (1 $ = 360 CFAF)	173.5	748.7	299.0	
Benefits Minus costs Hyp A 1983 $	(629.3)	(201.4)	(108.7)	
Benefits Minus costs Hyp B 1983 $	(586.1)	(12.2)	(32.4)	

9.0 Preliminary Economic Analysis

The internal rate of return of the project has been re-computed on the basis of new values obtained during the three years of experience with the plantation. Also an attempt has been made to assess the economic impact of the wages earned at the plantation which as of the end of 1982 totalled almost 200 million CFA.

9.1 Internal Rate of Return

The internal rate of return used new values, especially the costs of plantation and growth rates, based on the findings of the evaluation. The differences between the values used in the project paper and the values used in the re-computation are presented in Table D-24 .

In the project paper, five sensitivity tests were undertaken: These tests were:

Test 1: Phase 1 costs were decreased by 50% to indicate the normal per hectare cost of fuelwood planting, if the research, T.A. and training imposed by the pilot nature of this project are eliminated.

Test 2: Costs were decreased by 60% to reflect the anticipated per hectare cost of similar fuelwood planting under normal, non-pilot conditions and after experimental trials permit SWF to optimize production techniques.

Test 3: Costs were increased by 10% to reflect inadequate compensation for price escalation over time.

Test 4: Benefits were increased by 20% to reflect better growth in the case of normal rainfall as well as a better market price due to an improved official sale price for fuel.

Test 5: Combined tests 2 and 4.

The results of the analyses for Phase I indicated positive rates of return ranging from 6.4% to 18.1%.

Table D-24. Internal Rate of Return Assumptions

Plantation	Project Paper	3rd year evaluation
surface (has)	3,000	1,550
yield (m^3/ha/year)	10	1.5, 2,3,4
life of plantation	20 years	20 years
rotations (years)	5-4-4 4-3-3-3	6-4-4-5 6-5-5 6-3-3
Costs of establishment		
total costs	$2,985,000	$3,485,323
per ha.	$ 995	$ 2,231
direct costs only		
per ha.	$500, $700	$ 890
maintenance costs/ha	11,560 CFA	6,000 CFA
Price of charcoal/kg FCFA/kg	22	40 100 150

The present analysis of the internal rate of return did not compute losses foregone in the natural forests elsewhere in Senegal (which in the project paper represented substantial quantifiable benefits), instead the net difference in yield between the plantation and the pre-existing natural forest was taken as the plantation output.
Natural forests in the area yield 1.0 m^3/ha/yr.

The initial determination of direct costs at $890 per hectare used by the economist for the IRR has been revised downward, however it did not reflect depreciation of heavy equipment and other fixed investments, which total approximately $1 million dollars. The revised direct cost figure of $809 per hectare is not, however, greatly different from the initial $890 figure. It also does not include depreciation. (To the extent that the GOS has only paid for 27% of the equipment, the depreciation rate is correspondingly less meaningful from the standpoint of this project alone). For the present interim analysis, the sum of $890 per hectare in direct planting costs is retained. As will become apparent, the difference, plus or minus, of even $100 would not greatly alter the outcome of the analysis.

Preliminary calculations of the internal rate of return with the estimated 1.5 m^3/ha/yr yield showed that at the current market price of 40 CFA per kilo of charcoal in Dakar, the IRR is very considerably negative. Therefore, higher yields and prices were tested. Also different plantation harvesting schedules were tested.

New information from CNRF concerning the performance of eucalyptus before the first cut and after it, suggest a variation in the rotations

projected for a 20-year plantation. Instead of a cut after the fourth or fifth year, a longer initial period is indicated (6 years) with possible intervals between subsequent harvests of three, four or five years, as opposed to intervals of only three or four years in the original analysis.

The results of the calculations are shown in Table D-25 . Of the various combinations of productivity, rotations and charcoal prices only three yield a positive rate of return:

Harvest rotation	Yield	CFA/kilo	IRR
6-5-5	3m3	150	1%
6-4-4-5	4m3	150	7%
6-5-5	4m3	150	10%

The evaluation team does not judge that yields of $3m^3$ and $4m^3$ per hectare per year are possible in the present plantation. It is not out of the realm of possibility that charcoal prices will increase by 1986, when the first trees are harvested, and in the years thereafter. However, a real increase to 150 CFA does not seem likely in the foreseeable future. Thus, the present plantation will not re-coup the direct costs and maitenance costs. From the standpoint of the actual money invested by the government of Senegal in the plantation, the rate of return would be much more favorable. It has not been computed, however.

The project paper had anticipated a reduction of plantation establishment costs made possible by research results in cost-cutting measures. To date, no important ways of reducing costs have been found (See section D4), nor do the prospects look encouraging. In any case, it is judged impossible to reduce plantation establishment cost sufficiently to

Table D-25. Internal rate of return at direct cost of $890/ha for 1550 has.

Harvest rotation schedule (year)	Yields/ hectare (m3)	Charcoal price/kilo (CFA)	IRR (%)
6-4-4-5	1.5	40	-35
6-4-4-5	1.5	100	-27
6-4-4-5	1.5	150	-22
6-5-5	1.5	40	-34
6-5-5	1.5	100	-25
6-5-5	1.5	150	-20
6-3-3	1.5	40	-38
6-3-3	1.5	100	-29
6-3-3	1.5	150	-25
6-4-4-5	2	40	-29
6-4-4-5	2	100	-19
6-4-4-5	2	150	-13
6-5-5	2	40	-27
6-5-5	2	100	-16
6-5-5	2	150	-11
6-3-3	2	40	-32
6-3-3	2	100	-26
6-3-3	2	150	-16
6-4-4-5	3	40	-22
6-4-4-5	3	100	- 9
6-4-4-5	3	150	- 2
6-5-5	3	40	-19
6-5-5	3	100	- 6
6-5-5	3	150	+ 1
6-3-3	3	40	-24
6-3-3	3	100	-12
6-3-3	3	150	- 5
6-4-4-5	4	40	-16
6-4-4-5	4	100	- 4
6-4-4-5	4	150	+ 7
6-5-5	4	40	-14
6-5-5	4	100	+ 1
6-5-5	4	150	+10
6-3-3	4	40	-19
6-3-3	4	100	- 5
6-3-3	4	150	+ 4

compensate for the great difference in yields expected in the project paper and those likely to be achieved.

In terms of the implications for similar projects in the future, it is clear that these should be located in higher rainfall zones, where yields will be proportionately greater, making it worthwhile to expend future effort to achieve better organized and cheaper fuelwood plantations.

9 8.2 Economic Impact of Salaries Paid

Total salaries paid to plantation workers and administrative staff have been 200.000,000 CFA during the three years of the project. An attempt was made to evaluate the impact of this amount of money on the local and national economy. The factors taken into account included the geographical distribution of the plantation workforce, the relative importance of the payroll relative to the regional economy, and the multiplier effect of the money earned at PARFOB when it is spent. The detailed computations and descriptions of the various assumptions are presented in Annex C .

In the arrondissement of Nguekokh, Department of Mbour (region of Thiès), in which the project is located, are located most of the villages where permanent or temporary plantation workers reside. The plantation workforce varies according to the seasons, however, it is estimated that PARFOB's workers represent about 5% of the salaried population of Nguekokh Arrondissement. During the 1982 planting season, the 560 workers employed during August and September, 1982, represented 5% of the total active male population in the arrondissement. The 100 million FCFA injected by the project into the local economy in 1982 represented 3% of the total

income, monetary and non-monetary (which is calculated to be 50,000 FCFA per person).

The multiplier effect of this money at the local level is expressed largely through consumed products sold by local merchants. At the local level, it is estimated to be 1.36. At the national level it is much greater: 3.39. The important multiplier effect of the salaries paid is largely a consequence of the fact that the lower income worker spends virtually all of his income on food and other goods, and does not save. The propensity to consume has been measured at 94%.

In conclusion, the analysis confirms the fairly self-evident importance of the income spent locally. But it also points up the very considerable benefit of this income to the national economy, which was not considered in the project paper.

10.0 Energy Analysis

One of the expected benefits of the project was that of conserving foreign exchange that would be spent on energy imports. An energy input/output analysis of the project was made to test this idea, as well as to know what the returns on "energy" investment would be. The analysis, presented in Annex C, compares inputs in the form of diesel and gasoline fuel consumed during plantation establishment and maintenance to expected outputs in the form of fuelwood and charcoal, by converting these into common energy units (Gigajoules).

The energy output obtained at a yield of 1.5 m^3/ha/year is 160% of the energy inputs. If the energy output is equated to butane gas, it is equivalent to 1,125.9 tonnes. If the money spent on the diesel and gasoline fuel during the plantation's life were instead employed to purchase butane gas (at 130,000 CFA/tonne), 950 tonnes could be purchased, or an amount equal to 84% of the expected plantation output.

Energy inputs were computed on the basis of observed fuel consumption during Nov. 1981 to Nov. 1982. Diesel fuel was consumed at the rate of 145 liters per hectare established and 12 liters per hectare maintained (weeded by disk harrowing). Gasoline for supp[illegible] vehicles is consumed at the rate of 4,680 liters per year. Maintenance of the plantation was assumed to be continuous throughout each year of the plantation life, and six year rotations were assumed for a 20 year plantation life, using the surfaces of the present plantation of 1,550 hectares (150 ha.in 1980, 650 in 1981, and 750 in 1982) plus an estimated additional 300 has.in 1983.

Total energy inputs would be equivalent to 31,812.5 Gigajoules (GJ), representing 215,280 liters of gasoline and 690,000 liters of diesel.

Energy outputs assumed a yield per hectare per year of 1.5 m^3 harvested on a six year rotation. Total wood harvested during the life of the plantation would be 8,325 cubic meters of solid wood. Depending upon the amount of the total converted to charcoal, the energy equivalent of this harvest ranges from 54,196 GJ to 50,524 GJ, the lesser amount corresponding to the complete conversion to charcoal.

The net energy equivalents of air dried wood and charcoal were taken to be 9.3 GJ/Tonne and 28.9 GJ/Tonne respectively. The yield of charcoal from one cubic meter of solid wood was assumed to be 2.1 quintals (210 kgs). This is approximately 50% greater than the amounts achieved by traditional methods (which yield 20% of the air dried weight).

The butane gas equivalent of the plantation's production, assuming 90% conversion to charcoal, would be 1,125.9 Tonnes. A costs comparison of the diesel and gasoline inputs with the outputs expressed as butane gas (at 130,000 FCFA/tonne), indicates that for the same investment in foreign exchange used to buy gasoline and diesel an amount of butane gas equal in energy value to 84% of the plantation's production could be purchased. (950 tonnes could be purchased; 1,125.9 tonnes would be produced).

This limited analysis points up the need for a broader economic analysis of the project than has been accomplished in the present evaluation. Certainly, it raises an important issue concerning the appropriateness of energy-intensive production methods of fuelwood plantation operations.

Similarly, the emphasis on energy production may be misplaced or excessive, given the wider employment and environmental benefits, which have so far not been rigorously analysed.

Table D-26 . Diesel and Gasoline Consumption, Nov. '81 - Nov. '82 by operation

A. Diesel

Fuel consumed by two D-6's, one D-7, two 78hp Massey Ferguson four-wheel drive tractors, and eight 65 hp Massey Ferguson two-wheel drive tractors.

	Liters	
1. Land preparation 750 has.		93,678
Clearing - (défrichement)	26,926	
Brush removal - (ratissage)	17,525	
Sub-soiling (3-teeth) - (sou-soulage)	29,622	
Disk-harrowing (pulvérisation)	7,617	
Sub-soiling (1-tooth)	11,358	
Fire-breaks (pare-feux)	400	
Tree removal (déboisement)	230	
2. Plantation establishment 750 has.		10,491
Nursery (transport sand and loam earth,plants)	1,424	
Transport of plants to compartments	2,121	
Watering plants in compartments prior to planting	1,440	
Transport of pesticides	325	
Transport of personnel	5,181	
3. Weeding 1,550 has.		18,618
4. Miscellaneous		1,720
Diesel Total		124,507 liters

B. Gasoline

Consumed by three support pick-ups, air compressor and mobylettes

Gasoline Total	10,418 liters

E. RECOMMENDATIONS

Recommendations have been formulated by the evaluation team for the PARFOB project and for fuelwood plantation assistance in general. These recommendations are addressed to USAID specifically, however, they should also be useful to the Government of Senegal.

The authorship and the responsibility for the recommendations rest entirely with the evaluation team. Their appearance in the present review draft does not necessarily represent endorsement or approval by the AID mission.

1.0 The Senegal Fuelwood Production Project

The foremost reason for undertaking the evaluation was to determine whether the project should be continued into a second phase in which an additional 3,000 hectares would be planted. The first set of recommendations addresses this question. A second set is presented with respect to the PARFOB operation, itself.

1.1 Recommendations regarding a possible Phase II

The evaluation team finds no justification for continuing the project into a second phase. Rainfall and growth are too low in the Bandia Classified Forest. The team therefore recommends that AID not finance a Phase II in the Bandia Classified Forest.

Other forests to the south of Kaolack in higher rainfall zones were briefly examined by the team. They are too far away to be eligible as a second phase of the project. In practical terms a second phase should employ the same plantation infrastructure and labor force in order to capitalize on the investment and experience of Phase I.

1.2 Recommendations regarding Phase I PARFOB Plantation

Notwithstanding the viscissitudes of climate, financing, and management, the evaluation team found evidence that experience was being gained in the pilot project, and that as such it constitutes a valuable trial. Also, given that planning and actions preparatory to the 1983 season were well along, the team was virtually unanimous in concluding that plantation work should proceed to the end of the project (Dec. 1983). Only the economist disagreed, citing the poor financial return on the investment as sufficient reason to halt the project straightaway. No alternative possibilities with similar goals exist, however. The evaluation team also proposes that the existing plantation be maintained with a minimum of support until harvests begin, and on the basis of a rational management plan. Certain research projects should be concluded also.

The following specific recommendations are made in these respects:

(1) Plantation establishment

Carry out plantation establishment in 1983.

(2) Plantation maintenance

Provide financial support for the maintenance of the plantation until the end of 1986. This would ensure follow-up maintenance until the first major harvest (of trees planted in 1981), at which time plantation revenues could in theory cover costs, directly or indirectly. Level of support: 11 million FCFA/year, or 33 million FCFA total. This financial support would be used exclusively for supplying diesel and gasoline to run the project equipment.

(3) Research support

Continue financial support for selected research activities which are beginning to yield useful results, namely (a) the inventory and trials with various species in different climatic and soils combinations in Senegal, (b) the study of soils changes under Eucalyptus plantations, and (c) the water balance study in the plantation. It is proposed that this support be extended to the end of 1986. Approximate level of support is 10 million FCFA per year, totalling 30 million FCFA.

It has been planned that this support would be provided through the Title III program, Phase I of which is currently being extended for a one year period. Phase II is to begin after 1984.

(4) Technical assistance

Preparation of a management plan for the Bandia Forest, including the remaining natural forest as well as the plantation. The present American co-director should assist in the elaboration of the management plan. The plan would embrace aspects such as weeding, fire protection, protection from animals, nursery operation, organization and maintenance of equipment, and development of a system of routine record-keeping.

Since the present American co-director's contract runs to the end of May, 1984, there should be time after the 1983 planting season to prepare the management plan. No additional financing for this aspect of technical assistance would be needed.

Economic analysis of the PARFOB plantation. This analysis should be undertaken in order to more completely and rigorously examine the various direct and indirect costs and benefits of this particular

plantation. It is proposed that TDY assistance from economists in AID/Washington, REDSO/WA, and/or the SDPT be enlisted.

(5) The PARFOB operation

Numerous specific recommendations and ideas for improving the project were advanced by different members of the team. These are being presented in a separate communication directed to the SEEF and the director of PARFOB. A copy of the communication is presented as Annex D, of this evaluation.

2.0 Assistance to Fuelwood Production

This evaluation took place against the backdrop of the Plan Directeur de Développement Forestier du Sénégal, whose strategies include very ambitious goals for providing urban populations with fuelwood and charcoal by means of many plantations such as PARFOB.

2.1 The Plan Directeur de Développement Forestier

Among the various strategies for forestry development proposed in the Plan Directeur's 2nd volume (in reality a series of 7 reports) is a "projet type", or approach, termed "Reboisement des Forêts Dominales dans l'Ouest du Sénégal" also termed "Programmes Forêts Périurbaines". This type of project would concentrate on supplying the population of Dakar with charcoal from plantations established on the national forests which are closest to Dakar. It is stated in the plan that many of these forests are degraded and not productive at present. Candidate forests presented in the document include the forests of Thiès, Pout and Bandia. However, the Thiès and Pout forests (which are north of Bandia) are considered ineligible for plantations.

The Plan finds the Bandia forest to be the only one suitable for plantation work, notes the existence of the PARFOB project, and remarks as follows:

> "La mise en place d'un tel projet dès 1980 peut paraître prématurée car il est très tôt pour que les résultats définitifs des essais expérimentaux de la recherche soient solidement établis. Néanmoins, on a admis que l'urgence du problème et l'aspect pilote du projet peuvent justifier cette entreprise.
>
> Si des échecs intervenaient, il viendrait des sols et de la pluviométrie et non de la technique qui ne demande qu'à être serrée de plus près, et ces échecs seraient probablement partiel et cantonnés".
>
> "Il ne reste donc au Plan Directeur qu'à assimiler ce projet USAID/Sénégal et en faire son projet-type dans la région, puisque ce sera vraisemblablement le seul, en lui apportant éventuellement les modifications voulues".

The presentiment that the project would not be as successful as hoped has, of course, been borne out by this evaluation.

2.2 Recommendations concerning support to Fuelwood Production

A number of recommendations are made in order to orient future AID support for activities actions that would share the two major goals of the Senegal Fuelwood Production project, namely (1) increased fuelwood production and (2) reduction of fuelwood cutting pressures on forest resources, leading to environmental deterioration.

(1) Natural forest management

It is recommended that natural forest management be supported for the national forests in the Thiès and Sine-Saloum regions. This type of activity is identified in the Plan Directeur as project type A-2 ("Délimitation, inventaire et aménagement de forêts dominales et forêts de collectivités rurales dans le Sénégal Oriental et le Sine-Saloum").

TABLE E-1

NATIONAL FORESTS BETWEEN 800 MM ISOHYET AND GAMBIA (EXCLUDING SENEGAL ORIENTAL)

Végétation et utilisation des Sols
(hectares)

Nom de la Forêt	Forêts claires ou savanes boisées	Savanes Arborées	Steppes Arbustives	Zones Agricoles	Zones Urbanisées ou infertiles	Totaux
NIANING		2200	100	7000		6000
JOAL			2200			2200
BALLABOUGOU		900	200	100		1200
SAMBA		600		400		1000
SANGHAKO	1400			700		2100
FATAKO		1400		3300	600	5300
BARIA		2100		3200		5300
VELOR		4900		600		5500
FATHALA	3500			100		3600
DJILOR		1200		100		1300
SAMBOYA	1100			700	600	2400
MAMBY		1200		200		1400
PANE		1100		100		1200
NGAYENE		1000		1400		2400
TOTAL	6000	16600	2500	11600	1200	37900

Source: Plan Directeur du Développement Forestier, 1982.

The evaluation team concludes that much more needs to be known about the natural forests of these regions, including species composition, volume, species response to fire, grazing and different types and intensities of harvest, propagation and regeneration methods, present and potential uses, and the economic values of the various forest products. A management plan would include the acquisition of this information. As a logical extension of the Senegal Fuelwood Production project, work could be supported in the Thiès, Pout and Bandia forests.

(2) Large Scale Plantations

It appears that large scale plantations to supply Dakar with fuelwood would be feasible in the Sine-Saloum region, or south of the 800 mm isohyet found on most rainfall maps of Senegal, which show rainfall averages for the period 1930-1961. Casamance is more humid, but distances and haulage much greater.

The preparation of assistance for such plantation establishment should include soils surveys at a level of detail sufficient to locate and quantify the surfaces suited to plantation forestry. Rainfall and present uses should also be determined.

As regards scale of operation, the team recommends that no more than 500 hectares be planted per year and that in the first year only one half this much be planted.

2.3 Recommendations concerning AID assistance to the forestry sector

The evaluation team recognizes that substantial assistance to the forestry sector is being provided in AID's present portfolio of projects.

It appears to the evaluation team that lack of basic knowledge is a key constraint to development of the forestry sector. With that in mind it is recommended AID increase support to CNRF's research programs.

Reducing demand seems to have greater impact than continuously increasing production. It is recommended AID increase its already substantial role in promoting biomass conserving technologies.

Follow-up analysis of the great body of information assembled in the many volumes of the Plan Directeur could probably benefit from AID support. AID should urge CDA to call a technical meeting to review technical information in Volume I, the "diagnostique". One means of digesting this information would be through the incorporation into the computerized model for analysis of fuelwood supply and demand prepared for the various Sahelian countries by Henry Cole, and now being presented through CILSS to the various governments. AID should encourage the perfection of the Senegal model using data from the Plan Directeur.

Knowledge is useless unless it is shared. It is recommended AID increase its role in assisting the Senegalese government in public information and education. This would include promoting wood-conserving technologies, explaining government policies, and creating an environmental awareness.

Lack of trained manpower at all levels of Eaux et Forêts is continuously cited as a key constraint to management of Senegal's natural resources. The "Plan Directeur" discusses the need but does not seem to propose a solution. AID should consider more support for both long and short-term training. Properly conceived the impact can be great.

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ANNEXE A

PROJET DE PRODUCTION DE BOIS DE CHAUFFE AU SENEGAL (685-0219) AID 1025-3 (7-71)

MATRICE DU CADRE LOGIQUE

SOMMAIRE	INDICATEURS OBJECTIVEMENT CONTROLABLES	HYPOTHESES IMPORTANTES
A.1. BUT	A.2. DETERMINATION DE LA REALISATION DU BUT	A.3. (COMME ELLES SE RAPPORTENT AU BUT)
a) Arrêter/inverser la dégradation de l'environnement causée par l'insuffisance de la couverture forestière	a) Réduction du taux de dégradation des ressources naturelles dans les régions où la couverture forestière a été mince ou dimunie rapidement à cause des activités de bois de chauffe (réduction du compactage du sol, ruissellement et érosion éolienne).	a) L'aménagement de la couverture forestière constitue un but important dans le développement de la qualité de l'environnement au Sénégal.
b) Stabiliser/accroître la production nationale de bois de chauffe et réduire la sensibilité des forêts nationales à la sécheresse et aux variations climatiques.	b) Couverture végétale améliorée dans les zones de production traditionnelle de bois de chauffe c) Quantité plus importante de bois de chauffe produit dans des régions plus rapprochées des centres de population.	b) Le bois de chauffe continuera à être la principale source d'énergie domestique au Sénégal dans un avenir prévisible. c) Une production rentable de bois de chauffe est et restera une haute priorité du gouvernement du Sénégal.
B.1. OBJECTIFS	B.2. SITUATION EN FIN DE PROJET	B.3. (COMME ELLES SE RAPPORTENT AUX OBJECTIFS)
a) Améliorer le rendement de la production de bois de chauffe pour Dakar/Thiès et aider à stabiliser les variations saisonnières de l'offre et des prix	a) Projet de production de bois de chauffe sous contrôle Sénégalais et formation globale achevée. b) Ralentissement de la disparition de la couverture forestière de l'intérieur.	a) Le Service des Eaux & Forêts et le Gouvernement du Sénégal fourniront une orientation de politique, un soutien budgétaire et une coordination suffisants pour permettre au concept du projet d'être élargi ailleurs.

b) Fournir des emplois, améliorer l'environnement général et les recettes des bucherons et des villageois locaux de la Région de Thiès. c) Réduire la pression sur la coupe des forêts de l'intérieur	c) Régulisation des flux mensuels de bois de chauffe à destination de Dakar et stabilisation dans le temps des prix du bois de chauffe plus rapprochés des prix officiels. d) Climat modéré, eau améliorée au voisinage de la plantation, taux de chômage moins important sur le plan local.	b) Des méthodes techniques et économiques appropriées de production de bois de chauffe seront mises au point de façon à permettre une approbation, et des initiatives privées sur une vaste échelle.
C.1. EXTRANTS a) Production couronnée de succès de 3000 ha d'essences à croissance rapide pour produire 6% des besoins de bois de chauffe en vue de la demande locale. b) Formation des employés du Service des Eaux & Forêts pour gérer et élaborer des projets de bois de chauffe. c) Mise au point d'un système de production transposable de bois de chauffe.	C.2. INDICATEURS D'EXTRANTS a) 3000 ha à un rendement de $10m^3$/ha/an pour l'eucalyptus et de $6m^3$/Ha/an pour toutes les autres essences correctement transformés en bois de chauffe et commercialisés. b) Production globale de 700.000 semis par an c) 5 forestiers professionnels et 40 adjoints forestiers semi-qualifiés. d) Système de production de bois de chauffe justifié au plan économique et financier, utilisant un maximum de main-d'oeuvre et de matériel locaux.	C.3. (COMME ELLES SE RAPPORTENT AUX EXTRANTS) a) La récolte par secteur privé et la transformation du bois de chauffe seront convenablement entreprises. b) La demande de bois de chauffe n'augmente pas plus vite que prévu.
D.1. INTRANTS a) Assistance Technique. b) Formation (sur place et à l'étranger) c) Recherche. d) Enquêtes pédologiques.	D.2. BUDGET/PROGRAMME D'EXECUTION a) Spécialiste de gestion forestière pour 48 Hommes-mois = 400.000 Dollars. 10 Hommes-mois de conseils en gestion de courte durée = 100.000 Dollars Un volontaire du Corps de la Paix pour 48 hommes-mois = 40.000 Dollars. b) Formation à l'étranger et sur place=165.000 Dols c) Recherche (Forêt de Bandia et 11 autres sites= 238.000 Dollars d) Enquêtes pédologiques = 25.000 Dollars.	D.3. (COMME ELLES SE RAPPORTENT AUX INTRANTS) a) Le Gouvernement du Sénégal procédera au recrutement et à l'affectation de personnel compétent au projet. b) Le chef d'équipe américain et les responsables du Gouvernement du Sénégal peuvent choisir des candidats compétents et prendre les mesures en vue d'un programme approprié de formation. c) Des fournitures, du matériel et de l'équipement en quantité suffisante peuvent être prévus, achetés et livrés au site du projet en temps opportun.

Annex B

Impact of the Salaries Paid by the Project on the Local Economy

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February, 1983

Impact of the salaries paid by the project on the local economy

1) Geographical distribution of the workers around the project

a - Permanent workers:

At the beginning of October the project was employing 151 persons with the following geographical distribution:

	Number of workers	Distances from Bandia
MBour department	89	
of which:		
Bandia	64	0
Nguekokh	9	12
Samkhethe	2	6
Diasse	2	8
Mbour	3	
Sindia	6	4
Thiki	2	6,5
Keniabourg	1	8
Thies Department	49	
Fleuve area	7	
Cap Vert	1	
Sine-Saloum	3	
Other	2	
TOTAL	151	

59% of the permanent workers are from the department of M'Bour, and 91% originate from the region of Thies.

b - Part time workers

For the last growing season, running from the 29th of July to the 20th of October 1982, the geographical distribution of part time workers was as follows:

	Number of workers	Distances from Bandia
MBour Department	257	
of which:		
Bandia	109	
Nguekokh	22	12
Samkhethe	20	6
Diasse	18	8
Sindia	44	4
Thiki	12	6,5
Mbagmakh	6	10
Diogoye	9	12
Toglou Serere	5	14
Rafa	5	8
Dague	4	10
Others	3	
Other Departments	153	
TOTAL	410	

63% of the part time workers are from the Mbour Department.

Of the total of permanent and part time workers 172 workers or 31% come from the village of Bandia itself and 346 or 62% are from the M'Bour Department.

The benefits of the project in terms of salaries are therefore concentrated in the region of the project in particular for the permanent workers.

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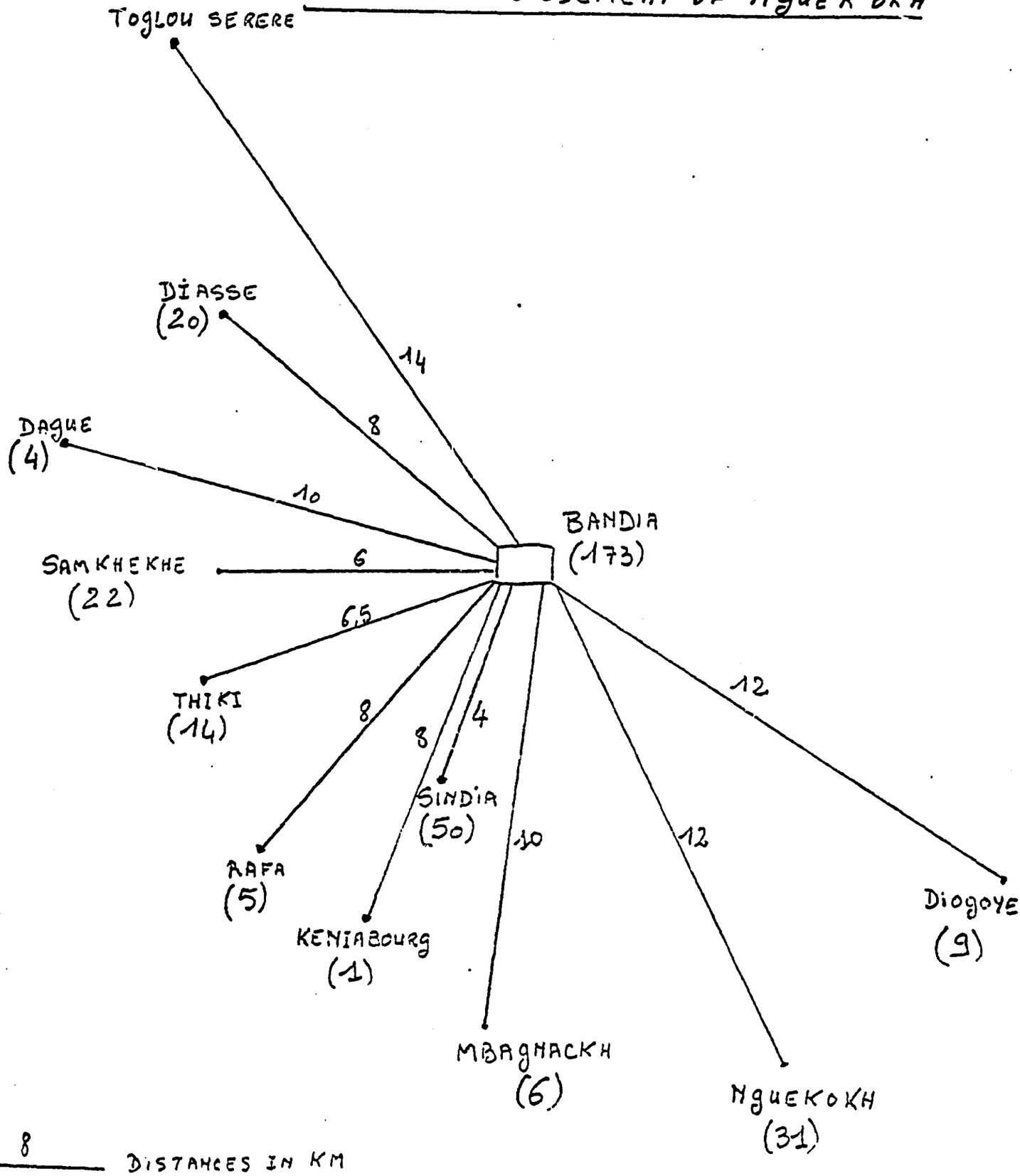
GEOGRAPHICAL DISTRIBUTION OF THE WORKERS IN THE ARRONDISSEMENT OF NGUEKOKH



8 DISTANCES IN KM

(20) NUMBER OF WORKERS PER VILLAGE

2) Evolution of the number of workers, and of the wage bill

The following table gives an idea of the evolution of the number of workers and the monthly and yearly wage bill from 1980 to 1982.

	Sept.1980	Dec. 1980	Aug.1981	Dec. 1981	Aug.1982	Nov.1982
Number of workers	193	79	437	76	567	164
Monthly wage bill	4,840,000	2,250,000	9,845,000	3,535,000	19,709,000	6,185,000
Yearly wage bill						

3) Distribution of the permanent workers by professional categories and wages

November 1982

Category	Number of workers	Monthly salary FCFA
1st	81	30550
2nd	33	33400
3rd	15	35700
4th	16	39000
5th	1	42000
6th	1	47900
Tractor drivers		
A1	6	45000
A2	2	46000
C1	4	47000
C2	2	51000
D2	3	54000
TOTAL	164	

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The monthly salary indicated here is computed in the following way:

		For the 1st category
Rate per hour X No.of hours/month		133,34 X 208 = 27735
Less	Social Security	888
	Retirement scheme	600
	Taxe on wages	-
Plus	Transportation allowance	4300
		30547

It represents the real amount received by the workers.

Nearly 50% of the workforce is unskilled (1st category) and all of the part time workers are also unskilled. This explains why such a large part of the workers are from very nearby villages: since no specific skills are necessary the project hires in priority people from the area.

4) Weight of the project in the regional economy

Data on the economic situation in the region of Thies, and in the department of M'Bour, and even more in the arrondissement of Nguekokh, where the project is located, are almost non existant or outdated.

The last census dates back to 1976; the general data on population have been updated, but more specific information like the distribution of population by age group or by type of occupation has not. Information on income, and its uses is very scarce. The last budget consumption survey in Senegal was published in 1975.

Only partial information is available in studies made here and there.

Therefore the quality of the data used in the following analysis is far from good.

a) Impact of the project

- In terms of population:

The 1981 population of the arrondissement of Nguekokh is 61250.

The male population is approximately 29900. The male population between 20 and 60 can be estimated at 11000 (assuming that the age structure is similar at the Thies region level - where we have updated figures - and at the arrondissement level).

The 560 workers of the project represent 5% of the male active population of the arrondissement.

The salaried population of the arrondissement is approximately 3000 people.

Therefore the 160 permanent workers of PARFOB represent a little over 5% of the salaried population of the area.

- In terms of income:

The average income per inhabitant in Nguekokh area, monetary and non monetary, can be estimated at 50000 FCFA (Based on an income and consumption study made by students of the Ecole Nationale d'Economie Appliquee - ENEA - in the area of Nguekokh); given the population of the arrondissement the total income, monetary and non monetary, generated in the area is over 3000 Millions FCFA. The 100 Millions FCFA injected by the project in the local economy represent therefore over 3% of the total regional income.

TABLE 1

Budget of a "Carre" (household) in Nguekokh - 1982 FCFA

* * *

Receipts	Monetary	Non Mon.	Total	% of Total
ricultural Products		32500	32500	6,18
ing	301000		301000	57,21
ut Picking		9000	9000	1,72
Income				
ell of smoked fish)	84000		84000	15,96
ifts and peanuts)	52500	43000	95500	18,13
ursement of loans	4200		4200	0,80
	441700	84500	526500	100,00

Expenditures	Monetary	Non Mon.	Total	% of Total
Current Food-Expenditures: Rice	255700	104800	360500	68,5
Oil	58500	--		
Fresh fish	63300			
Bread	9000	48900		
Tomato paste	28000			
Millet	18800			
Others	-	36200		
	78100	19600		
Exceptional food expenditures, of which -sheep	31500	700	32200	6,1
	20000			
Clothing	12800		12800	2,4
Lodging	33800		33800	6,4
Health	13700		13700	2,6
Transport	3400		3400	0,6
Leisure	4300		4300	0,8
Other (light & heat)	33800	2200	36000	6,8
Reimbursement of debts	4200		4200	0,8
Gifts	12700		12700	2,4
BALANCE	12600		12600	2,4
	418500	107700	526200	100,00

Source: Rapport de Stage - Ecole Nationale d'Economie Appliquee, DAKAR.

b) <u>The multiplier effect</u>

The idea here is to estimate how the money injected by the project in the local economy, benefits the population of the areas.
It is therefore necessary to know how the project workers spend their income. The ideal approach would have been to undertake a survey asking the PARFOB workers what they buy with their money and to whom; within the time available for this study this was not feasible, and consequently an alternative approach had to be found.

It has been possible to find data on budget and consumption patterns of a sample of households in the area of Nguekokh (ENEA study mentioned above), a household being composed on the average of 10 persons.
Table 1 below gives the detail of a typical budget : Income is derived mostly from fishing, but some agricultural work and fruit picking is also undertaken; most of the household expenditures go into consumption, savings and investment are almost non existant.

In order to compute the multiplier effect on local income, we will assume that the pattern of expenditures of the"project workers" households is similar to "non project" households of the area, as proposed in table 1.
This is the only possible if we accept two underlying assumptions:

The first one concerns the opportunity cost for the household to have one of its members working on the project.
In other words, does the fact that a member of the household works in the project reduce the "non project" income of the household?

It would seem that if there is an opportunity cost, it is a very small one Indeed most of the workers concerned by PARFOB work part time, and although the tree planting season coincides with that for millet and peanuts, the surfaces sowed are not significantly reduced by the employment of one member of the household in the project, with the other members of the household spliting among themselves the additional work involved.

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For full time workers, the case is not so clear, but empirical evidence seems to indicate that the worker will just work harder during the planting season, rather than reduce the surfaces planted which are considered vital to the household.

The second assumption relates to the variation of the marginal propensity to consume of project and non project households. It would seem that the M.P.C. does not change in the income bracket we are considering:
Given the structure of the extended family in Senegal it can be assumed that the additional income derived from the project is not spent by the worker for the satisfaction of his own needs, but for the satisfaction of the household needs.
Therefore the increase in income must really be divided by the number of people in the household. If the extra income derived from the project is 400,000 FCFA per year and with 10 people per household the increase in income is 40000 FCFA per person. If we consider that the average income per capita outside the project is 50000 FCFA, the income bracket we are dealing with is 50000 to 90000 CFA or between $150 and $265 per year (at $1 = 340 FCFA). i.e. a very low income (GNP per capita was around $400 in 1981).

It seems intuitively normal, and this point of view is confirmed by several Senegalese economists, that at such a low level of income, almost everything goes into consumption.
It is only at a much higher income level that real savings appear.

Under these conditions, we can assume that at least the percentage of income spent in consumption is similar for project and non project households of the area.
Table 1 indicates that, apart from reimbursement of debts, gifts and what is called balance, i.e. cash in hand, all the other items can be considered as consumption given a broad definition. Lodging expenditures for example are in fact repairs of the house such as new iron sheets for the roof.
Therefore 94% of the total income of the household goes into "consumption" This money is spent and benefit local merchants.

The average margin of these merchants can be established around 30%, the rest goes to pay the wholesalers in Dakar or Thies, outside of the area we are concerned with.
The merchants themselves spent a part of their income in the area.
We can assume that 50% of the merchant's income generated by the project go to the other local merchants and 20% to the local farmers or fishermen.
The process repeats itself then:
merchants spent 50% of their income which benefits other merchants and 20% to farmers ;
94% of farmers income goes to consumption of products sold by local merchants, who get a 30% margin, etc..
This multiplier effect of the income generated by the project computed on the basis of these assumptions is equal to 1.36.

In 1982 the overall wage bill distributed by the project was around 100 Millions FCFA, which has generated 36 Millions of additional income in the arrondissement of Nguekokh.

This can be compared with the multiplier effect at the national level which can be computed in the following way:

$$\frac{1}{1-C \times (1-m)}$$

where C is the marginal propensity to consume 94%
m is the import content of the goods consumed.
we can assume a figure of 25% for m.

The multiplier is then $\frac{1}{1 - 0,94 \times 0,75} = 3.39$

The income effect of the project is clearly more important at the national level that at the local one.

Annex C

ENERGY ANALYSIS
OF THE SENEGAL FUELWOOD PRODUCTION PROJECT

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April, 1983

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Introduction

This energy analysis of the Bandia Fuelwood Project, was prepared under the direction of the Environmental Advisor of USAID/Dakar. It addresses the following questions:

- What is the ratio of the usable energy of project inputs to project outputs (hereafter referred to as "energy output:input") ?
- How much butane gas provides an amount of energy equal to the output of the project ?
- Assuming constant real prices, how does the cost of this amount of butane gas compare to the cost of the project energy inputs ?

"Energy output:input" is not, in itself, a sufficient (or perhaps even relevant) criterion for project decision-making. Although this analysis provides useful information, it should not be considered a substitute for rigorous and theoretically sound economic analysis. At the least, the present report provides a compilation of data which may be useful in an economic re-evaluation of the project.

Energy Inputs

Only energy as fuel was calculated. The estimates for the rates of diesel fuel consumption in liters per hectare-year for plantation establishment and plantation maintenance are based on the observed 1982 rates:

Plantation establishment: 145.0 liters/hectare-year

Plantation maintenance: 12.0 liters/hectare-year

Plantation establishment entails land preparation, planting, firebreak construction and weeding (first year).

These operations have been performed with the following equipment:

- Two D-6 Caterpillar tractor
- One D-7 Caterpillar tractor
- Ten Massey Ferguson tractors

Plantation maintenance includes firebreak maintenance and weeding. Maintenance will probably employ one D-6 tractor and four or five Massey-Ferguson tractors.

The estimate for the rate of gasoline consumption in liters per hectare-year for field operations is based on the observed 1982 rate:

(15.0 liters/pick-up-workday) X (312 workdays/year)

= 4680.0 liters/pick-up-year

Since the Bandia tract was converted to plantation growth, no harvests have occurred. Energy input consumption data for harvesting is therefore unavailable and had to be disregarded in the present calculation.

It is assumed that the plots will be maintained up to and during the season in which they are to be harvested.

The heat content of materials are calculated in terms of new values. Net heat content values are taken directly or derived from figures compiled by Energy/Development International (E/DI).

The energy equivalent of gasoline in gigajoules (GJ) per liter is taken to be:

(5.2 GJ/Barrel) X (1 Barrel/159 liters)

$= 3.27 \times 10^{-2}$ GJ/liter

The energy equivalent of diesel fuel in GJ per liter is taken to be:

(5.7 GJ/Barrel) X (1 Barrel/159 liters)

$= 3.59 \times 10^{-2}$ GJ/liter

Table 1 presents a compilation of the energy inputs that would be consumed during the life of the project. The total energy inputs thus calculated would be :

Gasoline: (215280 liters) X (3.27×10^{-2} GJ/liter)

= 7039.7 GJ

Diesel fuel: (690050 liters) X (3.59×10^{-2} GJ/liter)

= 24772.8 GJ

Total energy equivalent of inputs: <u>31812.5 GJ</u>

Table 1 Energy inputs consumed during the life of the Bandia Fuelwood Project.

Year	Plant (ha)	Maintain (ha)	Harvest (ha)	Pickups Operated	Gasoline Consumption (liters)	Diesel Consumption (liters) Plantation Establishment	Plantation Maintenance	Total
1980	150	150	-	1	4680	21750	1800	23550
1981	650	800	-	3	14040	94250	9600	103850
1982	750	1550	-	3	14040	108750	18600	127350
1983	300*	1850	-	3	14040	43500	22200	65700
1984	-	1850	-	2	9360	-	22200	22200
1985	-	1850	-	2	9360	-	22200	22200
1986	-	1850	150	2	9360	-	22200	22200
1987	-	1850	650	2	9360	-	22200	22200
1988	-	1850	750	2	9360	-	22200	22200
1989	-	1850	300	2	9360	-	22200	22200
1990	-	1850	-	2	9360	-	22200	22200
1991	-	1850	-	2	9360	-	22200	22200
1992	-	1850	150	2	9360	-	22200	22200
1993	-	1850	650	2	9360	-	22200	22200
1994	-	1850	750	2	9360	-	22200	22200
1995	-	1850	300	2	9360	-	22200	22200
1996	-	1850	-	2	9360	-	22200	22200
1997	-	1850	-	2	9360	-	22200	22200
1998	-	1850	150	2	9360	-	22200	22200
1999	-	1700	650	2	9360	-	20400	20400
2000	-	1050	750	2	9360	-	12600	12600
2001	-	300	300	2	9360	-	3600	3600
Total	1850	35150	5550	-	215280	268250	421800	600505

* estimated

Energy Outputs

The energy output is the wood harvested and/or the charcoal produced from the wood.

A plantation life of 20 years is assumed with 6 years between harvests.

The yield of fuelwood is taken to be 1.5 m^3 of solid wood per hectare-year.

It is assumed that the wood crop is properly stacked and allowed to air-dry to a moisture content of 25 to 30 percent before carbonization.

The specific gravity of air-dried Eucalyptus wood is taken to be 0.70.

The mortality rate of fuelwood trees is taken to be zero for the purposes of the present calculation. However, tree mortality is included implicitly in the yield estimate of 1.5 m3/ha/year.

The conversion factors used to obtain the net heat content of Eucalyptus fuelwood and of charcoal are:

Fuelwood: 6.51 GJ/M3 solid wood

Charcoal: 2.89 GJ/quintal

The difference between net and gross heat content is represented by the following relation:

Net heat content = Gross heat content - Latent heat of vaporization of water formed in combustion

Estimates of the heat content of various materials vary according to the source *

Charcoal:

E/DI:	28.9 GJ/Tonne (net)
PP:	30 GJ/Tonne (net/gross unspecified)
GOS:	29.31 GJ/Tonne (net/gross unspecified)
Earl (1975):	29.7 GJ/Tonne (gross)

Air-dried hardwood:

E/DI:	9.3 GJ/Tonne (net)
PP:	18.4 GJ/Tonne (net/gross unspecified)
GOS:	14.24 GJ/Tonne (net/gross unspecified)
Earl (1975):	14.66 GJ/Tonne (gross)

* Sources: E/DI Energy Card
PP = Senegal Fuelwood Production Project Paper
Earl (1975)
GOS Rapport

The E/DI figures were selected over other figures used by the Government of Senegal (GOS), the Project Paper, and other sources for the following reasons:

- Heat contents for various materials are calculated on the basis of net values.

- Availability of heat content values for all materials relevant in this analysis allowed for consistency in comparison.

The fuelwood energy content was derived as follows:

(9.3 GJ/Tonne solid wood) X (0.70 T per m^3) = 6.51 GJ/m^3.

The yield of charcoal in quintaux per cubic meter of solid Eucalyptus wood is taken to be :

2.10 quintaux charcoal/M^3 solid wood, assuming a yield in carbonization of 30% of the weight of the wood.

The charcoal energy content conversion factor was derived as follows:

(28.9 GJ/Tonne charcoal) X

(1 Tonne charcoal/10 quintaux charcoal)

= <u>2.89 GJ/quintal charcoal</u>

The yield in solid M^3 of fuelwood for the life of the project is calculated to be:

(5550 hectares) X (1.5 solid M^3/hectare) = <u>8325.0 solid M^3</u>

Table 2 presents computations of the energy output and energy input for a variety of percent conversions of the fuelwood charge to charcoal.

Table 2. Energy output generated and energy output:input.

Percent converted to charcoal	Fuelwood yield (solid M^3)	Charcoal yield (quintaux)	Energy equiv. of output (GJ) Fuelwood	Charcoal:	Total	Energy output: input
0	8325.0	0	54195.8	0	54195.8	1.704
10	7492.5	1748.3	48776.2	5052.6	53828.8	1.692
20	6660.0	3496.5	43356.6	10104.9	53461.5	1.681
30	5827.5	5244.8	37937.0	15157.5	53094.5	1.669
40	4995.0	6993.0	32517.5	20209.8	52727.3	1.657
50	4162.5	8741.3	27097.9	25262.4	52360.3	1.646
60	3330.0	10489.5	21678.3	30314.7	51993.0	1.634
70	2497.5	12237.8	16258.7	35367.2	51625.9	1.623
80	1665.0	13986.0	10839.2	40419.5	51258.7	1.611
90	832.5	15734.3	5419.6	45472.1	50891.7	1.600
100	0	17482.5	0	50524.4	50524.4	1.588

The above calculations indicate that if 90% of the wood charge is converted to charcoal (as was originally planned for the Dakar market) the net energy available to consumers over the life of the project will be 160% of the net energy required as project inputs.

Butane Gas Comparison

The specific question of whether energy assistance to Senegal should be oriented toward the preservation/expansion of fuelwood resources or toward alternative energy sources can only be addressed within the context of a broader economic analysis of energy alternatives. Nevertheless, one expected benefit of the project was foreign exchange savings. It is, therefore, instructive to specifically calculate the amount of butane gas (the primary alternative to fuelwood and charcoal for domestic energy consumption) that is equivalent to the projected output of the project.

Using a net heating value for butane gas of 45.2 GJ per Tonne, the butane gas equivalent of the plantation output under the present set of conditions and assumptions (with 90% conversion to charcoal) is:

(50,891.7 GJ) X (1 Tonne butane gas/45.2 GJ)

= 1,125.9 Tonnes butane gas

Cost Comparison

The analysis that follows compares the cost of the energy inputs for the project with the cost of the amount of butane gas equal in net energy content to the output of the project..

The reader is cautioned that this comparison falls far short of answering the question of whether Senegal is better off spending foreign exchange on butane gas or on fuel oil inputs. The most immediately obvious reason is that the calculation presented here compares the cost of project energy inputs (which represent only a part of the total inputs required) with the purchase price of butane gas (which, assuming no price distortions, reflects the cost of all production inputs). Therefore, this analysis only provides an estimate of how much butane gas the GOS might have purchased had it forgone the purchase of fuel oil inputs for the project.

A more rigorous economic analysis of the relative merits of increased utilization of butane gas versus expansion of forest resources would require that the following factors be evaluated (to name a few):

- Opportunity costs of land, labor, and capital
- All other non-energy project input costs
- Intangible costs and benefits (e.g., recreational value of forest land)
- Shadow exchange rate
- Costs of capital conversion
- Taxes, subsidies, and other price distortions
- Import/export bans, quotas, etc
- Marginal costs of production
- Level and elasticity of demand
- GOS pricing policies

The cost comparison made the following assumptions:

- o Time value is disregarded. This assumption biases the analysis in favor of the fuelwood option since the output benefits are realized long after the fuel oil input costs are incurred.
- o The real price of each of the relevant commodities is assumed to be constant over time.
- o The price of butane gas is taken to be 130,000 FCFA per Tonne. This is the lowest 1981 price for imported butane gas incurred by the GOS. Source : GOS Rapport F, p. 85.
- o The price of gasoline is taken to be 212 FCFA per liter.
- o The price of diesel fuel is taken to be 113 FCFA per liter.

Using these price estimates, the total cost of fuel oil inputs to be incurred by the GOS for the life of the project is calculated to be:

Gasoline: (212 FCFA/liter) X (215280 liters)

= 45,639,360 FCFA

Diesel fuel: (113 FCFA/liter) X (690050 liters)

= 77,975,650 FCFA

Total cost of energy inputs: = <u>123,615,010 FCFA</u>

The cost of purchasing an amount of butane gas equivalent in net heating value to the output of the project is calculated to be :

Butane gas: (130,000 FCFA/Tonne) X (1125.9 Tonnes)

= <u>146,367,000 FCFA</u>

The cost of the diesel and gasoline inputs would be 123,615,010 FCFA. According to the above calculation, the cost of obtaining an amount of butane gas equivalent in energy terms to the output of the project is approximately 118% of the cost of obtaining the energy inputs for the project.

From another perspective, if the GOS had purchased imported butane gas with the funds spent on project energy inputs, 950 Tonnes of butane gas would have been obtained. This amount of butane gas represents a net energy value which is approximately 84% of the net energy output of the project.

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In concluding this section of the report, the reader is again reminded of the limited scope of this analysis. The analysis is intended to provide some insight into the value of the Bandia Fuelwood Project from an energy utilization perspective. Its greater value may be in that it indicates the need for a rigorous economic analysis of the project.

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ANNEX D

RECOMMENDATIONS TO PARFOB

1. Finance and personnel
2. Work supervision
3. Sale of nursery stock
4. Coordination of CNRF and PARFOB
5. Communications and consultations with other projects
6. Land clearing and site preparation
7. Production of nursery stock
8. Planting and tending
9. Protection

RECOMMENDATIONS TO PARFOB

1. Finance and personnel

Adherence to the budget plan by line items should be ensured principally by means of a running journal of expenses and commitments by line item.

The petty cash fund should be handled by the project accountant. Individual purchases from petty cash should not exceed 15,000 FCFA.

Hiring, firing and promotions should take into account money budgeted for various categories of skilled and unskilled labor, and the costs of vacations and severance pay in the case of permanent workers.

Time-keeping should be carried out at the nursery as well as the various assembly points on the plantation, and be done only by the time-keeper. Chef d'équipes should not be charged with keeping time for their crews. Total time corresponding to sick leave and annual leave should be summarized monthly.

2. Work supervision

A record-keeping procedure should be instituted as a means of supervising and monitoring plantation operations. At the field level, the chefs d'équipes should keep a daily journal of the tasks their crews have have been charged with and accomplished. The ATEF's would pass the information from these journals, and as well as their own observations and other information, onto the compartment history of forms, once a week. The two Division heads (Matériel et Sylviculture) would amplify, verify and certify the information so recorded, and keep these on permanent record.

There should be an ITEF (Ingénieur des Travaux Forestiers) residing at the plantation headquarters in Bandia.

3. Sale of nursery stock

Nursery stock should be sold at a price that would cover the costs of production of the trees sold in the case of fuelwood trees and at the market price in the case of fruit trees.

Written instructions, or fiches techniques, should be supplied to recipients of nursery stock.

PARFOB should solicit orders for trees destined for other government agencies in the Fall of the year previous to the planting year. Unsolicited requests for trees should be reserved for private individuals, and should be honored on a first come, first serve basis, except where a private entity may have placed a special request in advance.

4. Coordination of the CNRF and PARFOB operations

Periodic meetings should take place between PARFOB, CNRF technical staff, in order to: (1) coordinate the use of nursery facilities, project equipment, labor and plantation land; (2) provide periodic updates on the status of research; (3) exchange observations on the condition of the plantation and its operations and of the research plots.

At the end of each growing year, a meeting should be held in which CNRF presents the results of the research underway. A second meeting should be held in which CNRF would present the rationale and details of the next planting season research work, and elicit discussion and reaction from PARFOB technical staff. This process would permit ongoing, newly emerging problems or aspects of the plantation observed by PARFOB to be integrated into the research work, to the extent possible.

5. Communications and consultations with other projects

Visits, meetings and other opportunities for exchange of project experiences should be encouraged, and facilitated, especially among administrative as well as technical staff.

6. Land clearing and site preparation

(a) Delimitation

Now that the different soil types have been plotted on 1:5,000 aerial photographs , the should be identified on the ground, so that only the best types will be delimited and eventually planted. Areas with too many baobab trees and/or termite hills should be discarded.

There should be close supervision of the crews delimiting the plots so that the man-days/ha for this task can be reduced.

The Chief of the Division du Matériel should carefully examine present procedures for the opening of firebreaks with a view to improving the performance in this respect of the D7 crawler tractor.

(b) Land clearing

All possible effort should be deployed in order to expedite the procedure for the allocation of plots to the cooperatives of charcoal makers, so that they can complete their work in good time for subsequent operations to have a timely start.

Ways and means should be found, including if necessary, forfeiting the tax levied on each quintal of charcoal made, in order to ensure that once charcoal makers have left the area, the land stands ready for subsoiling. If forfeiting the charcoal tax is not appealing enough to the charcoal makers, they should be paid for the additional time required

of them. The purpose of this is to relieve the D6 crawler tractors of land clearing tasks and to allow them to concentrate on 3-tooth sub-soiling, which is the stumbling block.

D'6 s are overpowered for removing the type of vegetation growing in the Bandia forest. An alternative solution would be to purchase less powerful crawler tractors to knock down and windrow vegetation. In Northern Nigeria, in northern Guinea savanna (9.0 m2 basal area), one 65 hp crawler tractor knocked down vegetation over 1 ha in a couple of hours, and it took practically the same time for windrowing. Estimating at slightly over 1,000 the hours during which a crawler tractor can actually be used for land clearing operations during one year, and considering that basal area is most likely to be less in Bandia than in northern Guinea savanna, each such tractor would be able to prepare for sub-soiling some 300 ha/year.

As the knocking down of baobab trees and the levelling off of termite hills practically doubles the time required otherwise for land clearing, areas where there are too numerous baobab trees and/or termite hills should be discarded, and species more tolerant of competition than eucalypts, such as neem, should be planted in the proximity of baobab trees. As for termite hills, even after they have been levelled off they continue to be a nuisance, because their soil gets dry earlier than the surrounding soil and the plantation tends to become patchy.

(c) Sub-soiling by a 3-tooth ripper

By leaving aside areas with too many baobab trees and/or termite hills, and through a greater involvement of the charcoal makers in land clearing operations or the acquisition of additional but less powerful, crawler tractors to be used almost exclusively for this purpose, the two D6 and D7 tractors could be employed almost exclusively for 3-tooth sub-soiling in two directions at right angles. This would make pre-planting harrowing as such redundant (it could usefully be transformed into a 1st mechanized weeding in lieu of the now current hand weeding around each plant), and 1-tooth sub-soiling in two directions at right angles currently practiced would also become redundant.

If the other conditions could be fulfilled enabling the D6 and D7 crawler tractors to concentrate almost exclusively on 3-tooth sub-soiling in both directions at right angles (each such tractor would be able to work an area of about 250 ha/year) this is the procedure which would be hereby recommended, despite its somewhat higher cost (15% more, plus staking out):

PARFOB	hours/ha	FCFA/ha
3-tooth sub-soiling in one direction only.	*2.0 of D6 or D7	22.000
Pre-planting harrowing	*1.7 of wheeled tractor	5.440
1-tooth sub-soiling in both directions at right angles: 1st passage	*1.0 of wheeled tractor	3.200
2nd passage	*0.8 of wheeled tractor	2.560
		33.200
Recommended procedure		
3-tooth sub-soiling in both directions at right angles: 1st passage	*2.0 of D6 or D7	22.000
2nd passage	*1.5 of D6 or D7	16.500
		38.500 plus staking out

* PARFOB figure (in the absence of analytical cost accounting in PARFOB, the real audited 1981 running costs have been used of the Mali/OAPF Project: all direct costs including the man-hours of drivers and their guides, but excluding depreciation. The cost of crawler tractors is the average of the cost of 2 D6's and 1 D7; the cost of wheeled tractors is the average of the cost of two kinds: 89/96 and 651-4).

In addition to being more straightforward, the recommended procedure is recognized as being the most effective site preparation technique for sustained tree growth under the conditions prevailing in the Sahel, and leaves wheeled tractors available for carrying out weeding early in the rainy season, when it is cheap and most effective.

(d) Pre-planting harrowing

Whether it is maintained as part of site preparation, or it is transformed into a 1st weeding, the Chief of the Division du Matériel should pay particular attention to the manner in which this operation is carried out, with a view to improving the performance. Even if account is taken of the fact that in PARFOB this operation is carried out on soil previously sub-soiled by a 3-tooth ripper, the time taken is significantly higher than in other projects.

(e) Sub-soiling by a 1-tooth ripper

If the present site preparation technique is maintained unaltered, the Chief of the Division du Matériel should concentrate his attention also on this operation as there appears to be some room for improvement.

Closely associated with this operation is the question of spacing because the intersection of two sub-soiled lines at right angles indicates the place where the seedlings should be planted out. Spacing must permit full utilization of the site potential as well as the smooth carrying out of post-planting tending operations without damaging the planted seedlings. In order to achieve this, PARFOB has gradually moved from the recommended 4 m X 4 m spacing to a wider spacing allowing the planting of fewer trees/ha: 555 in 1980, 560 in 1981, 490 in 1982 against the recommended 625 trees/ha.

In order to avoid damage to the plantation crop, initial mechanized weeding should be kept at least 35 cm from the trees in order to allow for soil throw (the greater the speed of the tractor, the greater the soil throw). This implies that the disc harrow should be at least 70 cm less in cultivation width than the plant spacing. The width of the disc harrows recommended in the PP is 3.25 m, which leaves just 75 cm to allow for soil throw, or practically the bare minimum. It is recommended,however, that rather than reducing considerably the number of trees planted per hectare in order to maintain a square shape of the plantation pattern, a spacing of 4.5 m X 3.5 m be adopted which will allow the planting of practically the same number of trees/ha as recommended in the PP; 635 instead of 625. Mechanized weeding would then be done in one direction only, which suffices if executed before the soil gets dry, and would be completed by hand weeding.

(f) Staking out

This was done in both 1980 and 1981 and the density of planting was respectively of 555 and 560 trees/ha. In 1982, only every second line sub-soiled by 1 tooth-ripper was indicated on the ground and only 490 trees/ha were actually planted out. Should the present site preparation technique be maintained, it is recommended that complete staking out be resumed.

7. Nursery Stock

Through steady and close supervision of nursery operations by the Chief of the Division Sylviculture et Reboisement and the Chief of the Section Pépinière, it should be possible gradually to move towards the target of 20 man-days/thousand plants already obtained elsewhere in the Sahel.

As for the raising of eucalypt planting stock, it would be advisable to use the same polipots being employed by PARCE, with 9 holes instead of 6 of PARFOB's polipots (the greater the number of holes the lesser the risk

of roots spiraling in the pot). It would also be advisable to place the polipots, after pricking out, on an impermeable surface (such as sheets of polythene) in order to prevent rooting onto the substrate. It is worth repeating that pricking out the young seedlings from the seedling trays into the individual containers is the most delicate phase of the whole plant raising operation and ought to be done with the utmost care; the technique is known-supervision must ensure that it is applied at all times and must prevent its being done when it is clearly too late in the season. Culling of weak seedlings at the time of pricking out and again 1-1 1/2 months before planting is due to start must be ruthless, nothing less.

As for the other species raised in beds in a more traditional fashion, it is recommended that thinning be given greater attention that has been the case so far, and that watering of the beds be done from as low a height as possible.

8. Planting and Tending

(a) Transport of planting stock

It is very unfortunate that site conditions are such as to render this operation necessary: it was not foreseen in the PP. At the time the evaluation was carried out, right in the middle of the dry season, it was difficult to appreciate accessibility conditions during the wet season. One cannot help wondering, however, whether a greater number of 4-wheel-driven tractors might have eased the situation.

The Unimog-type of vehicles which would become handy for fire fighting would also be useful for carrying water to the bamboo crinting enclosures, and thus release wheeled tractors for weeding.

(b) Planting method

The Chief of the Division Sylviculture et Reboisement should watch carefully the development of planting operations and be ready to alter the composition of the standard planting crew if bottlenecks occur. Particular attention should be paid to the transport of plants.

Planting should start as early as possible in the second half of July, after 50 mm of rain have fallen, provided a sufficient depth of soil has been adequately moistened. Planting should also be completed in the shortest possible time: performance in 1982 was reasonably satisfactory, but more than 500 laborers should be able to plant 745 ha in 15 working days (except interruptions due to erratic rainfall).

(c) Hand weeding

If maintained, which is not recommended, this operation should be executed immediately after or even prior to planting when it is cheaper to do it and is most effective. Its replacement by a 1st mechanized weeding.

supplemented by hand weeding is recommended instead; a 2nd mechanized weeding would have to follow after weeding the plantations established during the previous years.

(d) Mechanized weeding

It should simply be remembered that weeding when there is no more moisture left in the soil is no longer a weeding operation, but perhaps a fire prevention operation. Just like planting, weeding must start as early as possible and in any case before weeds start seeding, and must be completed in the shortest possible time.

Lighter tractors than those available to PARFOB would have sufficed.

9. Protection

(a) Insect pests

It should become constant practice to start applying Sumifène against grasshoppers in the plots which are closer to the natural forests because it is from there that attacks spread.

(b) Rodents

Repellents should be tried out on an experimental scale.

(c) Domestic animals

Utmost use should be made of persuasion and the closest possible association of the local population with the project activities should be brought about.

(d) Fires

Visits should continue to nearby villages to create or resuscitate awareness of the danger caused by forest fires, and to encourage the establishment or awakening of village forest fire committees.

Vehicles of the Unimog type should possibly be purchased as they would boost the chance of successfully fighting forest fires.