PD-AAP-205

CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) — PART I

Report Symbol U-447

1. PROJECT TITLE

AFRICARE/Peace Corps Reforestation Project

2. PROJECT NUMBER

685-0247

3. MISSION/AID/W OFFICE

USAID/SENEGAL

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

A. First PRO-AG or Equivalent	B. Final Obligation Expected	C. Final Input Delivery
FY 80	FY 83	FY 84

6. ESTIMATED PROJECT FUNDING

A. Total $ 232,066

B. U.S. $ 232,066

7. PERIOD COVERED BY EVALUATION

From (month/yr.) May 1983

To (month/yr.) July 1983

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
(1) Continue current project activities under AFRICARE Management to Dec. 31, 1983 and provide funding by re-earmarking the $40,000 remaining in the original grant, to permit AFRICARE to carry out project activities to December, 1983. PIO/T already prepared by AID project Manager, cleared by mission and submitted to AID/W.		
(2) Project to be continue under P.L. 480 Title III funding for one year (FY 84) under the direct management of Service des Eaux et Forêts. $21,000 have been granted to the project by the title III committee. This money will be used to complete the annual budget and carry out project activities until December 1983.	Daby Diallo AID Project Manager	
(3) The WFP, program introduced to the project as an incentive has been well received but, needs to be carefully monitored.		

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
- ☐ 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
- C. ☐ Discontinue Project

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

Chun K. Lai, Team Leader
Elie Joseph Sambou, PARFOB, Bandia
Issa Faye, Société de Terres Neuves

12. Mission/AID/W Office Director Approval

Signature: [signature]

Typed Name: David Shear, Director

Date: 9/12/83

AID 1330-15 (3-78)

Clearances:
ADO:JBalis (in draft)
PRM:SRea (in draft)

PROJECT EVALUATION SUMMARY (PES) - PART II

13. Summary

The evaluation concluded that the project should be funded for two additional years under the PL.480 Title III Program (1984 and 1985), focusing on "old" villages which demonstrate an interest in continuing reforestation activities and recruiting a few "new" villages. The involvement of Peace Corps volunteers should be continued. The project should make a greater use of locally available technologies and materials notably live and thorn fencing, hand-dug planting holes, and seed collection at village level. The Project should encourage Private Sector participation by introducing the sale of surplus seedlings and encourage individual woodlots where the interest for such ventures exists. Over the next two years PCVS should introduce "Ban-Aksuf", an energy saving AID-funded woodstove in the Project area.

14. Evaluation methodology

The in-depth evaluation of this AIP activity was done in year 3. The evaluation is based on monthly reports and the information collected by the GOS Forestry Department, AFRICARE and Peace Corps personnel on all project activities, and project site visits by the evaluation team. The interpretation of the activities and the quantitative summaries are difficult as the Project after three years has not reached the point of first harvest. Thus the benefits can only be projected. The guidelines for the evaluation took into account the specific techniques used in the implementation plan such as the number of trees which survived, nursery management, and transplanting techniques, water deficits, site characteristics, social and economic factors. The evaluation was done in May - July 1983 by a three member joint American - Senegalese team. The report was submitted to the GOS in July and the findings and recommendations were approved.

15. External Factors:

None

16. Inputs:

Cumbersome administrative procedures caused delays in the start-up of nursery activities. The delay in the delivery of Project inputs such as fencing materials, tools, watering cans, plastic pots and seeds initially plagued the Project. These delays led to the late preparation of nurseries and the transplanting of premature seedlings for certain species such as kad. The role of the PCVS has been very positive in the dissemination of reforestation techniques among villages.

17. Outputs

I. 1981 Rainy Season: 40,572 trees were planted in eight villages in the Bambey and Diourbel Departments as follows:

. Bambey Department (4 villages) 29,820 trees

Eucaluptus	8,300 trees
Acacia Holocericea	19,453
Acacia tortilis	1,950
Leuceana	37
Total	29,820

. Diourbel Department (4villages) 10,752

Kad	3,600
Eucaluptus	3,215
Acacia holocericea	2,150
Cashew	272
Neem	190
Leuceana	50
Paw-paw	810
Mango	465
Total	10,752

The 32 hectare Ndiemane plantation had a very poor survival rate. The main causes of mortality were late planting, small seedling size, lack of protection against livestock and termites, and lack of proper weeding after planting. However, seedlings distributed to individuals for private planting had a better survival rate and grew better.

II. 1982 Rainy Season: The number of villages participating in the village woodlots program increased to twenty. The survival rate improved substantially (65 %) and most of the mortality can be attributed to the late installation of the "Australian" fencing (large mesh wire). Termites were a causal factor on the survival rate. Nurseries were established in each of the participating villages.

11.5 hectares were planted with eucalyptus and prosopis. 6695 trees were planted and 2301 trees survived with a survival rate of 34 %. The kad specie was planted in 92 crop fields (77.68 ha) and the survival rate was good (65 %).

III. 1983 Rainy Season Campaign: 35 villages are involved in the current campaign. The characteristics of this year's nursery efforts is the diversification of species and the broad experimentation with indigenous tree species. 38,359 seedlings were produced in the village nurseries. Training sessions were organized for 36 village nurserymen. One of the objectives of the 1983 campaign is to find a more cost-effective and timely protection scheme for the village woodlots. The "Australian" fencing has been replaced with barbed wire and run-palm posts reinforced with natural fencing materials provided by the villagers, mainly euphorbia balsamifera and thorn branches (mainly kad).

Grand total projected for 1983 plantations:

21.11 ha	of village woodlots (10,411 trees)
7.4 ha	of woodlot replanting (1,766 trees)
276.0 ha	of kad plantations (27,592 trees)
10.0 ha	of kad replanting (1,036 trees)
314.51 ha	

18/19 Purpose and Goals

The purpose of the project is to undertake community forestry activities in 40 participating villages in the Diourbel Region of Senegal, namely: woodlots, agro-forestry, windbreaks and fruit trees. Most progress indicators have been made in introducing fuelwood production techniques in the progress area. The foundation has been laid to enable beneficiary villagers to undertake reforestation activities on their own, especially with training and nurseries provided at each village.

20. Beneficiaries:

The direct benefits produced by the project by the fifth to seventh year will be firewood and wood construction materials that the village organizations will harvest and keep for personal consumption or sell on the local market. There are other benefits such as fodder from acacia and the regeneration of soils with the kad trees.

Indirect benefits could include related employment opportunities, consumer savings, transport savings and commercial activities. Those individuals who will be involved in the construction of the energy-saving woodstoves will also benefit from the project.

21. Unplanned Effects:

None

22. Lessons learned:

In the selection of species, the performance of Eucalyptus Camaldulensis planted in 1981 and 1982 indicates that this species is unsuitable for most parts of Diourbel Region. Prosopis Juliflora is the most drought resistant species in this region where there is an insufficient rainfall averaging 300 mm per annum. Motivation has been noted among some villagers. Some farmers were willing to commit themselves to onerous tasks.

Villagers are acutely aware of the lack of fuel and construction wood in the region. This has been an ever present concern since the 1973 drought.

The protection of woodlots by building fences remains unresolved costwise. It was found that the fencing system used thus far in the project is not economically feasible.

The fuelwood crisis coupled with the increasing pressure brought about by soil degradation due to land use practices have clearly forced people to combine reforestation to farming practices in order to increase agricultural production. However, it is the SERERE farmers who have adopted the new agro forestry methods.

Seedlings distributed for individual planting had the best overall survival rate due to protection, care, and watering.

Finally the role of religion as a motivating factor represents an asset to mobilize land and human resources.

23. Special Comments or Remarks:

none

24. Attachment: Evaluation Report (p 1 - 55)

-6- XD-AAP-205-A
ISN 34525

EVALUATION REPORT
DIOURBEL VILLAGE REFORESTATION PROJECT

Project No. 685-0247
Grant No. AID/AFR-G-1690

Cooperating Agencies:
Senegalese Service of Waters and Forests
Africare
United States Peace Corps
United States Agency for International Development

Presented to the
Office of Agricultural Development
USAID
Dakar, Senegal

Evaluation Team:
Forester - Chun K. Lai, Team Leader/Forestry Consultant
Economist - Ely Joseph Sambou, PARFOB
Sociologist - Issa Faye, Société de Terres Neuves

July 31, 1983

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This section responds to questions on technology transfer which AID's Africa Bureau has disseminated for inclusion into project evaluations (reference State 81077, March 27, 1982).

Prepared by: Chun K. Lai, Forestry consultant
Date: July 31, 1983
Project: Diourbel Village Reforestation, 685-0247
Country: Senegal
Cost: $232,066
Period of Project: 1981-1983

1. What constraint did this project attempt to relieve?

   Through its village woodlot component, the project attempts to ease the labor constraint of fuelwood collection, which is requiring the women in the Diourbel Region to walk increasingly long distances.

   Through its Acacia albida component, the project attempts to relieve the environmental constraint of increasingly degraded soils as a result of the extension of continuous, non-fallow cash cropping (peanuts) and a high population pressure on the land (over 100 inhabitants/km²).

2. What technology (knowledge, skills or practices) did the project promote to relieve this constraint?

   The project promotes the creation of village nurseries to produce seedlings for village woodlots, Acacia albida fields, and individual distribution.

3. What technology did the project attempt to replace?

   The project attempts to replace the traditional technology of fuelwood collection from distant sources of native vegetation with the establishment of woodlots for fuelwood production close to the villages.

4. Why did project planners believe that intended beneficiaries would adopt the proposed technology?

   The wood shortage problem in the Diourbel Region is taking on desperate dimensions. The severe drought of the late 1960's and 1970's has, in combination with demographic factors, accelerated the desertification process and intensified the "other energy crisis". Rural women walk a minimum of 3-5 km to find fuelwood; construction wood is becoming just as scarce.

   With Acacia albida, its benefits on soil regeneration and increased agricultural production is well known to farmers in the Region, especially to Serers..

5. What characteristics did the intended beneficiaries exhibit that had relevance to their adopting the proposed technology?

   Some villagers have, in the past, come to the Departmental or Regional Nurseries of the Service of Waters and Forests (SWF) to get seedlings for planting in family compounds or in village public places. These were usually shade or fruit trees.

6. What adoption rate has the project achieved in transferring the proposed technology?

   Between 1981 and 1983, 38 villages have been integrated into the project (3 dropped out this year). Local participation averages between 10 and 30% of the village population.

7. Has the project set forces into motion that will induce further exploration of the constraints and improvements to the technical package proposed to overcome it?

   Hopefully, villagers will eventually substitute external project inputs (wire fencing, tractor subsoiling, "crinting" fencing for nurseries) with local technologies (natural fencing materials, large hand-dug planting holes, live fencing around nurseries).

8. Do private input suppliers have an incentive to examine the constraint addressed by the project and to come up with solutions?

   Private input suppliers can play a role if the project introduces the idea of selling surplus seedlings produced in the village nurseries. This may serve as incentive for the start of private nurseries.

9. What delivery system did the project employ to transfer technology to intended beneficiaries?

   The project conducted training sessions for village nurserymen. Village reforestation quasi-cooperatives were set up. Peace Corps Volunteers (PCV's) and SWF technicians maintain close contact with villagers through their "sensibilisation" work.

10. What training techniques did the project use to develop the delivery system?

    Training techniques include "formal" sessions at the Regional Nursery and the Khandiar pilot farm and "informal" on-the-job training as project personnel assist and monitor work at the village level.

    In addition, PCV's came up with the idea of bringing village nurserymen to different villages to discuss and compare their work.

11. What effect did the transferred technology have on those impacted by it?

    This is too early to tell. It will depend on how much usable wood products the small woodlots (0.2 to 3.0 ha) will yield, how these products will be distributed or sold, and what this will represent in terms of reduction of the wood shortage, both on the village and regional levels.

LIST OF ACRONYMS

AID	Agency for International Development
ATEF	Agent Technique des Eaux et Forêts
CNRF	Centre National de Recherches Forestières
ORSTOM	Office de la Recherche Scientifique et Technique Outre-Mer
PAM	Programme Alimentation Mondiale
PARFOB	Projet Autonome de Reboisement de la Forêt de Bandia
PCV	Peace Corps Volunteer
PRECOBA	Projet de Reboisement Communautaire dans le Bassin Arachidier du Sénégal
SODEVA	Société de Développement et de Vulgarisation Agricole
SWF	Service of Waters and Forests (Eaux et Forêts)

LIST OF TREES CITED IN REPORT

Scientific Name	Common Name
Acacia albida	Kad ("sas" in Serer)
Acacia holocericea	acacia wolof
Acacia laeta	related to the gommier (A. Senegal)
Acacia tortilis	seing
Anacardium occidentale	darkassou
Azadirachta indica	neem
Balanites aegyptiaca	sump
Borassus aethiopum	ronier
Celtis integrifolia	mboul
Casuarina equisetifolia	filao
Detarium microcarpum	danx
Eucalyptus camaldulensis	eucalyptus
Euphorbia balsamifera	salan
Guiera senegalensis	nguer
Khaya senegalensis	khaye
Leucaena leucocephala	leucaena
Melaleuca spp.	niaouli
Poinciana regia	flamboyant
Prosopis juliflora	prosopis
Ziziphus mauritiana	sidem
	agrume
Carica papaya	papayier
Mangifera indica	manguier
Psidium guajava	goyavier
Annona muricata	corrossolier
	gaîc
	sap-sap

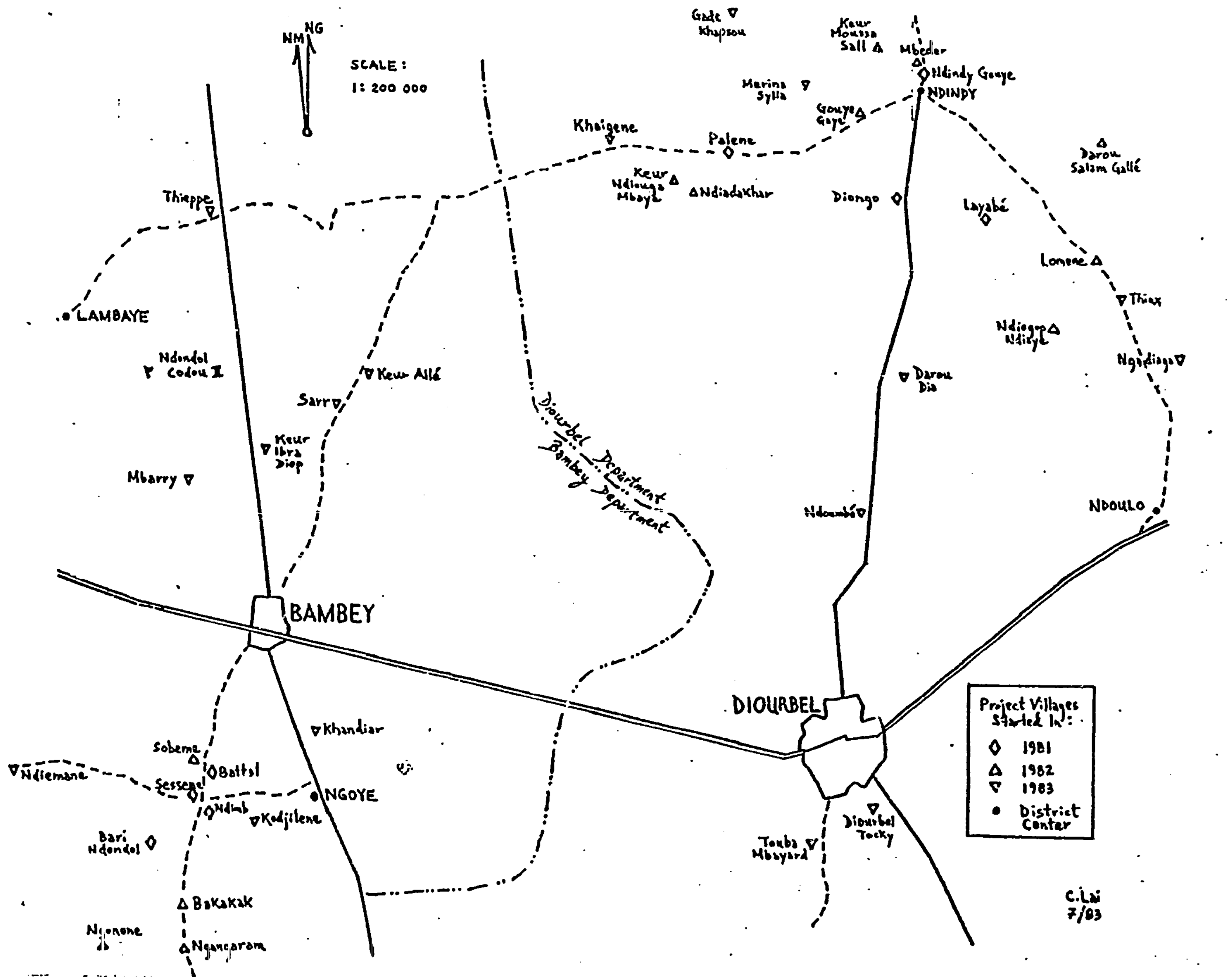

Figure 1. Locational map of project area.

1. INTRODUCTION

1.1 Evaluation Team

The evaluation work was undertaken by a core of three members:

Chun K. Lai - Master of Forestry candidate at the Yale School of Forestry (USA); Fulbright Researcher on reforestation in Senegal (1982/83). Team leader: responsible for evaluating technical and sylvicultural components and for writing the final evaluation report. Ely Joseph Sambou - Master of Science degree in Resource Management and Policy (Forest Economics) at SUNY Syracuse (USA); Coordinator in charge of Economic Affairs at PARFOB. Responsible for analyzing economic components of the project. Issa Faye - Master of Sociology degree at the Sorbone (France); Director of Rural Migration at the Société de Terres Neuves. Responsible for evaluating sociological aspects concerning the project.

1.2 Methodology

Information and data for this evaluation were obtained through field visits to project sites, interviews with project personnel, review of project documentation and pertinent literature, and consultation with forestry researchers (CNRF, ORSTOM). The evaluation itinerary is presented in Appendix A.

An evaluation of the first year project activities was conducted by Mr. Fred Weber in November, 1981. This current effort will concentrate on evaluating project activities during 1982 and the first semester of 1983, with accent on the evolution of project design and modes of implementation.

All 38 villages which are or have been in the project were visited by the forester. The economist visited 30 of the villages; the sociologist conducted interviews in 8.

1.3 The Conceptual Framework

Essentially, the evaluation seeks to determine the progress of the project towards its overall goal, that is: "To involve villagers in the national reforestation program. More specifically, Africare will assist the Government of Senegal and inhabitants of rural areas to undertake communal forestry activities including the planting of trees for fuelwood, shade and fruit, windbreaks, soil conservation, and protection of natural regeneration".

In addition, it is AID's desire that the evaluation address the issue of replicability: has the project been successful in developing a model for community forestry activities which can be applied to other regions of Senegal or the Sahel?

Before proceeding further, these questions must be evoked and kept in mind:

- Can the desired project goals be realistically attained in the short time frame involved? (originally set for two years, later extended to three)
- What different (if any) evaluative criteria should be imposed on "pilot" or "test" projects as opposed to more traditional, production-oriented projects?
- Can (or should) one affix a "positive value" to lessons learned from "failures"?
  (e.g. that 9-ha village woodlots or *Eucalyptus camaldulensis* are infeasible or inappropriate in the project zone).
- How should "successful" be defined with regard to reforestation activities one is trying to initiate at the level of the villager? In hectares planted? In survival rates? In the level of participation and motivation shown? In the likelihood that these activities will be sustained in the future?

2. GENERAL PROJECT INFORMATION

2.1. Funding

The project is funded under an Operational Program Grant from AID/Washington to Africare/Washington. This Grant (No. AID/AFR-G-1690; PIO/T No. 685-0247-3-0024) was authorized on August 29, 1980 in the amount of $211,344 and signed by the Africare Representative on September 5, 1980. The project was planned for a two-year period ending December 31, 1982. Because of the difficulties encountered in the start-up year of 1981, it was decided to extend the project for a third year in order to profit from the many lessons learned to date. Unexpended funds ($40,032) would be used and supported by an additional $20,722 from the Title III program under an amendment approved by AID/Senegal on June 27, 1983. This brings the total AID committment to $232,066.

Peace Corps Senegal has assigned nine PCV's to the project during its life span; three are currently serving in the Diourbel Department. The financial support of these volunteers are estimated to total $219,000 -- with $52,000 for training expenses and $167,000 for "volunteer support".

The Government of Senegal contributes administrative and technical personnel to the project. The salaries of the Regional Inspector ("Chef de Project") two Departemental Heads ("Chef de secteur"), four forestry technicians ("ATEF"), and one chauffeur are estimated to be 27,792,000 FCFA over the three-year period. These personnel, of course, perform some traditional SWF functions as well as project duties.

2.2 Personnel

The table below indicates the people involved in the project during and since its conception. The frequent and numerous personnel changes have hampered attempts to establish a sense of continuity and harmonious rapport among the various actors.

Table 1. Project personnel from 1980 to present.

Function	Project Design 1980	Project Implementation 1981	1982	1983
AID Project Mgr.	Mary Young	Carol Ulinski	———	Daby Diallo
AID Project Assis.			Daby Diallo-Mamadou Ba	
Africare Project Mgr.	David Jackson	R.J. Benn	———	———
Africare Project Assis.		———	Ibrahima Camara	———
SWF Project Mgr. (Dakar)	Abdoulaye Kane	———	M. Danso - Amadou NDiaye	
SWF Project Director (Diourbel)	Bakary Sèye	———	Abdoulaye Séne-Cheikh Savané	
Chef de Secteur (Diourbel)		Seringue Mbodj	Cheikh Mbaye	———
Chef de Secteur (Bambey)		Abdoulaye Diallo	———	———
ATEF's :Diongo		Lassabe Ly	———	———
Diongo			Baba Cobar	———
Ngoye		Mamadou Diémi	———	———
Lambaye		Moe Samb	———	———
Peace Corps Project Mgr.	Ken Barber	———	———	Chris Kopp
PCV's: Ndindy Gouye		Peter Maille	———	
Layabé		Lynn McConnville	———	
Palene		Steve Scott	———	
Thiax				Mike Hendrix
Merina Sylla				Tilda Gouveia
Khaigene				Ann Maitland
Ndimb		Denise Ingram	———	
Bari Ndondol		Matt Chotkowski	———	———
Bakakak		Joe Virnig	———	———

2.3 Original Project Design

The first project design papers envisioned "individual woodlots at the rate of 9 hectares or 5,625 trees per year in each of 40 participating villages (8 in the first year, 32 in the second)" ("Program Description", Attachment A of AID/Africare Grant Agreement").

The Africare/SWF Agreement has two components: 1) village woodlots — 216 ha in Ngoye District (Bambey) at a 4X4 m (625 trees/ha) spacing for fuelwood production; and 2) Acacia albida (kad) plantation — 216 ha of kad planted at 10 X 10 m spacing in millet and peanut fields to improve soil conditions in Ndindy District (Diourbel).

2.4 Design Modifications

The mid-project evaluation carried out by Mr. Fred Weber proposed some important changes in the operational mode. Concerning the overall project goal, he recommended to "enlarge the scope of the project to include all forestry and conservation activities of particular interest to the local people, including food and fruit trees, shade plantations, windbreaks, protection of natural vegetation, soil conservation, etc." (Weber 1981).

This led to the adoption of creating small (usually less than 1 ha) woodlots located near the villages and more emphasis on distributing trees for family compounds and village public places, as well as extending the kad component to the Bambey Department.

2.5 Regional Scope of Problem

The Region of Diourbel, in the heart of the groundnut basin, faces severe fuelwood shortages due to a rapidly increasing population, extension of cash cropping (peanuts), and a natural vegetation resource base that is rapidly diminishing due to demographic and climatic factors.

At the end of 1983, the population of Diourbel Region will approach or exceed 517,000 (assuming a 2.8% annual increase since 1976). With a total land area of 4359 km², this means an average population density of 118 persons/km². Indeed, after the Cap Vert Region, the Serer-dominated Bambey Department has the highest population density in Senegal (Jeune Afrique 1980).

The Former Environmental Officer of AID/Senegal, Mr. Peter Freeman, has pointed out that village woodlots are not a feasible means of achieving fuel self-sufficiency in this Region due to the scarcity of land (Freeman 1982).

Using these parameters for the rural sector of Diourbel:

* production rate of 3 m³/ha/yr in woodlots, consumption rate of 0.6 m³/person/yr (these two assumptions from the Master Plan for Forestry Development, CTFT/SCET 1982).
* Rural population of 413,200 in 1982 (2% annual increase projected in rural sector).
* 350,000 ha of arable land (0.75 ha/person) (VIè plan ... Rép. du Sénégal 1981).
* 300,000 ha of land actually cultivated in 1981, 10,000 ha of land in fallow (SODEVA 1982a).

Freeman calculated that 82,600 ha of village woodlots would have to be established in order to meet the fuelwood needs of the rural populace. This figure is more than double the area of arable land which remains available.

One possibility that Freeman disregarded is the establishment of woodlots on non-agricultural lands, which represent over 40,000 ha of the Diourbel Region. It is becoming increasingly clear that this is the type of land most often "donated" for project woodlots (e.g. depressions or "bas-fonds").

In recognizing the land constraint (among others), the Master Plan for Forestry Development (CTFT/SCET 1982) has advocated reducing, not eliminating, the fuelwood problem in the densely populated Regions of Diourbel, Thiès and Cap Vert. Objective n°1 of the Plan is to "reduce regional shortages of fuelwood for rural populations". For Diourbel, the goal is to decrease the fuelwood deficit by 25-30% in the year 2,000. This would require a production target of 92,000 m³/yr by the end of the century, or the establishment of over 30,000 ha of woodlots in the Diourbel Region.

3. PROJECT ACCOMPLISHMENTS

3.1 1981 Campaign

(a) Planting. The following tables summarize the number of trees planted in 1981, the project start-up year. The Ndiemane plantation was completed between August 17 and September 2 with labor provided by the four Bambey villages, located 6 to 10 km away. Planting occurred roughly during the same period in Diourbel; Ndindy Gouye planted from August 10 to September 4

Table 2. Trees planted in Bambey Department in 1981.

Operation	Nursery Source	Eucaluptus	Acacia holocericea	Acacia tortilis	Leuceana	Totals
Ndiamen	Ndimb	-	4,880	300	-	5,180
Plan-tation	Sessene	-	2,523	-	-	2,523
(4X4 m)	Battal	-	3,900	-	-	3,900
	Bari Ndondol	-	-	-	-	-
	Sambe + PARFOB	8,300	-	-	-	8,300
Subtotals		8,300	11,303	300	-	19,903*
Individual	Ndimb	40	-	-	37	77
Distri-bution	Sessene	40	4,350	1,650	-	6,040
	Battal	-	-	-	-	-
	Bari Ndondol	-	3,800	-	-	3,800
Subtotals		80	8,150	1,650	37	9,917
Totals		8,380	19,453	1,950	37	29,820

* At a 4X4 m spacing, represents 32 ha at 622 trees/hectare

Table 3. Trees planted in Diourbel Department in 1981.

Village	Kad	Eucalyptus	A.holo.	Cashow	Neem	Lence.	Papaya	Mango	Totals
Palene	900	900*	900	30	-	-	200	140	3,070
Layabé	800	1,040	190	200	-	50**	240	125	2,645
Ndindy Gouye	850	275	60	22	190	-	270	50	1,717
Diongo	1,050	1,000	1,000	20	-	-	100	150	3,320
Totals	3,600	3,215	2,150	272	190	50	810	465	10,752

* 1.5 ha village woodlot

** village square planting
(aside from kads and otherwise denoted, trees were used for individual distribution and windbreak trials).

Grand Total for 1981 = 40,572 trees planted

(b) Survival Rate

The 32-ha Ndiemane plantation, with the exception of perhaps a few scattered trees, can be considered a total failure. The major causes of mortality were: late planting, small seedling size, lack of protection against livestock and termites, and lack of proper weeding after planting (Weber 1981).

In Diourbel, kads planted in 1981, without protection, are estimated to be surviving at a rate of 5 to 10%.

Individually distributed trees survived and grew better although the exact survival rate is not known. Some excellent subjects of Acacia holocericea were observed at Palene, some about 3 m in height. Many neems and A.Holo. are growing in Ndindy Gouye. It is possible that some villages have over 50% survival for trees distributed individually.

3.2 1982 Campaign

(a) Goals. The number of participating villages was increased to 20 -- 12 "new" villages and the 8 original ("old") villages from 1981 -- with 12 in Ndindy District (Diourbel Department) and 8 in Ngoye District (Bambey Department).

Each village was to produce 4,000 seedlings which would be used for the following purposes:

* village woodlots (eucalyptus, neem, prosopis, A.holo.)
* soil regeneration (kad) and windbreaks
* shade tree and roadside plantings (neem, prosopis, flamboyants)
* fruit trees (lemon, orange,paw-paw guava)

(b) Village nurseries . Nursery production was as follows:

Table 4. Village Nursery Production in 1982.

Department	Village	No. Seedlings Produced
Diourbel	Palene*	1,889
	Keur Ndiouga Mbaye	2,167
	Ndiadakhar	2,729
	Layabé*	675
	Ndiogop Ndiaye	3,024
	Lomene	2,422
	Darou Salam Gallé	625
	Ndindy Gouye*	1,288
	Keur Moussa Sall	2,596
	Mbeder	2,076
	Gouye Gaye	942
	Diongo*	1,643
Subtotal		22,076
Bambey	Ndimb*	454
	Sessene*	560
	Battal*	2,501
	Bari Ndondol*	125
	Bakakak	1,702
	Ngonene	1,761
	Sobeme	370
	Ngangaram	3,624
Subtotal		11,097
Total		33,173

* denotes "old" village

(c) Village woodlots. The first rain fell on July 10, 1982. Planting began in late July (e.g. July 27 in Keur Moussa Sall) after two significant rains. Most woodlots, owing to their small size, were planted within two days. Woodlots had previously received one-tooth subsoiling in two directions ("sous-solage croisé") at a 5X5 m spacing with a tractor (1974 Fiat) borrowed from SWF/Diourbel.

Survival information of trees planted in woodlots are based on actual field examinations by the evaluation team and data furnished by ATEF's and PCV's.

Table 5. Tree survival in 1982 village woodlots, Diourbel Dept.

Village	Area (ha)	Species*	No.Planted	No.Surviving	% Survival
Palene	1.0	E/P	400/50	0	0
Keur Ndiouga Mbaye	0.7	E/P	235/40	0	0
Ndiadakhar	1.0	E/P	625	15	2
Layabé	No woodlot	-	-	-	-
Ndiogop Ndiaye	0.6	N/P/E	249	8/8/3	8
Lomene	0.8	N/P/E	323	28	9
Darou Salam Gallé	1.0	N/P/E	627	120/16/22	25
Ndindy Gouye	0.84	E/N/P/A	416	164	39
Keur Moussa Sall	0.32	N/E/P	572	518	91
Mbeder	0.45	E	215	0	0
Gouye Gaye	0.24	N/P/E/A	418	263	63
Diongo	0.41	P/E/N	208/46/31	122/0/23	51
Totals	7.4		4,455	1,310	29

Average planting density = 602 trees per hectare (tph)
Average surviving density = 177 tph

*E = eucalyptus
P = prosopis
N = neem
A = Acacia holocericea

Table 6. Tree survival in 1982 village woodlots, Bambey Dept.

Village	Area (ha)	Eucalyptus Planted	Eucalyptus Surviving	Eucalyptus %	Prosopis Planted	Prosopis Surviving	Prosopis %	Total Planted	Total Surviving	Total %
Ndimb	0.35	216	106	49	95	63	66	311	169	54
Sessene	0.29	83	39	47	75	70	93	150	109	69
Battal	0.50	93	5	5	98	64	65	191	69	36
Bari Ndondol*	0.50	300	200	67	100	75	75	400	275	69
Bakakak	0.54	143	102	71	145	98	68	288	200	69
Ngonene	0.25	150	64	43	-	-	-	150	64	43
Sobeme	0.26	49	5	10	78	10	13	127	15	12
Ngangaram	1.40	472	75	16	143	15	11	615	90	15
Totals	4.09	1,506	596	40	734	395	54	2,240	991	44

* Denotes 3 individual woodlots

Average planting density = 546 tph
Average survival density = 242 tph

Grand Total for 1982 Woodlots:

11.5 ha
6,695 trees planted 582 tph
2,301 trees surviving 200 tph
34% survival

Most of the mortality can be attributed to the late installation of the "Australian" fencing (large mesh wire). This was not completed until December in Bambey and mid-January in Diourbel thus rendering the woodlots susceptible to livestock depredations. Termites damage was a second causal factor especially on weakened, stressed eucalyptus.

(d) Kad plantations. Kad fields also received tractor subsoiling in two directions (at right angles), at roughly a 10 X 10 m spacing (100 tph).

The following table summarize the number and surface area of fields planted with kad and the current estimated survival.

Table 7. Estimated survival of kads planted in 1982.

Department	Village	No. Fields	Total Area (ha)	Est.%Survival	Observations
Diourbel	Palene	6	6	?	
	K.Ndionga Mbaye	7	7	40	
	Ndiadakhar	12	10.21	?	
	Layabé	-	-	-	
	Ndiogop Ndiaye	10	9.5	25-50	
	Lomene	20	17.74	25-50	
	D.Salam Gallé	-	-	-	entourage of natural regeneration
	Ndindy Gouye	-	-	-	
	K.Moussa Sall	6	4.46	10-20	
	Mbeder	3	1	?	
	Gouye Gaye	4	3	?	1 field enclosed with euphorbia
	Diongo	2	3.27	?	
Subtotal		70	62.18	25 (?)	
Bambey	Ndimb	7	3.4	80	Some individual protection w/thorns
	Sessene	2	0.8	75	"
	Battal	2	0.4	65	
	Bari Ndondol	5	2.4	60	
	Bakakak	2	4.1	70	
	Ngonene	2	0.5	45	
	Sobeme	1	1.1	65	
	Ngangaram	1	2.8	65	2 fields enclosed with euphorbia
Subtotal		22	15.5	65	
Totals		92	77.68		

The kad trees are surviving very well in Bambey, even in the absence of protection measures. Survival is not very satisfactory in the Diourbel fields. Implications of the special affliation Serers have with kads will be explored later.

The surviving kads are very small, mostly under 30 cm in height. This slow above-ground growth is confirmed by a kad trial established in Bambey (1968) on "deck" soils for which the following height growth was recorded (Giffard 1975):

Age (yr)	Avg. Ht. (m)
1	0.45
3	2.12
5	3.39

Most of the young plant's growth during that period is underground. Kads have a vigorous tap-root system and mature specimens may have tap roots which extend down to 30 m (Freeman and Fricke 1980).

(e) Individual distribution. Due to the wide dispersion of individually distributed trees, exact survival figures are impossible to obtain. In general, trees planted for shade and/or fruit are given some care whether in the form of protection or watering (e.g. water "disposal" on trees in compounds). For this reason, survival rates can be assumed to exceed 50% in some cases.

An effort was made during some village visits to follow up on the survival of these trees. In Ndiadakhar, for example, a tour was made through several family compounds where many trees planted in 1982 were growing. And the general impression was as one villager proclaimed: "more lived than died".

In public places, such as village squares and along village roads, neems and prosopis are the two most frequently observed species planted during the 1982 campaign. Protection schemes include nguer (*Guiera senegalensis*), thorns, mud bricks, and a slew of other materials. Even when unprotected and damaged by livestock (e.g. roadside plantings in Ndiadakhar), prosopis have a remarkable survival ability.

3.3. 1983 Campaign

(a) Village selection. The present campaign encompasses 35 villages and, for the first time, extends into Ndoulo and Lambaye Districts. Three villages -- Layabé (Diourbel) and Ngonene, Sobeme (Bambey) -- were dropped from the project due to "internal conflicts" in their villages. The breakdown of this year's villages is as follows (refer to Figure 1 for locational aspects):

Table 8. Villages participating in the project in 1983.

Department	District	No."New"Villages	No."Old"Villages	Totals
Diourbel	Ndindy	5	11	16
	Ndoulo	4	-	4
Subtotal		9	11	20
Bambey	Ngoye	3	6	9
	Lambaye	6	-	6
Subtotal		9	6	15
Totals		18	17	35

(b) Village nurseries. Tables 9 and 10 display nursery production in the villages as of mid-June The actual numbers may be higher at outplanting time due to some reseeding of pots in early June and the natural phenomenon of some germination stimulated by the early rains (June 20 and 27) in pots which had not germinated under nursery watering regimes. It remains to be seen whether these lately germinated seedlings will attain minimally acceptable size before outplanting.

A key characteristic of this year's nursery efforts is species diversity. This is especially true in Bambey where for the "new" villages an average of 13 different species are growing in each nursery. In Diourbel, the nurseries have an average of 5 different species.

Another key characteristic found in the Bambey nurseries is a broad experimentation with growing indigenous tree species. In all, 21 species are found in this year's nurseries. In decreasing order of production, they are: prosopis, kad, eucalyptus, neem, A.holo., citrus ("agrumes"), khaye, filao, sidem, papaya, sump, mango, mboul, flamboyant, seing, leuceana, danx, sap-sap, gaic, darkassou and corrossol (see LIST OF TREES CITED IN REPORT for scientific names).

Most nurseries are integrated with vegetable gardens. This serves as an incentive for watering as well as providing vegetables for consumption or sale.

Table 9. Village Nursery Production in Diourbel Department as of mid-June, 1983.

District	Village	Nursery Production	% Survival	Number of speci
Ndoulo:	Touba Mbayard	1,245	73	4
	Diourbel Tocky	1,000	50	6
	Ndombé	173	12	3
	Ngadiaga	1,839	77	6
Ndindy:	Darou Dia	1,557	93	6
	Thiax	1,330	62	9
	Marina Sylla	1,555	69	7
	Gade Khapsou	361	24	4
	Khaigene	2,051	74	7
"New" Villages Subtotal		11,111		
Ndindy:	Palene	252	23	2
	Keur Ndiouga Mbaye	422	44	3
	Ndiadakhar	1,551	91	4
	Layabé	replaced by Gade Khapsou		
	Ndiogop Ndiaye	1,140	52	9
	Lomene	641	32	6
	Darou Salam Gallé	0	0	0
	Ndindy Gouye	384	18	2
	Keur Moussa Sall	318	14	3
	Mbeder	0	0	0
	Gouye Gaye	1,946	81	8
	Diongo	0	0	0
"Old" Villages Subtotal		6,654		
Totals		17,765		

Table 10. Village Nursery Production in Bambey Department as of mid-June, 1983

District	Village	Nursery Production	% Survival	Number of species
Lambaye:	Mbarry	1,822	46	17
	Ndondol Codou II	3,431	92	16
	Thieppe	2,186	67	13
	Keur Allé	1,167	42	13
	Sarr	2,340	77	15
	Keur Ibra Diop	1,669	51	14
Ngoye:	Khandiar	3,321	78	14
	Kodjilene	1,713	43	10
	Ndiemane	2,145	54	9
"New" Villages Subtotal		19,794		
Ngoye:	Ngangarem	450	-	4
	Bakakak	350	-	2
	Sessene	0		
	Ndimb	0		
	Battal	0		
	Bari Ndondol	0		
"Old" Villages Subtotal		800		
Total		20,594		

Grand Total for 1983 Village Nurseries = 38,359 seedlings

In addition, some seedlings (especially kads and fruit trees) will be available from the Regional Nursery at Sambé which has about a 100,000 plant production: 6,000 kads from that nursery will be available for project use

There are departmental nurseries in Ndounka (Diourbel), which have about 25,000 prosopis, sump and mangoes, and in Bambey (production numbers unknown) which may provide some seedlings, if needed.

(c) Training of Village Nurserymen. A one-day training session (scaled down from the 1982 version due to the lack of funds in the "Caisse d'avance") was held on March 18, 1983 for 18 Diourbel villagers (2 from each of the 9 "new" villages) at the Regional Nursery at Sambé. The Bambey session, also for 18 villages from 9 "new" villages, took place at the "pilot farm" of Khandiar on April 8, 1983. The purpose of these sessions was to give some basic training on nursery techniques to the newly-designated village nurserymen.

(d) Accomplishments as of June 30, 1983. With a few exceptions caused by the early rains, tractor subsoiling of woodlots and some kad fields had been completed by this date.

One of the objectives of this campaign was to find a more cost-effective and more timely protection scheme for the village woodlots. The "Australian" fencing approach was replaced by a system which utilizes project-furnished materials -- barbed wire and ronier palm (Borassus aethiopum) posts -- and is reinforced by natural fencing materials provided by the villagers, namely transplanted Euphorbia balsamifera, thorn branches (mainly kad), and nguer.

A few villages lack some or all of the barbed wire required, but for the most part, this system has been installed and is in various stages of reinforcement with local fencing materials. The natural fencing work has slowed down due to two reasons: 1) the villagers are occupied with work in the fields following the first early rains, and 2) the root system of euphorbia has a tendency to rot when transplanted during the rainy season. This work should be resumed after the harvest season, when labor becomes available.

Tables 11 and 12 show the projected planting surfaces of village woodlots and kad fields. Not included are individual distribution requirements which were not available before compilation of this report.

Table 11. Projected planting surfaces and seedling requirements for 1983 in Diourbel Department.

District	Village	Nursery Production	Woodlot Area (ha)	Spacing (m)	Woodlot Trees Required	Estimated Kads Required	Kads in Nursery	Fruit Trees in Nursery
Ndoulo:	Touba Mbayard	1,245	3.0	5X5	1,200	0	0	7
	Diourbel Tocky	1,000	0.63	5X5	250	0	7	0
	Ndombé	173	1.0	5X5	400	500	124	0
	Ngadiaga	1,839	{1.0* / 0.25	4X4 / 5X5	625* / 100	1,000	549	11
Ndindy:	Darou Dia	1,557	1.0	5X5	400	500	351	84
	Thiax	1,330	0.18	2.5X 2.5	300	550	90	28
	Merina Sylla	1,555	0.25	3.5X 3.5	200	2,500	229	74
	Gade Khapsou	361	0.28	5X5	125	400	109	2
	Khaigene	2,051	0.25	3.5X 3.5	200	5,800	662	63
"New" Villages Subtotal		11,111	7.84		3,800	11,250	2,121	269
Ndindy:	Palene	252	0.25	5X5	100	1,000	0	0
	K.Ndiouga Mbaye	422	0.25	5X5	100	400	0	0
	Ndiadakhar	1,551	0.25	5X5	100	600*	1	0
	Layabé	replaced by Gade Khapsou						
	Ndiogop Ndiaye	1,140	0.25*	5X5	60*	{200 / 300*	126	4
	Lomene	641	1.0*	4X4	250*	{300 / 100*	0	1
	D.S.Gallé	0	1.0*	5X5	150*	natural regeneration		0
	Ndindy Gouye	384	{1.0	5X5	400	2400	0	0
	"		0.84*	5X5	100*			
	K.Moussa Sall	318	{0.58	5X5	250	800	53	0
	"		0.32*	2.5X 2.5	80*			
	Mbeder	0	0.25	5X5	100	0	0	0
	Gouye Gaye	1,946	1.21	4X4	750	{1400 / 36*	569	6
	Diongo	0	0.41*	4X4	100*	0	0	0
"Old" Village Subtotal		6,654	3.79 / 3.82*		1,800 / 740*	6,500 / 1,036*	749	11
Totals		17,765	11.63 / 3.82*		5,600 / 740*	17,750 / 1,036*	2,870	280

* denotes replanting of existing plantations.

Table 12. Projected Planting Surfaces and Seedling Requirements for 1983 in Bambey Department.

District	Village	Nursery Production	Woodlot Area (ha)	Spacing (m)	Woodlot Trees Required	Estimated Kads Required	Kads in Nursery	Fruit Trees in Nursery
Lambaye:	Mbarry	1,822	0.38	2.5X 2.5	579	1,900	237	287
	N.Codou II	3,431	1.0	5X5	400	800	407	372
	Thieppe	2,186	0.44*	2.5X 2.5	582	1,500	591	117
	Keur Allé	1,167	0.54	4X4	300	600	21	235
	Sarr	2,340	1.22	4X4	750	550	488	198
	K.Ibra Diop	1,669	0.90	4X4	600	700	145	208
Ngoye:	Khandiar	3,321	1.0	5X5	400	2,250	969	145
	Kodjilene	1,713	2.0	5X5	800	542	770	60
	Ndiemane	2,145	1.0	5X5	400	1,000	825	0
"New" Villages Subtotal		19,794	8.48		4811	9,842	4,453	1,622
Ngoye:	Ngangaram	450	1.4*	5X5	525*	Kad	40	-
	Bakakak	350	0.54*	4X4	88*	requirements	200	-
	Sessene	0	0.29*	4X4	49*	unknown	-	-
	Ndimb	0	0.35*	4X4	142*		-	-
	Battal	0	0.50*	5X5	122*		-	-
	Bari Ndondol	0	0.50*	4X4	100*		-	-
"Old" Villages Subtotal		800	3.58*		1,026*	?	240	0
Totals		20,594	8.48 3.58*		4,811 1,026*	9,842	4,693	1,622

* Denotes replanting of existing plantations

Grand Total Projected for 1983 Plantations:

20.11 ha of village woodlots (10,411 trees)
7.4 ha of woodlot replanting (1,766 trees)
276 ha of kad plantations (27,592 kads)
10 ha of kad replanting (1,026 kads)

4. TECHNICAL EVALUATION

4.1 Nursery

(a) Water. Water problems are of two sorts: quality and quantity.

Recommendation n°6 of the mid-project evaluation: "test water for salt content..." (Weber 1981) has not been followed. Salinity levels of over 320 PPM (parts per million parts of water), or an electrical conductivity of greater than 500 micromhos/cm, can adversely affect seedling growth.

Water salinity appears to be more prevalent in the Bambey Department. Certain village nurseries in 1981 and 1982 were suspected of having this problem. This year, Keur Allé (Lambaye District) seems to be suffering from salty well water, as their low nursery survival percentage indicates (Table 10).

Keur Allé also is affected by the other water problem -- quantity. The water table in their well is situated at 70 m or deeper and during one field visit (June 8, 1983) it was noted that drawing the waterbag up, once filled, required more than one minute's time. Some wells located in the Bambey villages are very deep: 70 m at Thieppe, 60 m at Khandia, 50-60 m at Mbarry and 50 m at Sarr.

At Ndoumbé (Diourbel), the well level is at 50 m and there are constant problems with lack of water in the nursery.

(b) Delivery of materials. The tardiness of delivering nursery materials -- "crinting" fencing, tools, watering cans, plastic pots, seeds, cement for water basin, etc. -- has plagued the project. In general, these deliveries have been made between mid-March and the end of April.

In 1981, the delays were attributed to "start-up" problems: late arrival of project truck, late mobilization of funds. In 1982, funding delays pushed the program back; the first installment, about 10.5 million FCFA, was received by SWF/Dakar on March 3 (some advances were previously made). In 1983, multiple factors were responsible: the Africare program design for 1983 was done late and without consultation of SWF/Diourbel nor Peace Corps; the first payment to SWF/Dakar was not made until the end of January; there was uncertainty about additional AID funding for the third year extension; the operational budget submitted by SWF/Diourbel to Africare required two revisions because it was not adequately broken down into line items; the national election campaign in February caused the project vehicle to be convocated for electoral use.

Late arrival of materials has two negative consequences. First, this means that seeding in pots usually does not start until mid-to-end of April and continues into May, or even early June in cases of reseeding. Some species, such as kad, should remain in the nursery for about four months after germination (Weber 1977). Late seeding can result in under-sized seedlings being planted. In a stressful environment like the Sahel, these seedlings are at a great disadvantage from the start. Secondly, delays cause a period of nursery work to coincide with the distribution of seed peanuts (in May) and results in less labor availability in the nurseries.

(c) Seed. The quality (and sometimes quantity) of seed for the village nurseries has been cited by project personnel as a major problem.

This year, eucalyptus seed was procured from CNRF/Dakar, and consisted of two provenances (Cheikh Savaré, personal communication, 1983):

E. camaldulensis - SANGALKAM
origin: Cap Vert Region - "Niayes"
collected: 1980

E. Camaldulensis - KOUTAL Verger
origin: Sine-Saloum Region
collected: May 6, 1980

Normally, eucalyptus seed remains viable for several years if air-dried and stored in sealed containers in the dark at 1-4°C. In unsealed containers at room temperature, the seed has an "acceptible germinative capacity" for 1-2 years (FAO 1979).

The seed storage conditions are not known by the evaluation team. Germination of eucaplyptus in this year's nurseries has been generally poor. One can only speculate if the cause rests with the quality of the seed or with improper techniques (e.g. careless watering).

Neem seed used in the project are often collected along roads -- neem being a common species for roadside ("axes routiers") plantings. This year many neem seed were described as "rotten" or "dried out", indicating they laid on the ground for a long time before collection and have no or very poor viability.

With kad seed collection, it is recommended to avoid collecting old, woody-looking pods and to use the seeds immediately after they have been separated from their pods (Sidibé, cited by Giffard 1975).

These two species, neem and kad, are present throughout the project zone. Where possible, villagers should be encouraged to carry out their own seed collection from parent trees of good vigor. A large piece of material can be placed under desired trees, when seeds are ripe to receive the seed fall.

(d) Shading. A prolonged or unnecessary use of shading ("ombrières") on seedlings was observed at some nurseries. For example, "crinting" shade panels were seen over kads in Ndoumbé (May 24, 1983) and over neem seedlings in Ngadiaga (May 25).

Although there are no absolute rules for the duration of shading, it should be gradually removed once the seedlings are beyond the vulnerable stage. For eucalyptus, this stage is generally a few weeks after germination in the pots (or after "pricking out" in the case of the "germoir" method). For prosopis, this danger period is even shorter, about a week. Of course, when the weather is extremely hot, the shading period may have to be prolonged, at least for the hottest hours of the day. Shading is not recommended for kad or neem seedlings (O.Hamel and C.Bailly, personal communication, 1983).

The adverse effects of prolonged or unneccessary shading are: slower initial growth due to reduced photosynthesis; longer period of succulence and hence vulnerability to damage by birds, insects and rodents; and a delay in the hardening off of the plant to actual solar conditions.

(e) Pests. Damage to seedlings have been attributed to insects, birds, lizards, rats, ground squirrels and rabbits. On kad, both in the nursery and once planted in the field, certain caterpillars have been observed as well as a "cabbage-leaf" phenomenon indicative of a fungus.

In 1982, HCH was distributed by the project. However, AID Project Manager Diallo has informed project personnel that this substance was banned recently in the U.S.; he advised to discontinue its use. The insecticide used this year is Tymul 35 which comes in a liquid form and is applied at a 1:200 dosage (e.g. 1/2 liter for 100 liters of water). Use of any chemical pesticide must be rigorously supervised and monitored by project staff.

For protection against birds and rodents, thorny branches laid across the top of the seedling pots can prove to be effective. This was seen at the Kodjilene nursery.

4.2. Plantation

(a) Site selection. Most village woodlot sites are "donated" by an individual who customarily "owns" the land. While land scarcity is the rule in this Region, there are some landowners who hold important hectarages. For them, the donation of 1/2 - 1 hectare to the village reforestation cooperative ("groupement") is no personal sacrifice because they own more land than they can farm at any given time.

In addition, many sites given over for woodlots are marginally or non-cultivatable land such as slightly elevated (drier, more exposed) sites or "bas-fonds" (seasonally inundated depressions). Many of the 1983 woodlot sites are located in little "bas-fonds", where soils are of the type "sol deck dur" -- hard, compact, clay soils subject to seasonal inundations during the rainy season (July through September). This is quite a contrast to the "sol dior" type that is characterized by light sandy (<1% clay content) soils low in fertility (<1% organic matter) and is the dominant type in the Region.

One important characteristic of the 1983 sites is that they are usually situated close to or on the periphery of the villages. This allows easy access for maintenance. Also, on cultivatable sites, the close proximity to villages makes agroforestry practices in woodlots -- intercropping of peanuts, even vegetables such as eggplant and squash -- both feasible and desirable.

(b) Species selection. The performance of *Eucalyptus camaldulensis* planted in 1981 and 1982 indicates that this species is an inappropriate choice for most of the Diourbel Region:

Department	1981 No.Planted	1981 % Survival	1982 No.Planted	1982 No. Surviving	1982 %
Diourbel	3215	10	2055	355	12
Bambey	8380	1*	1506	596	40

* Reflects the total failure of the Ndiemane plantation

Guidelines for the minimum rainfall required to sustain good survival and growth of this species are of the magnitude:

$\geq$ 500 mm/yr for rural plantations.
$\geq$ 800 mm/yr for state-owned("en regie") plantation.

Figures 2 and 3 present the rainfall data registered in the project zone (SODEVA 1982 b). The average for the entire Region was below 420 mm/yr for 1981 and 1982.

The fact that Ngoye received 427 mm in 1982 -- almost 70 mm more than Ndindy -- may partly account for the better survival rates of eucalyptus planted in Bambey in 1982. A note of caution: rainfall in the Sahel is highly localized and variable. This limits (short of installing rainfall gauges in every woodlot) the conclusiveness of impressions drawn from available rainfall data.

It is conceivable that E. camaldulensis can perform well on sites with a shallow, exploitable water table (perhaps less than 20 m deep) even when annual rainfall is below 500 mm. Examples of this can be found in the "Niayes" zone (e.g. FAO Dune Stabilization Project in Kébémer). Contrary to the recognition that a rootzone of one meter or deeper is a requirement for camaldulensis, its best growth has been observed in "bas-fonds" where soil are compact but water availability and retention are much greater. This, however, raises two questions:

1) How long can E. camaldulensis grow well in compacted soil situations which restrict root growth?

2) Given the water salinity problem in Bambey, how will that eventually affect Eucalyptus within exploitable range of the groundwater?

Research at the CNRF Bambey Station has resulted in suggesting Eucalyptus microtheca for hard or very hard soils ("sol deck dur") in the groundnut basin (Hamel and Bailly 1981 a).

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Figure 2. Accumulated and monthly rainfall for 1982 in Ngoye and Ndindy Districts.

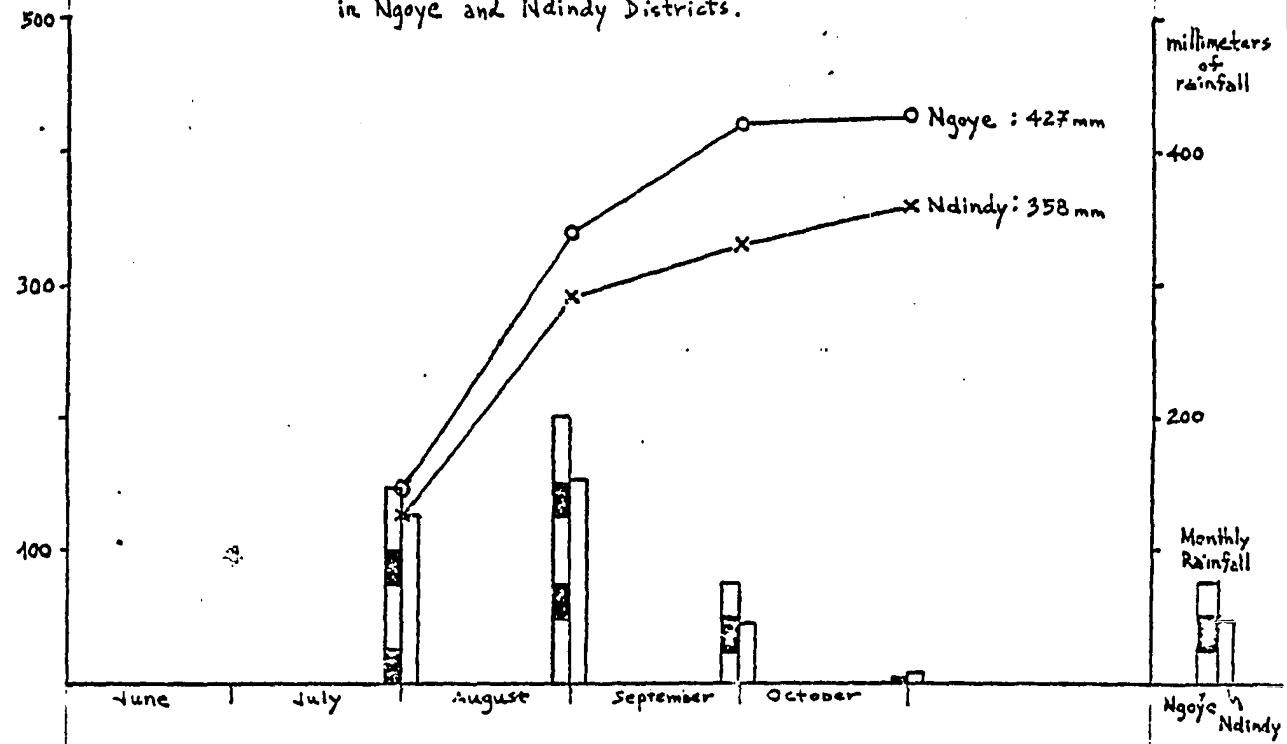
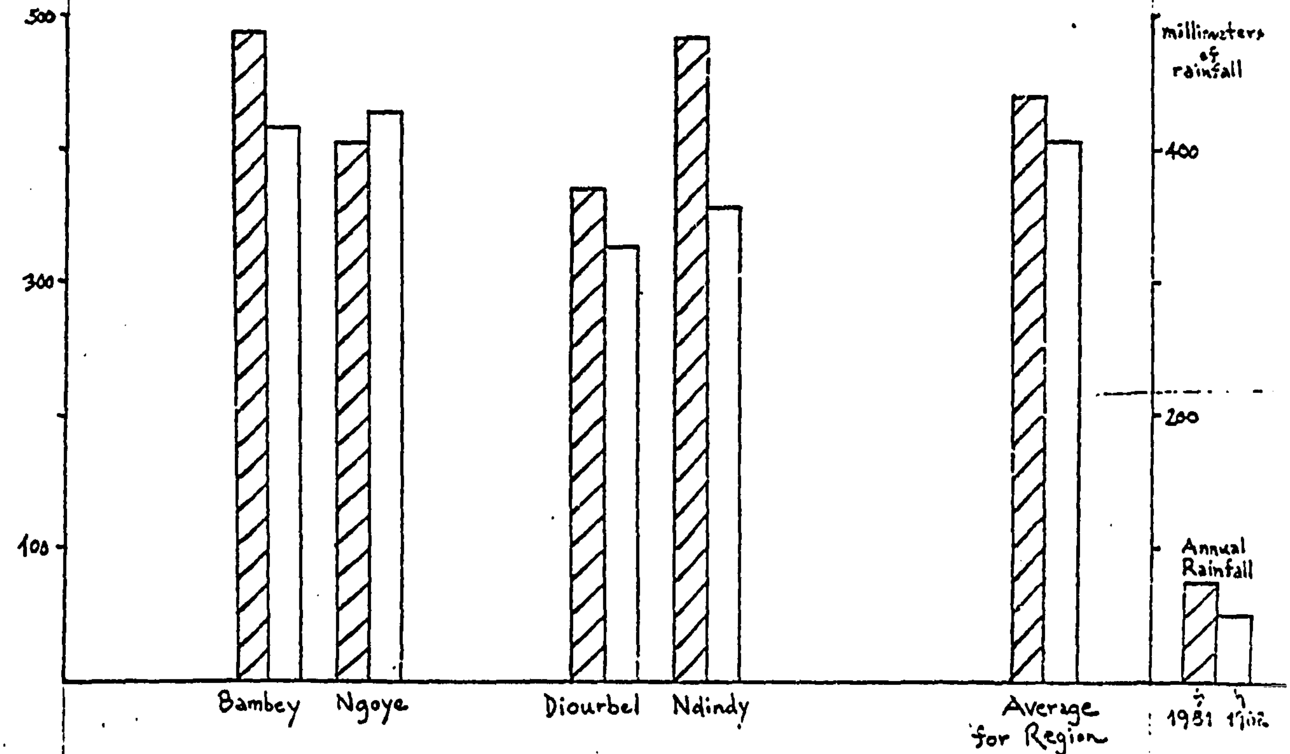


Figure 3. Comparison of annual rainfall for 1981 and 1982.



The most recent growth data (1982) on E. microtheca indicates a rate of 3.4 m^3/ha/yr for trees planted in 1972 (O. Hamel and C. Bailly, personal communication, 1983). This compares favorably with the yield of 2.2 m^3/ha/yr recorded in 1980 for the best provenance (7791/FTB) of E. camaldulensis at the Bambey Station.

On this basis, Eucalyptus microtheca should be tried on an experimental scale in project woodlots located in "bas-fonds". Experience with this species in the Sudan has shown that it is tolerant of flooding as well as being more drought and heat-resistant than E. camaldulensis (FAO 1979).

At this point of the project, Prosopis juliflora has proven to be the most resistant species against drought, termites and water salinity. Species trials for reforestating the saline "tanns" soils of the Sine-Saloum Region attest to the salt tolerance of prosopis. Planted in 1971, P. juliflora had a survival rate of 56% in 1980 on the "tanns" soils of the CNRF Keur Makhar Station. This rate was surpassed only by Melaleuca spp. and Acacia laeta (Hamel and Bailly 1981 b). In addition, prosopis has been the most successful species in the nurseries. A total of 16,786 prosopis were growing in the project nurseries in mid-June, more than the total number of kad, eucalyptus and neem.

As mentioned, the growing of local species in nurseries has expanded this year, especially in Bambey. The species diversity concept should also be encouraged in village woodlots. A well-known ecological principle is that polycultures are more resistant to climatic, pest and disease problems than are monocultures. The 1982 woodlot at Gouye Gaye -- eucalyptus, neem, prosopis, and Acacia holocericea -- is a fine example of a mixed plantation which will yield fuelwood, poles, forage, and other products.

(c) Site preparation. Ground preparation has been performed by a 1974 Fiat tractor on loan from SWF/Diourbel. One-tooth subsoiling in two directions at right angles is done at a spacing of roughly 5X5 m in woodlots and 10X10 m in kad fields. The utility of this operation is questionable. First, on light, sandy "sol dior", ground preparation needs are minimal and simple hand-dug holes would probably suffice. Secondly, on "sol deck dur" in depressions where subsoiling is definitely needed, the tractor is not powerful enough to adequately rip the compact soils. It appears that the most valuable function the tractor serves is "piquetage"; the spots where the subsoiling lines cross mark the planting locations.

The trials on digging large holes ("grands potets") in woodlots with hard soils in Bambey -- Mbarry (175 "grands potets"), Sarr (185) and Ndiemane -- should be followed closely.

While digging holes of this dimension (a cube of 40-50 cm on each side) is very labor-intensive, it may prove to be more effective than the current tractor subsoiling.

(d) Spacing. Spacing guidelines used for village woodlots are roughly 5 X 5 m. In 1982, some villages planted additional rows of trees in between the subsoiled rows, thus approximating a 2.5 X 2.5 m spacing (e.g. Keur Moussa Sall).

Talking in consideration the current mortality rates (only 1 in 3 survived from 1982 woodlots), and even with a reduced proportion of eucalyptus planting in 1983, it is recommended that closer spacings (2-3 meters between trees) be adopted. The rationale is to fully occupy the site, increase yields, and avoid the need for replanting ("regarnissage"). The exception to this recommendation is woodlots which have agroforestry potentials, in which case a 5 X 5 m spacing should be retained to allow intercropping between trees.

(e) Size of Woodlot. It logically follows that the smaller the woodlot is, the easier it is to maintain. Figure 4, though perhaps lacking in statistical validity, suggests the relevance of the above statement to the 1982 woodlots. As woodlots size increases beyond 0.5 ha, survival rates generally become lower. Though desirable from a survival standpoint, a 0.5 ha woodlot can theoretically only fulfill the fuelwood needs of three people. Perhaps the best approach is to keep woodlots small, but to establish as many woodlots as land and labor constraints would allow and in a time-staggered fashion to ensure a sustained flow of wood products.

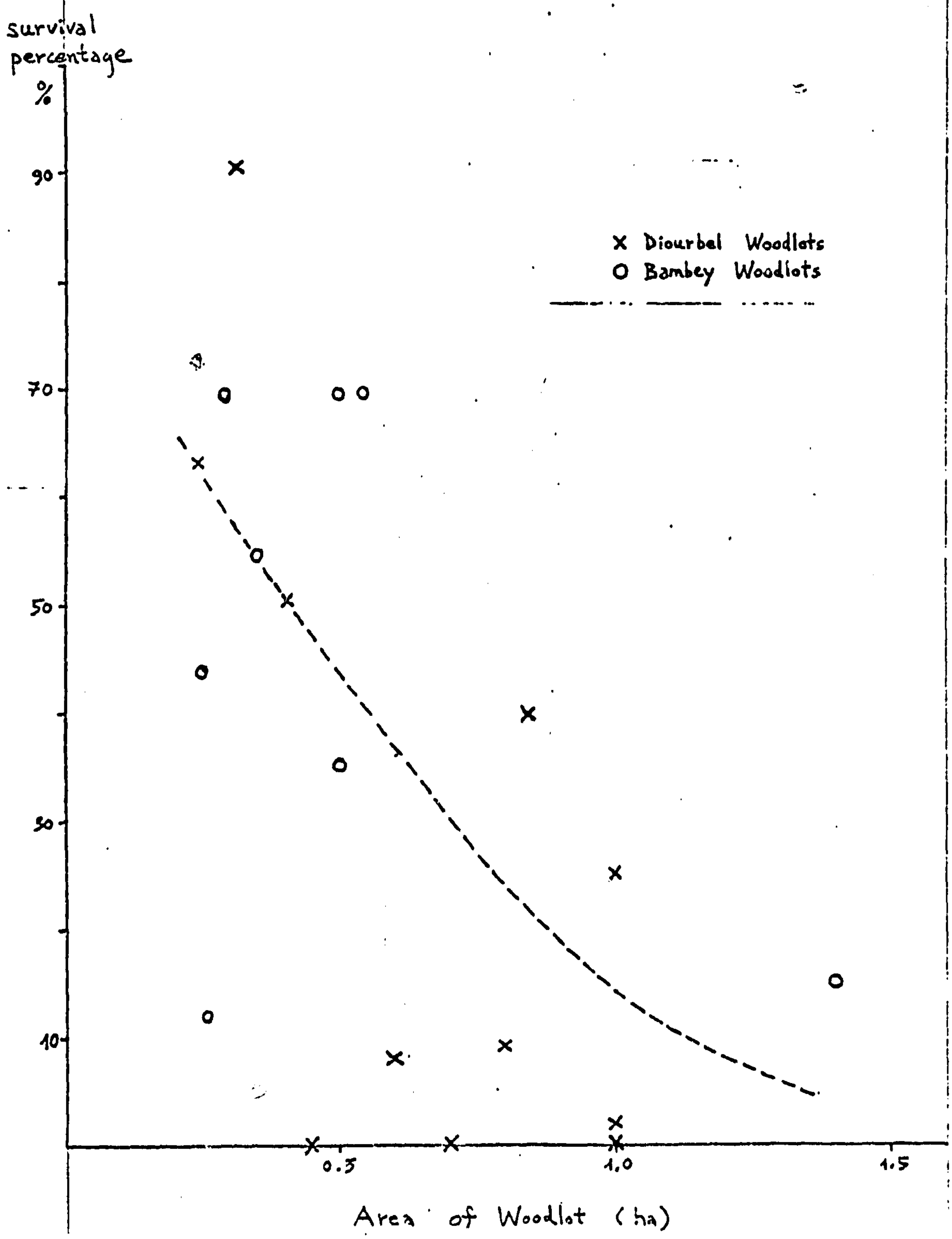
4.3 Protection and Maintenance

(a) Village woodlots.

(1) Fencing. The fencing of woodlots is critical in the Diourbel Region due to the increasing numbers of livestock present, in permanence or in transhumance. The lesson learned from the past campaigns is that an effective fencing system must be erected before the end of harvest season, when livestock reappear in the fields for stubble grazing.

The delays in delivery and installation of the "Austrailian" fencing in 1982 resulted in significant mortality to trees as a result of livestock damage.

Figure 4. Survival rates of woodlots as a function of woodlot area.



In fact, three woodlots in Diourbel -- Palene, Ndiouga Mbaye and Ndiadakhar -- had suffered such serious depredations before the arrival of the fencing, that a decision was made to reserve the fencing for new woodlots to be established by those villages in 1983.

In general, the "Austrailian"fencing is very effective, especially against small ruminants who "bounce" off of the wire mesh. However, it is expensive (about 400 F/linear meter, installation included) and requires "experts" with special equipment to correctly apply tension to the fence during installation. Some villagers had begun to install natural fencing on their own but ceased when told by ATEF's that the wire fencing would arrive.

This year, a different fencing system was adopted: a three-strand barbed-wire enclosure, supported by ronier posts at five meter intervals, and reinforced by a combination of euphorbia, thorn branches and/or nguer provided by the villagers. During a field visit in June, the Africare Project Assistant proposed, independent of other project personnel, adding a fourth strand of barbed wire to all the 1983 woodlot fences. The cost-effectiveness of the current system (3-and 4-strand versions) is examined in the Economic Evaluation.

From a technical standpoint, the barbed-wire system (regardless of 3 or 4 strands) is relatively ineffective without reinforcement by natural fencing materials. In Merina Sylla (Diourbel), goats were observed to "walk through" a section of the 3-strand fence where euphorbia had not yet been transplanted. One advantage of this system is that barbed wire can be installed by the villagers themselves and conceivably be taken down and used for future woodlots once the euphorbia has rooted and is reinforced by thorns and/or nguer. However, the ronier posts -- which constitute almost one-half of the total cost of this fencing scheme -- cannot be expected to last much beyond three years, without insecticide treatment, in spite of its reputed termite resistence. In addition, one should question the importation of wood into a project designed to generate wood products. What, then, is the input/output ratio of usable wood?

One positive aspect of this year's fencing is that most of it is already installed and being reinforced with natural materials. The timing of the current protection effort is a vast improvement over that of the past campaigns. One cannot overstate the value of having the village woodlot protected before planting.

(2) Pest control. Termites are the biggest pest problem encountered thus far in the woodlots. In a general sense, termites do not kill healthy trees; they prey on weakened, stressed individuals. That is why many eucalyptus, a species marginally suited to this zone, have succumbed to termites.

In 1982, HCH powder was distributed to villages and applied in woodlots to control termites. The effectiveness of this action was variable. Although judicious applications of the insecticide inevitably helped to reduce the termite problem, there was some abusive use. In at least one woodlot -- that of Mbeder -- trees were killed by an overdose of HCH. Some villagers have even dusted mattresses with HCH in order to get rid of bugs. This illustrates the potential danger (to humans as well as trees) of insecticide misuse and the imperative need for project personnel to continuously control its distribution and application.

For severe termite problems, "Dielpoudre" appears to be the most effective agent. In one test conducted by CNRF on the effectiveness of insecticides against termite attacks on eucalyptus, trees treated with "Dielpoudre" sustained 0-2% mortality, compared with 25-30% mortality for other insecticide treatments and 90% for control trees (O. Hamel and C. Bailly, personal communication, 1983).

(3) Weeding. There is considerable variation in the weeding operation of woodlots. In general, weeding seems to have been done frequently and early in the Diourbel woodlots. During a visit to the Battal woodlot (June 9, 1983) in Bambey, the ATEF explained that the villagers wait until there is a substantial grass "crop" (for livestock feed) before they weed the woodlot. A line weeding (one meter on each side of the rows of trees) is performed in November and the rest of the herbaceous cover left to exploit the remaining soil moisture before a complete weeding is done in December or January to harvest the grass "crop".

This is inadvisable since for weedings to have a positive impact on trees, they must be performed as early as possible during the rainy season. Otherwise, the herbaceous layer will use up much of the available ground moisture. This is especially important for a species such as Eucalyptus camaldulensis which competes poorly with grasses for moisture (NAS 1980).

(b) Protection of Kad. Planted kad have survived better in Bambey than in Diourbel (Table 7).

In Bambey, two systems of kad protection have been used: 1) protection of individual kads with thorn branches (usually cut from mature kads) anchored by wood pickets around the tree (Ndimb, Sessene),and 2) protection of entire fields of planted kad with an enclosure of transplanted euphorbia (Ngangarem).

Supposedly, there is this second type of protection for a planted kad field in Gouye Gaye and a natural kad field in Dar Salam Gallé (both in Diourbel).

Encouraging protection of kad -- planted or naturally regenerated -- should be a top priority of the project. With natural regeneration, the protection operation should be combined with the practice of selecting the best stem and pruning the excess shoots, a sylvicultural technique already known to Serers.

(c) Protection of Individual Trees. Despite the lack of precise survival information, this category of trees has, most probably, a higher overall survival rate than trees planted in woodlots or kad fields. The main reason is because trees planted in family compounds and village squares usually receive some form of protection and/or watering. This component of the project should be encouraged -- especially the protection aspects.

Another area worth encouraging is the development of small, individual woodlots. The two individual woodlots (a third failed) in Bari Ndondol attest to the potential value of small, "backyard" plantings. The eucalyptus, prosopis and lemon trees in those two mini-plantations are protected with natural fencing and growing very well, amongst the best trees planted in 1982. The incentives and benefits are very clear in this type of endeavor.

(d) Fruit trees. Fruit trees, although much demanded by villagers, are generally not doing well. Last year, when the majority of individually distributed fruit trees came from the Sambé Regional Nursery, the factor of transport shock (especially the long distances from Sambé to the Bambey villages) decreased the survival rate.

In village nurseries, growing fruit trees can prove difficult. This year's production (1,900 citrus, papaya and mango trees) represents about 5% of the total village nursery production.Once planted, fruit trees require protection and some watering in the first year or two.

As the SWF Project Director has noted, the desire for fruit trees should not overshadow the more paramount needs of the Region -- fuelwood and forage. As such, fruit trees should remain a vigorous but minor component of the project. It is recommended that their production level in the village nurseries should not greatly exceed 10% of the total nursery production, In addition, this is a prime consideration area for the sale of surplus trees from village nurseries. Ideally, some fruit trees (e.g. mango) should grow for about a year -- especially with bare-root stock -- in the nursery before outplanting. Perhaps the introduction of the sale of some fruit trees will be incentive to operate and water the nursery on a year-round basis, which would benefit all bare-root nursery stock.

5. ECONOMIC EVALUATION

5.1 Constraints and Limitations

A detailed economic analysis at this time is hampered by a lack of data on the actual time spent by villagers on the project, the opportunity costs of labor in this Region, and an inability to quantify some of the projected benefits.

An excellent conceptual approach to this problem is offered by Asif Shaikh (1981) in "The economics of village-level forestry: a methological framework". Shaikh advocated using the opportunity cost of labor (for both peak and off-peak seasons) as a measure of costs -- labor inputs into the project -- and as a measure of benefits -- labor saved in wood collection as a result of fuelwood produced by project.

Unfortunately, there is a lack of reliable baseline data on time spent on project and fuelwood collection, on off-peak seasonal migration of labor force. This makes it impossible to pursue a rigorous economic analysis within Shaikh's framework. Because of these shortcomings, the following assumptions are made (even at the risk of oversimplication).

* that the opportunity cost of land is zero: assumes that either non-agricultural land is donated for woodlot establishment or, in the case of cultivatable land, assumes some agroforestry application -- intercropping in woodlots or kad fields.

* that the opportunity cost of labor is fully offset by "vivres PAM" food distribution.

* that the market price of fuelwood and polewood be used to estimate future benefits.

5.2 Cost Analyses

(a) General costs. The following recapitulation is compiled from financial reports submitted by the Project Director and by Africare and do not include Africare overhead costs ("Bilans financiers" for 1981, 1982 and "Proposition du budget ..." for 1983).

Table 13. 1981 and 1982 Expenditures, Projected 1983 Expenditures.

Category	1981 (FCFA)	1982	1983
Personnel	2,100,000	2,082,500	
Equipment	5,883,000	2,915,000	
Fuel and lubricants	1,279,580	3,175,991	
Maintenance and repairs	219,655	2,667,526	
Nursery and plantation	1,718,280	8,723,616	
Other	413,917	772,293	
Totals	11,614,432	20,336,926	21,871,440

(b) Direct costs of 1982 campaign. Below is a breakdown of 1982 nursery and plantation costs:

Table 14. 1982 Nursery and Plantation Direct Costs.

Category	Amount (FCFA)	% of Total Direct Costs
Personnel	2,082,500	12
Nursery and plantation	8,723,616	50
Equipment operation		
fuel and lubricants	3,175,991	18
repairs and maintenance	2,667,526	15
Other	772,293	4
Totals	17,412,926	99

(c) Fencing Costs. In 1982, costs for the "Australian "fencing totalled 3,350,000 FCFA (at a unit price of 400 F/linear meter). This represented 19% of the total direct costs. The barbed-wire fencing used this year, 1983, has two cost components: barbed wire at 5,500 F per 100-m roll and ronier posts at 750 F/post. The unit cost (per linear meter) is about 315 F for the original 3-strand fence and 370 F for the 4-strand version proposed by the Africare Project Assistant.

Cost comparisons of the three aforementioned fencing schemes is given below:

Table 15. Comparison of Fencing Costs (FCFA).

Woodlot Area (ha)	Woodlot Perimeter (m)*	1982 "Austrailian"fence Cost per Woodlot	1982 "Austrailian"fence Equivalent cost per ha	1983 3-strand Cost per Woodlot	1983 3-strand Equivalent cost per ha	1983 4-strand Cost per Woodlot	1983 4-strand Equivalent cost per ha
.25	200	80,000	320,000	63,000	252,000	74,000	296,000
.50	283	113,200	226,400	89,145	178,290	104,710	209,420
.75	347	138,800	185,067	109,305	145,740	128,390	171,187
1.00	400	160,000	160,000	126,000	126,000	148,000	148,000

* Assumes a square area; in reality woodlots are often rectangular or trapezoidal thus increasing the actual perimeters and fencing costs.

It has been calculated that the "Austrailian"fencing system becomes cost-effective only when a woodlot surface is greater than 30 ha (according to Chris Berring, German Embassy,DKR). . Applying that standard, the 3-strand barbed-wire fence (representing 79% of the cost of the "Austrailian"fencing) would be cost-effective for areas of 24 ha or larger. And the 4-strand fence, amounting to 92.5% of the "Australian "fencing costs, would be minimally cost-effective for woodlots of 28 ha.

Considering the maximum size of village woodlots in the project -- 1.4 ha in 1982 and 3.0 ha in 1983 -- the fencing systems used thus far in the project are not economically feasible.

5.3 Present Net Value Analysis

The 1982 project activities were, essentially, : 1) village woodlots,

2) kad plantations, and 3) individual distribution of shade and fruit trees. The three components added up to 125 equivalent hectares. Concerning overhead costs, the indemnities paid to project personnel (1,9500,000 F) will be imputed evenly over the 125 ha. Hence, a overhead cost of 15,640 F/ha. The indemnity paid to the tractor operator (2,500 F/day) will be included in the woodlot and kad plantation analyses, the two components which involved tractor subsoiling.

(a) Village woodlots. The following direct costs are assumed for the 11.5 ha of village woodlots established in 1982:

- seedling costs: assume 3-year life expectancy for each nursery at a total start-up and recurrent cost of 250,000 F and a total production of 3,000 plants over three years (based on actual 1st and 2nd year production in project nurseries). Therefore, an average production cost of 80 F/plant. 6,695 seedlings used in the 1982 woodlots X 80 F = 535,600 F

- subsoiling costs: at 32.5 liters of gasoil required for one hectare of tractor subsoiling (about 1 1/2 hours), and 155 F/liter, fuel costs for 11.5 ha of subsoiling = 57,931 F.

The tractor operator spent about 12 days subsoiling the woodlots. At 2,500 F/day, his indemnities = 30,000 F

-Protection costs; 3,350,000 F for "Austrailian"fencing

-Overhead costs: 11.5 ha X 15,640 F/ha = 179,860 F. The total of all above costs = 4,153,391 F

Normally, species such as eucalyptus and proscpis regenerate after coppicing and one can excapt a second and possibly third rotation in this manner. However, given the low survival rates and the need to replant, this aspect is not considered for the 1982 woodlots. Future benefits are calculated as such:

- 3 m^3/ha/yr production under full stocking, this corresponds to 1.02 m^3/ha/yr for the current 34% survival rate in 1982 woodlots.

- a 7-year rotation period.
- polewood as the end-product of eucalyptus.
- 30/70 ratio of polewood/fuelwood trees surviving in woodlots.
- 1982 base market prices in Diourbel of;
  1,000 F/pole and 35 F/kg of fuelwood.
- conversion rate of 700 kg of fuelwood/1 m^3.

Assuming a 12% discount rate, the present net value (PNV)and the internal rate of return (IRR) of the project are calculated at different sensitivity levels of market price, wood yield and natural fencing.

Table 15. Calculation of PNV and IRR for 1982 woodlots.

Hypothesis	Yield (m^3/ha/yr)	Polewood (FCFA/pole)	Firewood (FCFA/kg)	IRR (%)	PNV (FCFA)
1A	1.02	1,000	35	- 9.2	-3,194,402
1B	1.02	1,200	42	- 6.7	-3,002,604
1C	1.02	1,400	49	- 4.7	-2,810,806
1D	1.02	2,000	70	+ 0.3	-2,235,412
1E	1.02	4,000	140	+10.7	- 317,433
1F	1.02	4,500	157.5	+12.6	+ 162,061
2A	3.0	1,000	35	+ 6.0	-1,329,952
2B	3.0	1,200	42	+ 8.8	- 765,264
2C	3.0	1,400	49	+11.2	- 200,576
2D	3.0	1,500	52.5	+12.3	+ 81,768
3A*	1.02	1,000	35	+14.9	+ 155,598
3B*	1.02	1,200	42	+17.9	+ 347,396

* Assume natural fencing of woodlots

This particular set of calculations affirms that "Australian "fencing is prohibitively expensive as a protection method. Under current survival rates (34%) and expected yields (1.02 m^3/ha/yr), market prices would have to increase by a factor of 4.5 before one arrives at a profitable IRR (Hypothesis 1F). If full stocking could be acheived (nearly 100% survival rate of woodlot trees), expected yields would be of the order 3 m^3/ha/yr, and economic profitability would be acheived if market prices of fuel-and polewood increased by 50% (Hypothesis 2D).

If natural fencing is substituted for the "Austrailian"fencing, the 1982 village woodlots would be profitable even with actual survival rates and current market prices (Hypothesis 3A).

(b) Kad plantations. For the 77.68 ha of kad plantation in 1982, the cost breakdown is as follows:

- seedling costs: 7768 seedlings X 80 F = 621,440 F

- subsoiling costs: assume 16.25 liters/ha (spacing of 10 X 10 m is twice as wide as woodlot subsoiling spacing) X 155 F/liter X 77.68 ha = 195,656 F

The tractor operator worked approximately 33 days in kad fields X 2,500 F/day = 82,500F

-Overhead costs: 77.68 ha X 15,640 F/ha = 1,214,915 F

The total cost = 2,114,511 F/77.68 ha
or 27,221 F/ha

In calculating future benefits, the following assumptions are made:

- agricultural surfaces in the Diourbel Region are divided into 55% for millet and 45% for peanut production (from "Consumption effect of agricultural policies: Senegal", University of Michigan).

- Kad has maximum, beneficial effect on agricultural production between 20 and 40 years after kad is planted.

- Average production of millet and peanuts is 600 and 800 kg/ha, respectively, in fields without kad.

- Between the ages of 20 and 40, kad can increase millet production by 100% and peanut production by 30% in intercropping situations (Giffard 1974, Giffard 1975)

Therefore, on an "average" hectare in Diourbel, the potential agricultural increase due to planting Acacia albida is:

.55 X 600 = 330 kg of millet
.45 X 240 = 108 kg of peanuts
438 kg total

Current producer prices are about 60 F/kg for both peanuts and millet. If an average price of 100 F/kg were assumed for both crops between the years 2002 - 2022 (20-40 years after the 1982 kad plantings), an annual benefit of 43,800 F/ha is accrued for each of the years in that period. Discounting at a rate of 12%, we find:

$$\sum_{t=20}^{40} \frac{43,800}{(1+i)^t} = 38,456 \text{ F}$$

where i = 12%

Thus the present net value is:

PNV = 38,456 - 27,221 = +11,235 F/ha

Therefore, kad plantations can be considered to be economically profitable from a standpoint of increased agricultural production.

In addition, in fields where the density exceeds 45-50 large mature kads per hectare (at this level, a fairly continuous canopy exists), the excess trees present a potential fuelwood source. This is based on two hypotheses: that after age 40, the kad produces fewer leaves and pods and is less beneficial to agricultural production; and that more than 50 mature kads/ha may adversely affect the groundwater balance during the dry season (Freeman 1982). Harvesting one excess, mature kad each year would produce about 1 m^3/ha/yr.during the period excess trees were available.

A PRECOBA study on kad plantations in Diakhao and Ndiakhar Districts (Sine-Saloum Region) -- a zone situated between Diourbel and Fatick -- indicates a possible fuelwood yield of 1.8 m^3/ha/yr. This is based on a 40 - year rotation of kad planted at 10 X 10 m, with pruning of branches for fuelwood commencing at age 10 and thinning of trees for fuelwood starting at age 20 (PRECOBA 1982).

The potential fuelwood benefits of 1982 kad plantation are not considered here because of the highly variable survival rates on a project-wide basis.

"One important area of forestry benefits is not quantifiable within the scope of a village level project analysis: the external (macroeconomic) benefits of environmental stabilization " (Shaikh 1981). This observation applies perfectly to Acacia albida. How can one evaluate the magnitude of its effects on "halting desertification"? And how can one quantify the value of that effect?

(c) Individual distribution. For the 22,292 shade and fruit trees distributed to villagers in 1982, an equivalent planting area of 35.7 "equivalent" hectares was presumed (625 trees/ha). The cost breakdown for these trees is:

- seedling costs: 22,292 seedlings X 80 F = 1,783,360 F
- overhead costs: 35.7 ha X 15,640 F/ha = 558,348 F

The total cost = 2,341,708 F/35.7 ha
or 65,594 F/equivalent ha

The benefits of these plantings -- shade, fruit, village beautification, etc. -- are next to impossible to quantify. It should be noted that trees in this category probably have the highest overall survival rate due to protection, care, and watering.

(d) Other benefits. There are other important benefits generated by the project: the improvement of nutrition during the difficult pre-harvest time is beneficial to farmers. They obtain food through the distribution of food for Program. Other advantages are the energy and fatique saved from wood collections; the importance of *Acacia albida* leaves and pods as livestock fodder furing the dry season; the increased production of peanut vines under kad as another important dry season fodder; the transfer of nursery and plantation technologies to villagers in the Region; and the potential revenue from sale of vegetables, seedlings, forage, and polewood.

6. SOCIOLOGICAL EVALUATION

The sociologist visited eight project villages -- Layabé, Gouye Gaye and Paléne (Diourbel Department) and Battal, Ndimb, Sobeme, Bakakak and Ngangaram (Bambey Department).

Group interviews were held at each village and a series of nine question (see Appendix B) were posed to the villagers. With the exception of Layabé, the villagers showed a willingness to cooperate and answered openly to the questions.

6.1 Survey Findings

(a) Perception of problem. In general, the villagers are acutely aware of the lack of fuel and construction wood in the Region. They perceive this "crisis of wood" to originate from the severe drought of the late 1960's and early 1970's which led to the death of many trees. They cite the current difficulties: the drudgery of fuelwood collection (3-5 kilometers is the minimum distance women walk to find wood) and the problems of finding wood for construction needs.

(b) Desired Trees. The species most cited as desirable for planting by villagers were kad, eucalyptus, neem, prosopis and fruit trees. The reasons given were:

(1) Kad - multiple benefits: forage, construction and fuelwood, soil regeneration. One saying heard is that "seven kads in a field constitute a reliable wealth".

(2) Eucalyptus - polewood for construction and potential source of revenues.

(3) Neem - rapid development, good fuelwood. One villager boasted of selling a neem at 3,000 F for fuelwood every year.

(4) Prosopis - good fuelwood and forage.

(5) Fruit trees - mango, papaya and citrus fruit.

The villagers think that February is a good time to start nursery activities because they have the greatest availability of time during that period.

The villagers view the woodlots as their own property and the basic understanding is that future benefits will go to those individuals who have worked on the woodlots.

(c) Perception of "sensibilisation". One general reaction concerning how the villagers view the "sensibilisation" role played by PCV's and ATEF's is voiced as such: "if someone travels dozens of kilometers to come to tell you, "I want to help you plant trees which will belong to you", you should listen and pay attention to him".

(d) Land Tenureship. Land scarcity is perhaps the most limiting factor on the project. Sometimes two conditions may be imposed by the donor of the land for a village woodlot:

- that the herbaceous cover growing in the woodlot remains the donor's property. When villagers weed the woodlot, the grass goes to his livestock.

- that if the woodlot operation ever ceases for one reason or another, the land rights revert back to the donor.

6.2 Level of Village Participation

In 1982, the 8 villages of Bambey had an average of 19 people per village who contributed "self-help" labor to the project. In Diourbel, there was an average of 10 workers per village for the 12 villages engaged in 1982 (Cheikh Savaré, personal personal communication, 1983).

Thus far in the 1983 campaign, the level of participants has generally been higher. In the Bambey villages, the average number of workers in the nurseries of the 9 "new" villages was 57 in April and up to 79 in June (of which 41 were women). (from "WFP food/or work program" information, SWF/Bambey). In Diourbel, the 9 "new" villages have an average of 25 participants, while the 11 "old" villages have about 7 workers in each (some with only 1 or 2 workers).

The participation of women in the project is critical since women traditionally perform the task of drawing water from the wells. In villages such as Thieppe, which has a water level deeper than 70 m in their well, the nursery operation is dependent upon the village women (64 of them participate in the project) to provide water for the seedlings and the associated vegetable garden.

Most project villages range from 200 to 300 inhabitants. Therefore, the rate of participation in the project is roughly from 10 to 30% of the population.

6.3 "WFP Food For Work" Distribution

Distribution of the WFP Food Program to villagers for reforestation work is under the SWF but has been integrated into the project as a work incentive.

The WFP Program (SEN 2236) is administred by Mr. Mansour NDiaye, who is also the Director of the FAO Dune Stabilization project in Kébémer. The first phase of the program was from 1978 to 1980; the second phase will expire at the end of 1983. A possible third phase is under study.

The general guidelines of WFP FFW distribution for reforestation activities is as such:

Table 16. WFP-FFW Distribution for Reforestation Activities

Category	Equivalent man-days
Kad plantations	80/ha (40% after planting)
Roadside plantings	15/km
Windbreak plantings	80/km
Village woodlot	40/ha

The daily WFP ration, per man-day, is 2.5 lg pf sorghum, 125 g of canned meat, 125 g of canned fish, and 100 g of vegetable oil.

In addition, the project gives WFP foodstuffs for village nursery participation. Distribution guidelines are followed when possible, but the actual amount of food given to villagers is subject to the availability of WFP stock. In general, food aid has been used more heavily in project villages in Bambey Department than in Diourbel Department. This may reflect the operational philosophy of the Chef de Secteur in Bambey.

Table 17. 1982 WFP Food Distribution to Project Villages

Type	Bambey Dept.* (Kg)	Diourbel Dept.
Sorghum	11,023	5,986
Meat	581	516
Fish	556	371
Oil	410	130
Totals	12,570	7,003

* This represents 2,990 man-days of nursery work and 1,450 equivalent man-days of plantation.

Thus far in 1983, participation in nursery work has increased greatly. For example, over 5,800 man-days were recorded for the 9 "new" villages in Bambey in April alone. One must ask what influence "WFP FFW" have on that increase.

The pros and cons of "WFP FFW" distribution have often been debated. It is clear that WFP food should not be the sole or major motivation for local participation in reforestation. However, it can be used as an effective form of incentive, especially towards the end of the long dry season when local food resources are depleted. The role of WFP Food in the project has, in general, been a beneficial one. Given the fact that the precedent of distribution WFP food had been already set for reforestation actions by villagers in the Region, its inclusion in the project was almost inevitable However, it should remain a minor incentive for participation in the project.

6.4 The Ethnology Issue

It is important to recognize the different ethnic groups and their "mindsets" with regards to reforestation. There appears to be a direct correlation between the degree of sedentarization and the propensity towards reforestation activities.

As such, the Peuls who are in the Region most often as transhumant herders do not have much interest in reforestation. They view the tree as a source of fodder for their livestock and herders are often responsible for indiscriminate lopping of trees.

The Wolofs, the dominant group in the Diourbel Department have some propensity towards reforestation as evidenced by shade tree plantings (especially neems) in their villages and, occasionally., self-initiated village woodlots with trees obtained from SWF. However, it appears that they are not very receptive to the idea of protecting planted kad trees. One PCV recounted that a typical Wolof response to the issue of protecting kads is to point to mature, naturally-regenerated kads in the fields and say: "you see, kads don't need to be protected".

The case is exactly the opposite with the Serers, concentrated south of Bambey. Acacia albida is a characteristic of some of the oldest traditional agrarian societies in West Africa -- the Serers of Senegal, the Dogons of Mali, the Haussas of the Zinder Region, Niger. Paul Pelissier, in his seminal work Les Paysans du Sénégal (1966), contended that throughout West Africa, Acacia albida is an anthropogenic species, indicative of and dependent upon long-term, sedentary cultivation. The kad is absent from "végétation sauvage".

Another element required in this system is the presence of sedentary livestock which ingest kad pods and break down the seed coat with digestive enzymes in their stomachs. Once excreted, the "treated" kad seed is able to germinate. The growth of kad into a tree requires systematic sylvicultural care. Its tendency is to start growing in a prostrate, multi-branch form. To develop into a tree, the principal stem must be selected and the others pruned. Protection is imperative until the terminal shoot reaches a man's height -- out of the reach of livestock. This continuous and methodical tending of a kad takes on a special meaning in the Serer language: "yaram sas" ("I raise a kad"), in the same sense as "yaram ndiay" ("I raise a child") (Pelissier 1966).

While the kad is dependent on sedentary cultivation integrated with livestock, it also perpetuates that system due to its soil enrichment qualities (allowing non-follow agriculture) and its dry season fodder value (allowing some livestock to remain near the village during the dry season).

As the kad signifies Serer territory, the nguer (Guiera senegalensis) is an indicator of the sandy soils low in fertility (due to continuous peanut cropping) which is prevalent in Wolof territory. The central issue, then, is how to impart kad sylvicultural techniques to Wolof farmers and how to motivate them to carry out planting and protection of kad in their fields.

6.5 The ReligiousIssue

The Region of Diourbel is the center of Mouridism (the largest Moslim brotherhood in Senegal) with Touba (MBacké Department) being the spiritual Mecca of Mourides.

The influencial and sometimes absolute power of "marabouts" (religious leaders) is a factor that the project must reckon with. Even though the project seeks to promote a collective, communal participation, many times the fate of the project rests with the village religious leaders.

This fact has hampered efforts in some villages (e.g. - Palene) when the marabout (a "Baye Fall" in this case) is reluctant to fully commit his village to project objectives. On the other hand, religious leaders can be a great asset because of the land and human resources that they can potentially mobilize. This factor will have even greater bearing if the project extends into the Mbacké Department.

6.6 The Self-Motivation Issue

At the heart of all village-level projects is the motivation of the villagers, their willingness to commit themselves to onerous tasks. This is perhaps the most crucial factor to project success.

A prime example is the village of Thieppe. Based on physical criteria of the village -- a water table of more than 70 meters -- one would not propose selecting this village as a nursery site. Yet, Thieppe has proven to be one of the most dynamic, successful nursery and gardening operations in the project.

Seen from this light, the resourcefulness and self-motivation of a group of villagers becomes the most important factor. Unfortunately, this is a very difficult criterion to evaluate based on a few preliminary site surveys or visits.

7. RECOMMENDATIONS

Administrative:

1. Project should be funded for two additional years (1984,1985) by the Title III program with the following administrative modifications:
   a. Since Title III involves counterpart Senegalese funds going directly to earmarked projects, Africare's administrative and financial management expertise is not needed.
   b. To further streamline and decentralize the administrative structure, Title III funds should go directly to a special project account in Diourbel without passing through SWF/Dakar. The project director would have financial autonomy and operational responsibility for specified categories of expenditures, with periodic AID audits.
2. ATEF's should be assigned full-time to the project to concentrate on "sensibilisation" work without conflicting tasks imposed by CER's, etc.
3. AID's policy on indemnities as it applies to project personnel should be clarified.
4. Monthly project meetings should be held regularly.

Programming:

5. Project should focus its annual programming resources (financial, logistical and human) on "old" villages that demonstrate an interest to continue reforestation work; beyond that, a modest recruitment of "new" villages with the possibility of extending into MBacké Department.
6. PCV's should be programmed for the future phase of the project. Their roles and responsibilities should be clearly defined; motocycles should be provided for "sensibilisation" work in other villages.
7. The training component should be strengthened:
   a. Longer and more thorough nursery training sessions; should involve both "old" and "new" village participants.
   b. More inter-village "tournées" for nurserymen to compare and discuss ideas.
   c. ATEF's (perhaps PCV's also) should be sent to the PARCE training center in Kaolack for sessions on "vulgarisation forestière" (scheduled for January and June, 1984; M.A. Andéké - Lengui, Director).

Technical:

8. Project should strive for greater use of locally available technologies and materials — live and thorn fencing, hand-dug planting holes, seed collection at village level.

9. The priority of the Acacia albida component should be re-evaluated due to its demand. This year, villagers requested 28,000 kad seedlings; 7,500 are available in village nurseries, another 6,000 kads in Sambé.

10. An effective protection scheme for A. albida -- both planted and naturally regenerated -- must be sought.

11. The use of Eucalyptus camaldulensis should be restricted to only the very best sites (with readily accessible water table). E. microtheca should be tested in "bas-fouds".

12. Questionable well water should be tested for salinity. ORSTOM performs this service (4,700 F/sample). A letter of request, indicating approximate dates and number of samples, must be sent to Director Dalmayrac.

13. Greater attention should be directed towards the quality of nursery materials -- namely watering cans, ropes for wells, and seed -- as well as the quality of nursery work — proper seed collection and treatment, watering, shading and weeding.

14. Woodlots should receive early and frequent weedings.

15. Experimentation and documentation should be stressed:

    local species trials, different methods of ground preparation, agroforestry schemes, effective ways to protect kad.

Socio-economic:

16. Private sector initiatives should be created by:

    a. Introducing the sale of surplus seedlings.
    b. Encouraging individual woodlots where interest exists.

17. The possibility of integrating a "ban ak suuf" improved cookstove component into the project should be explored. CERER and PCV's have already initiated activities in the Region.

18. Greater collaboration between PCV's and ATEF's, between project personnel and SODEVA should be promoted in order to pursue mutual goals.

Future Studies:

19. A study should be commissioned at the time of the first major exploitation of the woodlots (circa 1989) to ascertain woodlot yields; harvesting and regeneration methods; distribution and/or sale of wood products; disposition of villagers towards sustaining nurseries, woodlots, kad plantations and individual distribution of trees.

APPENDIX A:

ITINERARY OF EVALUATION TEAM

Chun K. Lai

May 2, Thiès	-	Peter Maille (PCV)
May 3, Dakar	-	Ken Barber (PC Project Mgr.)
		Carol Ulinski (former AID Project Mgr.)
		Daby Diallo (AID Project Mgr.)
May 21, Diourbel	-	Matt Chotkowski and Joe Virnig (PCV's).
May 24 to May 27, Diourbel	-	
		Ely Joseph Sambou, Peter Maille,
		Cheikh Savaré (SWF Project Director),
		Cheikh Mbaye (SWF Chef de Secteur),
		Lassabe Ly, Baba Cobar (ATEF's), Mike Hendrix, Tilda Gouveia, Ann, Maitland (PCV's).
May 31 to June 1, Dakar	-	
		R.J.Benn (Africare Project Mgr.)
		Ibrahima Camara (Africare Project Assis.)
		Ely Joseph Sambou, Issa Faye.
June 8 to June 9, Bambey	-	
		Daby Diallo, Ibrahima Camara,
		Abdoulaye Diallo (SWF Chef de Secteur),
		Moe Samb, Mamadou Diemi (ATEF's),
		Peter Maille, Joseph Sambou.
June 22, Dakar	-	Amadou NDiaye (SWF Project Mgr.)
		Mssrs. Dalmayrac and Lenel (ORSTOM).
June 27 to July 1, Diourbel and Bambey	-	
		Cheikh Savaré, Cheikh Mbaye, Baba Cobar,
		Mike Hendrix, Tilda Gouveia, Ann Maitland,
		Abdoulaye Diallo, Mamadou Diemé, Moe Samb,
		Mssrs. Niang and Ndao (SODEVA).
July 5, Dakar	-	Mssrs. Hamel and Bailly (CNRF),
		ORSTOM Library,
		Norman Rifkin, David Kingsbury (AID Title III)

July 6, Dakar - Chris Kopp (PC Project Mgr.)
July 21, Dakar - John Balis (AID/ADO), Daby Diallo, David Kingsbury.
July 26, Dakar - Joint Project Review (DGEF).

Ely Joseph Sambou

May 24 to May 25, Diourbel - with Lai *et al*.
May 31, Dakar - Africare.
June 8 to June 9, Bambey with Lai *et al*.
June 15, Dakar - Amadou NDiaye.
June 24, Dakar - J.F.Damon (AID Economist).
June 27, Dakar - Africare.
June 29, Dakar - J.F. Damon.

Issa Faye

May 31, Dakar - Africare.
June 3 to June 6, Diourbel and Bambey.

APPENDIX B:

QUESTIONS USED IN SOCIOLOGICAL SURVEY

1. Why have you decided to do reforestation?
2. Indicate by order of priority the trees that you wish to plant in your woodlot and in your fields?
3. What do you except from the reforestation project which you take part in?
4. Are you willing to continue your participation in the coming years?
5. What do you think is the earliest period of the year that you have the available time to start the nursery work?
6. Who donated the land for the village woodlot?
7. Do you think that additional land can be obtained to enlarge the woodlot?
8. What practical difficulties have you encountered in the nursery work?
9. To whom belong the trees that you plant?

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