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COMPREHENSIVE REPORT AND EVALUATION

Cereals Production II
(685-0235)
Project Extension
(March 1985 - December 1987)
USAID/Senegal

by

Peter H. Freeman
Felipe Tejeda

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TABLE OF CONTENTS

Page

Acronyms and Special Terms vi

Basic Project Identification Data viii

1. Executive Summary 1-1

1.1 Background 1-1

1.2 Achievement of Purpose 1-2

1.2.1 Production 1-2

1.2.2 Training 1-2

1.2.3 Extension 1-2

1.2.4 Research 1-3

1.2.5 Collaboration 1-3

1.2.6 Soil and Water Conservation 1-3

1.2.7 Project Management 1-3

1.3 Lessons Derived From Project 1-3

2. Lessons Learned 2-1

2.1 Background 2-1

2.2 The Lessons 2-1

3. Project Background 3-1

3.1 Introduction 3-1

3.2 Previous Research and Development Work on Degradation 3-1

3.3 The Cereals II Project Evaluation and Review. 3-2

3.4 The PAFOCSE Evaluation 3-3

TABLE OF CONTENTS (Continued)

Page

. Project Setting 4-1

. The Cereals II Project Extension--PAFOCSE 5-1

. Project Design 6-1

. Project Implementation 7-1

7.1 Project Elements 7-1

7.1.1 SODEVA/ISRA Agreement 7-1

7.1.2 SODEVA/DEF Agreement 7-2

7.1.3 SODEVA/Peace Corps Agreement 7-3

7.1.4 Technical Assistance 7-3

7.1.5 SODEVA Staff Assignment 7-3

7.2 Project Management 7-4

7.2.1 Management Structure 7-4

7.2.2 USAID Management 7-4

7.2.3 SODEVA Management 7-5

7.3 Project Results 7-6

7.3.1 Village-Level Planning and Extension Work 7-6

7.3.1.1 Village Technical Package 7-7

7.3.1.2 Village Management Committees 7-7

7.3.1.3 SODEVA Extension Agents 7-7

7.3.1.4 Other Collaboration 7-9

TABLE OF CONTENTS (Continued)

Page

7.3.2 Agroforestry and Other Tree Planting 7-9
7.3.2.1 Calendar of Activities 7-9
7.3.2.2 Seedlings, Nurseries, and Plantings 7-9
7.3.2.3 Agroforestry Species 7-10
7.3.2.4 Intercropping and Irrigated Crops 7-12
7.3.2.5 Plantations 7-13
7.3.2.6 Fencing 7-13
7.3.3 Water Resources Improvement 7-13
7.3.4 Soil and Water Conservation 7-14
7.3.5 Improved Wood-Burning Stoves 7-14
7.3.6 Research and Studies 7-15
7.3.7 Village-Level Results and Reactions 7-15
7.3.8 Project Documentation 7-16
7.3.9 Short-Term Training 7-16

8. Project Assessment 8-1
8.1 Background 8-1
8.2 Project Design 8-2
8.3 Agroforestry and Other Tree Planting 8-2
8.3.1 Tree Production 8-2
8.3.2 Outplanting 8-3
8.3.3 Soil Conservation/Composting 8-3
8.4 The Project's Experimental Component 8-3

TABLE OF CONTENTS (Continued)

Page

8.5 Project Management 8-4

8.6 Land-Regenerating and Land-Conserving Innovations 8-5

8.7 Degraded Soils--The Fundamental Problem 8-5

TABLES

6-1 Estimated Project Outputs 6-3

7-1 Number of Participating Villages by Season 7-7

7-2 Changes in Village Technical Package 7-8

7-3 Agroforestry Schedule 7-10

ANNEXES

A. Methodology, Schedule, and Interviewees A-1

B. Map of Senegal B-1

C. Procurement Implementation and Payment Method C-1

D. Chronology of Significant Project Events D-1

E. Supplies Distributed to Project Villages E-1

F. Additional Tables F-1

G. Data Form G-1

H. Detailed Setting of the Project H-1

I. Previous Research and Development Work on Degradation I-1

J. Scope of Work J-1

K. References K-1

ACRONYMS AND SPECIAL TERMS

CAs	Conseilleurs agricoles
CERER	Centre d'Etude et de Recherche sur les Energies Renouvables
CETAD	Centre d' Entrainement aux Techniques Agricoles (SODEVA Training Center at Pout)
CNRA	Centre National de Recherches Agricoles
CNRF	Centre National de Recherches Forestieres (became DRPF)
DCSR	Direction de la Conservation des Sols et du Reboisement
DEF	Direction des Eaux et Forets
DEFC	Direction des Eaux et Forets et Chasse
Dek soils	Soils with high organic matter and clay content
Dior soils	Predominantly sandy soils
DRPF	Direction des Recherches sur les Productions Forestieres
GNB	Groundnut Basin
GOS	Government of Senegal
ISRA	Institut Senegalais de Recherches Agricoles
ISTI	International Science and Technology Institute
Kad	Common name for *Acacia albida* trees
Nguer	Native species used for tree protection
PACD	Project authorization completion date
PAFOCSE	Projet de l'Agroforesterie et du Conservation des Sols et des Eaux
PCVs	Peace Corps Volunteers
PIL	Project implementation letter
PPS	Project paper supplement
RR	Responsable Regional de Reboisement (regional agents)
SENAGROSOL	Societe Senegalaise d'Etudes Agropedologiques

ACRONYMS AND SPECIAL TERMS

SODEVA	Societe de Developpement et Vulgarisation Agricole
TA	Technical assistance advisor
USAID	U.S. Agency for International Development

BASIC PROJECT IDENTIFICATION DATA

1. Country: Senegal

2. Project Title: Senegal Cereals Production: Phase II (Reprogramming of remaining funds for a pilot program in agroforestry/soil conservation)

3. Project Number: 685-0235

4. Project Dates:

   a. First Project Agreement: PPS amendment of April 4, 1985
   b. Final Obligation: FY 88
   c. Project Assistance Completion Date: Dec 31, 1987

5. Project Funding:

   a. AID Bilateral Funding Grant: $2,189,451
   b. Peace Corps: $270,000
   c. Host Country Counterpart Funds: $405,000

6. Mode of Implementation: USAID direct contract with International Science and Technology Institute (ISTI)

7. Project Design: USAID Dakar

8. Responsible Mission Officials:

   a. Mission Director: Sarah Jane Littlefield
   b. ADO Project Officer: Daby Diallo

9. Previous Evaluations: None

1. EXECUTIVE SUMMARY

1.1 Background

This document is an end-of-project synthesis report and evaluation of a USAID-financed pilot project for agroforestry and soil conservation in Senegal. Accomplishments of and lessons learned from this pilot project, referred to as Projet de l'Agroforesterie et du Conservation des Sols et des Eaux (PAFOCSE), are reviewed and assessed.

PAFOCSE, a thirty-three-month project costing approximately $2 million, was financed under an extension of an earlier project, Senegal Cereals Production II (685-0235). PAFOCSE aimed to carry out--

- Soil conservation and agroforestry activities in sixty villages.
- Adaptive research on agroforestry techniques.
- Studies of environmental degradation, interagency coordination, village reactions, and the technical and economic feasibility of various interventions.

The project addressed the ongoing degradation of soils and vegetation in Thies and Diourbel, farming regions of central Senegal characterized by population exceeding one hundred people per square kilometer; lack of adequate soil-restoring fallows; low rainfall averaging around 450 millimeters per year; increasing deforestation of existing vegetative cover; and high, hot "harmattans" (winds that sweep through the region each dry season causing dust storms, topsoil depletion, and sand movement).

In these farming regions, peanuts, millet, sorghum, corn, and some cowpeas are grown, often in a continuous rotation. Nitrogen-fixing *Acacia albida* trees, or Kad, also are common.

A number of institutions were involved in PAFOCSE, some through official protocols established early in the project. The institutions included--

- USAID, which undertook to directly purchase a number of commodities and services, including tree seedlings.
- Societe de Developpement et Vulgarisation Agricole (SODEVA), which provided extension and extension education.
- The Ministry for the Protection of Nature, which collaborated on tree planting and technical advice.
- Institut Senegalais de Recherches Agricoles (ISRA), which planned to carry out the research.
- Centre d'Etude et de Recherche sur les Energies Renouvables (CERER), which provided stove-building techniques.
- The U.S. Peace Corps, which supplied village-level volunteer forestry extension workers.

- The International Science and Technology Institute (ISTI), a U.S.-based contractor, which was asked to provide a long-term forestry technical advisor and ten months of short-term consultant time.

1.2 Achievement of Purpose

PAFOCSE was designed as a pilot project to test approaches and to experiment with techniques. This overall goal was achieved in that the major elements of the project were tested; however, limited progress was made in identifying, testing, disseminating, and evaluating agroforestry techniques.

The project's agroforestry objectives in production, training, and village extension were met. The Government of Senegal (GOS) agencies that were involved, particularly SODEVA, gained valuable experience in participating in the design, implementation, and evaluation of PAFOCSE. The project achieved its research goals via a modified mechanism. However, only marginal success was registered in reaching the collaborative research objectives of the project, and little progress was made in the area of soil conservation techniques.

1.2.1 Production

Chief among the production successes were the tree-planting accomplishments. Trees were raised, distributed, and planted in 1985, 1986, and 1987 in many project villages. Survival rates measured at the end of 1987 were approximately 60 percent in the better protected woodlots and 34 percent in the double-line windbreaks, the most difficult to protect. Natural regeneration of Kad, which was increasingly promoted as the project went along, was highest: 89 percent.

1.2.2 Training

The project was able to successfully sponsor a number of training events that were conducted for SODEVA extensionists. Also, three SODEVA staff and two Direction de la Conservation des Sols et du Reboisement (DCSR) staff participated in a one-month study tour of agroforestry work in the United States, which was coordinated by the contractor. Project personnel also profited from stateside training in information management and farming systems research.

1.2.3 Extension

The project was successful in reaching out to and working in a number of villages that were major beneficiaries of the project's extension and tree-planting activities. Included in these activities were woodlots, orchards, windbreaks, windrows, individual plantings, and live fencing. A complicating factor in village work was the unavailability of water and materials for well digging and compost pit construction.

1.2.4 Research

Funds for adaptive research on soils and trees, which was to be conducted via collaborative working agreements, were used for technical studies carried out by local Senegalese firms.

1.2.5 Collaboration

During the life of PAFOCSE, collaboration was good between SODEVA, Direction des Eaux et Forets (DEF), and the Peace Corps. However, Centre d'Entrainement aux Techniques Agricoles' (CETAD's) dwindling budget from SODEVA and increasing work from the private sector hampered anticipated cooperation in developing and extending audiovisual techniques to village-level work. The planned collaboration of SODEVA and various research organizations did not take place as originally designed in the project.

1.2.6 Soil and Water Conservation

Soil and water conservation measures were not fully addressed because of problems with local contractors and limited ability to respond technically to this area of the project.

1.2.7 Project Management

Project management proved to be the most challenging aspect of this pilot effort. Because of the cooperative management mode--involving USAID, the contractor, and GOS--as well as the direct procurement method used by USAID, administrative bottlenecks often contributed to slow responses to project needs. The following factors contributed to this problem:

- The project's small size and innovative nature.
- The diversity of inputs and outputs.
- The involvement of six participating agencies.
- The direct contracting mode of financing project inputs.

1.3 Lessons Derived From Project

The following is a list of lessons learned from PAFOCSE. Section 2 provides detailed explanations of each lesson.

- The value of trees cannot be demonstrated only by planting them.
- Tree protection is a good indicator of village acceptance and commitment to different plantings and species.
- Windbreak plantings and maintenance require a more sophisticated approach than that employed by the project.
- Fencing with local materials is very labor-intensive and is beset by several technical problems that call into question the use of barbed-wire fencing rather than local fencing materials.

hypotheses as well as technical aims.

- Community dynamics and community-level property resource management must be considered to avoid a top-down approach to project implementation.

- Data collection and analysis methodology are crucial to developing projects based on village-level trials.

- Successful soil conservation and regeneration activities require accurate data and innovative approaches, hence soil studies should precede project design.

- Agroforestry is not a sufficient response to the problem of land degradation.

- Improved management of Kad is needed.

- The degraded status of the region's Dior soils needs to be addressed with solutions specific to the problem.

- Training of development cadres and villagers should take place as early in the project life as possible so that learnings can be reapplied to the project.

- Innovative projects require field-based management and streamlined administrative procedures.

- Pilot projects require unique coordinating mechanisms.

2. LESSONS LEARNED

2.1 Background

The pilot and experimental nature of the Projet de l' Agroforesterie et du Conservation des Sols et des Eaux (PAFOCSE) is well-suited to the formulation of lessons learned. The very reason for designing and implementing the project was to extend and monitor techniques to arrest the environmental deterioration of the soil resource base of Senegal's Groundnut Basin (GNB). The results of the techniques that were employed have been formulated into a series of lessons that can be applied to future endeavors of this kind, both in Senegal and in other countries with similar environmental constraints and socioeconomic conditions.

The lessons presented here represent the combined learnings of PAFOCSE, gleaned from the evaluation team's review of the extensive documentation produced by project personnel and from site visits to select project villages in December 1987. The lessons emphasize the importance of reversing the decline of the natural resource base of rural Senegal's GNB and of ultimately improving its agricultural base through village-based innovations in resources management.

Some of the major lessons were derived from weaknesses in design or execution that, to the project's credit, were sufficiently documented to allow the formulation of lessons learned. Other lessons were the result of successess of the project in reaching its goals.

2.2 The Lessons

Lesson 1. The value of trees cannot be demonstrated only by planting them.

If the value of trees is not already known and accepted, they will probably not survive because of lack of protection. Special extension techniques are needed to introduce resource management innovations with medium- to long-term payoffs.

A combination of the following is necessary to stimulate the needed commitment:

- Site visits by village leaders to well-established plantings.
- Improved educational work.
- Compensatory measures for extraordinary costs incurred, especially in tree protection.

Site visits and testimonials by other farmers are the indicated means of informing and demonstrating resource management innovations with long-term payoffs but high short-term costs in the form of protection and maintenance. Videotapes and slides could substitute for site visits (as long as they convey convincing experiences that farmers can relate to) and could be important in gaining the cooperation of an entire village, not just the few dignitaries chosen for the visits.

Lesson 2. Tree protection is a good indicator of village acceptance and commitment to different plantings and species.

Tree protection is perhaps the key to the ultimate success of village forestation efforts. No better indicator exists for measuring the relative acceptance of different plantings. Protection of various kinds must be continued for up to five years for most species. In projects where the villagers will be expected to use local resources to protect trees, the least popular tree plantings will be the least protected, as was true for the windbreaks (see Lesson 3).

Lesson 3. Windbreak plantings and maintenance require a more sophisticated approach than that employed by the project.

The windbreak intervention, envisioned in this project as a means to protect soils (that is, continuous, straight double rows of trees; one to two kilometers long; and perpendicular to the prevailing dry season winds), did not produce its desired result. Windbreaks were poorly protected in most villages, as evidenced by survival rates and project reports. Of all the tree plantings, windbreaks fared the worse.

Unless durable fencing is provided and windbreak configurations are devised that are acceptable to landowners and to the customary movement of herd and domestic livestock, windbreaks are not likely to succeed. Even with more durable fence protection, windbreaks will compete for water with other plant growth. These disadvantages must be squarely faced and analyzed in terms of costs and benefits to villagers in the short term and in terms of appropriate compensation.

The investment in labor and local materials to create an effective fence for village-level tree plantings can be enormous. The monetary cost of the labor can exceed the cost of barbwire fencing. At an estimated fifty person-days per one hundred meters (a medium estimate based on the project's SONED study), a total of one thousand person-days would be required to erect protection for a kilometer of windbreak. This is a tremendous investment for a village with only 100 to 150 able workers and a scarcity of local materials. Given this situation, villages will tend to assign priority use of local materials to trees deemed more valuable, such as individual fruit trees or more efficiently protected woodlots.

Lesson 4. Fencing with local materials is very labor-intensive and is beset by several technical problems that call into question the use of barbed-wire fencing rather than local fencing materials.

When Kads are the only source in most villages of thorny branches needed to reinforce live hedges of Euphorbia, conflicting results can ensue. The use of Kads may result in excessive pruning of tree crowns, to the detriment of soil productivity. Also, some species used for living hedges can extract large amounts of water from the soil and thereby compete with the trees they are supposed to protect for soil water. Dead branches woven into fences can attract termites, which subsequently attack the young trees.

Lesson 5. local ingenuity is a source of innovations that should be employed.

It is important to analyze and improve on existing low-cost techniques developed locally. For instance, some farmers planted cassava barriers around their Prosopis seedlings that bordered a path and field edge, effectively discouraging herders from allowing their cattle to browse on the young plants. The discovery by cattle herders that cassava leaves make their cattle sick guarantees the protection of cassava plants, which have a growing cycle of twelve to eighteen months. Cassava plants are the only food crop still growing on the land during and after the traditional harvest season when herd cattle enter the region to forage on crop residues, damaging or eating young trees not well protected.

Lesson 6. Data collection and analysis for village-level regeneration trials must be well planned and executed for testing various behavioral hypotheses as well as technical ones.

Although the various interventions promoted through Societe de Developpement et Vulgarisation Agricole (SODEVA) by the project in the sixty-three villages were not designed as trials or applied research, a general lesson emerges concerning data collection and analysis, and related design.

The project was a de facto experiment in the sense that it attempted to introduce the same technical package in sixty-three similar-sized villages. It was possible to observe differences in the acceptance of the various interventions and their successes. However, data collection and analysis methods fell short in capitalizing fully on this opportunity. Thus, while data were collected on the survival rate of various plantings, as well as the proximate causes of failure (that is, cattle damage, termites, for instance), the role played by individuals or entire villages was neither analyzed comparatively nor considered objectively. An opportunity was missed to explore the individual and collective behavioral dimension of land-regeneration innovations and technologies.

The role of pilot projects is crucial in testing interventions that are considered for generalized diffusion. Mass or national campaigns are a common device used in the promotion of new technologies in Senegal, and other African countries, and may be the only way to quickly promote innovations that are technically necessary for environmental restoration (for example composting, agroforestry, improved wood-burning stoves). However, mass campaigns should be based on empirical knowledge of the suitability and acceptability of the technologies to be promoted, as well as their technical validity in the rural milieu.

Lesson 7. Community dynamics and community-level common property resource management must be considered to avoid a top-down approach to project implementation.

This is especially important where the cooperation of entire communities is involved. Sahelian villages traditionally manage grazing and fuelwood resources, and water resources. The degree of community cooperation in these traditional areas is a necessary additional variable to the technical and

economic factors usually considered in the design of field trials. Consequently, pilot projects involving a number of villages are needed to test approaches entailing total village involvement.

> **Lesson 8.** Data collection and analysis methodology are crucial to developing projects based on village-level trials.

Trials of a given intervention aimed at village-level land regeneration, undertaken in multiple communities, require well-planned data collection and analysis methodology. Behavioral aspects related to the adoption and adaptation of innovations are involved, in addition to technical factors related to the management of trees, soils, and soil-enhancing techniques. To provide this kind and quality of data, sophisticated data recoding and manipulation is needed. Computer-assisted data storage and analysis could be used to test hypotheses and compare variables among the different communities. Also, comparative baseline studies of the communities and their environments will be needed to make possible the formulation of working hypotheses to be tested.

> **Lesson 9.** Successful soil conservation and regeneration activities require accurate data and innovative approaches, hence soil studies should precede project design.

When developing projects that focus on interventions aimed at reversing land degradation or conserving soils, data on the soils should precede project design. Baseline soil studies that establish the extent and nature of land degradation are a necessary point of departure for determining the interventions and activities needed to regenerate degraded agro-ecosystems.

Soil conservation and regeneration innovations also require a different extension approach. Although runoff erosion control can yield immediate and perceptible benefits when extremely degraded soils are the problem and wind erosion as opposed to water erosion is present, benefits from required interventions may be delayed for years.

Demonstration fields can be used in selected villages to test and show the benefits of--

- Soil and water management measures such as runoff control ridges or ditches, micro catchments, deep plowing, postharvest plowing, and tied ridges.

- Fertility-enhancing measures such as the application of lime, rock phosphate, and compost.

> **Lesson 10.** Agroforestry is not a sufficient response to the problem of land degradation.

Agroforestry--the association of multiple-purpose trees with crops--will not solve the immediate problems of land degradation in the region or other degraded areas in the Sahelo-Sudanian belt. There will be at least a

ten-year period before trees protected or planted by the villagers will yield significant soil-enriching benefits and fodder.

Integrated activities, such as local nursery development, stove construction, and composting are relevant and useful in a more global approach to the land degradation problem. Until benefits are evident, all plantings will require protection, and all except Kad will compete for crop land. Studies on land-use constraints, farming habits, and community management and ownership practices should provide information that can be helpful in planning longer term solutions to the problem.

Lesson 11. Improved management of Kad is needed.

The *Acacia albida*, or Kad, was declared the patron tree of the 1988 national forestation campaign by President Diouf and will be a prominent species in the USAID-financed Senegal Reforestation Project (685-0283). However, PAFOCSE's experience with this species indicates that a more thoughtful and technically appropriate management approach is needed.

The legal status of the Kad as an officially protected tree should be refined. A management approach consistent with the law, which permits limb cutting but not felling of Kads, is needed if this multipurpose tree is to be a key element in intensified land use in the region. Excessive pruning, especially of very large limbs, is detrimental, but the removal of small branches is not. Old trees no longer producing pods or good foliage probably should be felled to make way for regeneration.

In the future, account must be made of these factors and the uses of the Kad. Cooperation among landowners, those with usufruct of the trees, and herders is needed to manage the multiple uses of this valuable species.

Lesson 12. The degraded status of the region's Dior soils needs to be addressed with solutions specific to the problem.

Soils surveys have confirmed the generally recognized degraded state of the Dior soils. Wind erosion is one of many processes causing degradation. More than conservation is needed in this situation. Restoration of productivity potential is needed.

Acidity; low-cation-exchange capacity; low levels of organic matter; low available phosporus; low levels of nitrogen and of exchangeable calcium, magnesium, and potassium; and high density were found in the dominant Dior soils. Increasing organic-matter levels in the soils is key to reversing this condition. Higher levels of organic matter serve to increase cation-exchange capacity, reduce acidity, and make the soils more porous and more stable. However, soil acidity and low available phosphorus will need to be corrected, initially, to grow the additional biomass in the form of stalks, vines, and roots that will build up soil organic matter. Acidity inhibits plant growth and nutrient availability; lack of phosphorus as well as high density inhibit root growth.

Practical experimentation is needed to find a strategy for correcting the worst soil problems, thereby reversing soil degradation. The addition of

partially acidulated rock phosphate or even raw rock phosphate and of powdered limestone--deposits of both exist in Senegal--could overcome the initial barrier to greater plant growth. (The Centre National de Recherches Agricoles (CNRA) already has done work along these lines.) Instead of entire fields, parts of fields could be treated in a mini-fallowing rotation that suits the purposes of demonstration and addresses the difficulty of removing too much land from food production.

Lesson 13. Training of development cadres and villagers should take place as early in the project life as possible so that learnings can be reapplied to the project.

Development projects should be designed to implement training events in their early stages. In this way, the participants can apply their learnings directly to the project, thus furthering project goals and benefiting their fellow workers and village-level collaborators.

Lesson 14. Innovative projects require field-based management and streamlined administrative procedures.

Small pilot projects involving village-level work are best managed if close as possible to the place of project implementation. A regional or local management unit is a practical way of ensuring rapid and responsive management turnaround time on project procurement. USAID's financial and contractual administrative procedures are best suited to large projects with multiple sectors. They are often too complicated to fulfill the demands of innovative projects requiring coordination of authority and small, timely cash disbursements. Control of these kinds of projects should be ideally decentralized and given to the project implementators. It is not recommended that USAID use the direct-purchase method for needed inputs for such projects, but rather consider hiring a contractor for input administration.

Lesson 15. Pilot projects require unique coordinating mechanisms.

Experimental or pilot projects such as PAFOCSE, which involve the coordination of various government agencies and disciplines, require a permanent coordinating and planning entity, such as a technical secretariat, and autonomy in applied research.

A technical secretariat could be empowered to ensure coordination, propose and approve various actions, undertake its own studies, and conduct monitoring or data analysis activities that are unique to an innovative project. However, this secretariat should exist only as long as the pilot effort and its ultimate extension (if there is an extension) into a larger program.

Applied research and village-level trials in agro-ecosystem regeneration and conservation involve a diversity of institutions and skills and new ways of posing research and survey questions. A unique or special research program associated with the project effort can be used to successfully overcome inertia and interinstitutional friction, and the distortions in counterpart

contributions caused by weak core funding for the necessary research efforts, as was the case in PAFOCSE.

In projects where applied research is essential to arriving at certain results, a specially funded and organized program of applied research could provide the needed freedom to address the physical, environmental, and socioeconomic variables at the village level. Such a program would allow needed flexibility by offering financial and logistical autonomy, while drawing intellectual resources from the research agencies to be involved. Later, organizational and programming skills could be exported back to the parent agencies or, alternatively, used as the core of a new institutional effort.

3. PROJECT BACKGROUND

3.1 Introduction

The Projet de l' Agroforesterie et du Conservation des Sols et des Eaux (PAFOCSE) grew out of a mounting concern and awareness on behalf of both the Government of Senegal (GOS) and USAID/Dakar for the deterioration of the agricultural resource base of the Groundnut Basin (GNB) of Senegal. This 2-million-hectare area of mixed grain and peanut farms, located in West Central Senegal, has traditionally supplied Senegal's primary export of peanut oil for many years. However, as areas under cultivation have expanded at the expense of fallows, infield trees and crop residues have been increasingly exploited for fuel and fodder. The resulting degradation of soils and vegetative cover has been exacerbated and accelerated by a number of low rainfall years and drought conditions.

3.2 Previous Research and Development Work on Degradation

The problem, defined since the onset of the drought in 1968 as desertification, has concerned the government and the international community for some years. In 1980, USAID/Dakar included environmental rehabilitation of the southern half of the GNB in its Country Development Strategy Statement.

Initially seen as the result of tree loss to woodcutters, degradation was countered with projects to increase fuelwood supplies by means of either large plantations or small village fuelwood plantations. Donors supported research in soil fertility maintenance and agroclimatology and provided funding for adaptive village-level research on a number of land regenerating solutions, planned and executed jointly with GOS institutions

Forestry research had also received modest support, but important results were accumulating in the areas of multispecies trials, windbreak configurations, intercropping, herbicide use in weed suppression, open-root planting, and the soil-moisture regime under new plantations, as opposed to natural forests.

Village-level community forestry projects in the Thies-Diourbel region in the early 1980s had experienced limited success in social forestry and agroforestry techniques. Among the more important lessons learned from these and other project experiences were--

- Land shortages in Thies and Diourbel severely limit the block plantation approach.

- Village nurseries are very effective in general, but poor quality groundwater (too salty) found in some places may jeopardize germination of certain species.

- Protection of planted trees or natural regeneration of *Acacia albida* (Kad), for example, is a difficult issue because of lack of suitable materials.

3.3 The Cereals II Project Evaluation and Review

As USAID's Senegal Cereals Production II project was nearing its 1984 project authorization completion date (PACD) with mixed results, a general agreement was being articulated by an ad hoc intergovernmental committee regarding the need for a coordinated approach to solve land degradation in the GNB. The committee's evaluation report recommended a two-year extension to the Cereals II project to continue and upgrade off-station research on soil conservation and regeneration, to support planting and regeneration of Kad, and to undertake a baseline study for soil conservation and regeneration. The committee also recommended activities in support of women and the further development of the audiovisual center in Pout.

Shortly thereafter, in April 1984, USAID requested a two-person team to reconnoiter the GNB and develop recommendations addressing the soil degradation problem. The team's report (Weber and Majors, 1984) recommended the following:

- Concentrate actions in Thies and Diourbel.
- Extend the Cereals II project to accomplish soil and forest conservation work.
- Establish a mechanism for effective interagency coordination.
- Develop improved experimental procedures for implementation by the Institut Senegalais de Recherches Agricoles (ISRA) and the Societe de Developpement et Vulgarisation Agricole (SODEVA).
- Provide centralization of GNB documentation and maps.
- Conduct on-farm agroforestry, especially with Kad.
- Provide research and demonstrations on windbreaks.
- Foster adjustment of forestry species to conditions and end uses, and de-emphasize *Eucalyptus camadulensis*.
- Provide protection of natural woodlands.
- Provide training of forestry agents.
- Demonstrate experimental results with composting.
- Conduct on-farm research and demonstration on various methods of soil conservation.
- Improve extension work.

- Develop audiovisual programs.
- Improve regional-level interagency coordination to accomplish the above.

Their recommendations set the stage for the design of the Cereals II project extension, PAFOCSE.

3.4 The PAFOCSE Evaluation

The purpose of the PAFOCSE final evaluation is to measure the impact and progress of the project in achieving project objectives and to synthesize the extensive documentation produced by the project. This evaluation has two major purposes: assessment and synthesis. The assessment looks carefully at the human, political, and environmental backdrop for the project; reviews project design; summarizes implementation strategies; and assesses the achievement of project outputs. The synthesis looks carefully at the wealth of documents produced immediately before and during PAFOCSE to derive the relevant information.

The output of this evaluation report is a series of lessons learned (presented in detail in Section 2). These lessons are based on the specific findings of the evaluation--combining the information gathered by the evaluation team in interviews, site visits, and document review. The lessons are presented in a form designed to make them applicable on an agencywide basis, useful in guiding USAID in the design and implementation of future natural resource projects in Senegal and elsewhere. Annex A contains the evaluation's methodology, schedule, and list of interviewees.

4. PROJECT SETTING

The Thies and Diourbel administrative regions where PAFOCSE was carried out are situated in the middle portion of the GNB, to the east of Dakar (see map in Annex B). With the exception of low limestone outcrops in a few places in the westernmost portion of Thies, the landscape is gently rolling to flat and the elevation is near sea level.

The region occurs within the semiarid tropics, the Sahelo-Sudanian West African climatic zone. The seasons are typified by a long dry period from November to June, followed by a rainy season of erratic rainfall. Average annual rainfall in the region has been in the range of 420 to 440 millimeters. Rainfall intensity is not great, hence erosivity caused by rainfall is not high. However, soils are totally bare at the moment of first rains and this, combined with the soils' lack of a stable surface structure, can result in quick sealing by raindrop impact and surface runoff. Annual average temperatures range from 19^{0} C to 35^{0} C.

"Leached Ferruginous soils" is the accepted designation for the region's soils, typical of those found throughout the West African Sahelo-Sudanian and Sudanian zones. Locally, they are called either "Dior," predominantly sandy soils, or "Dek," soils with somewhat higher clay content. Over the years, cultivation and the loss of organic-matter restoration, caused by the disappearance of fallows, have made these soils relatively infertile and unproductive. However, Dior soils near Kad trees and soils that are heavily manured and devoted exclusively to millet for household consumption have retained their productivity. In general, Dek soils have higher organic matter and clay content and are less acidic, therefore more productive.

This is a region of many small settlements, averaging 250 to 300 people, and high population density, now exceeding 100 persons per square kilometer. Bushy fallows and permanent grazing reserves are no longer seen. Continuous rotation of millet and peanuts is the dominant land use, with cowpeas, corn, and manioc sometimes grown. Yields fluctuate considerably in parallel with rainfall but have been declining as soil productivity has dropped. In recent years, village woodlots and improved wood-burning stoves have been actively promoted in this region. Village nurseries can sometimes be seen, and irrigated vegetables are often added to the enclosed nurseries.

5. THE CEREALS II PROJECT EXTENSION--PAFOCSE

The Cereals II project extension ultimately came to be called the "Agroforestry Pilot Project," or "Projet de l' Agroforesterie et du Conservation des Sols et des Eaux," referred to as "PAFOCSE." The project was conceived of as an experimental or pilot program that would extend and monitor agroforestry plantings at the village level, as well as conduct adaptive research and support training in agroforestry and in the use of audiovisual techniques in extension.

PAFOCSE was financed with a $1.5-million residual from the $7.7-million Senegal Cereals Production II project and was to be undertaken from January 1985 (when the project paper supplement (PPS) was approved) through December 1987.

The Cereals II project purpose was retained, but the objective was modified to focus on arresting the environmental deterioration of the soil resource base specifically through--

- Agroforestry activities in sixty villages.
- Adaptive research on agroforestry techniques.
- Studies of environmental degradation, village reactions, interagency coordination, and the technical and economic feasibility of various interventions.

In the villages, woodlots and windbreak plantings were to be the major interventions, with attention to survival of plantings influenced by maintenance rather than number of hectares or trees planted. Costs of fencing alternatives were to be determined. Well drilling or improvement in a few selected villages with nurseries was foreseen.

Trees were to be provided, but subsidization did not extend to fruit tree species, which were to be sold at cost and produced by private nurseries.

Off-station research conducted by Centre National de Recherches Agricoles (CNRA) and Centre National de Recherches Forestieres (CNRF) (later retitled Direction des Recherches sur les Productions Forestieres (DRPF)) was foreseen, but its design was left to subsequent annual planning.

Short-term training in agroforestry program management was to be provided to personnel from SODEVA, ISRA, and Direction des Eaux et Forets (DEF). SODEVA staff were to be trained in audiovisual equipment usage as well.

One long-term technical advisor for program coordination and ten months of short-term consultancies were stipulated.

Project input procurement was handled as shown in Annex C.

6. PROJECT DESIGN

The supplement to the Cereals II project was designed in late 1984 and finalized in January 1985. PAFOCSE was conceived of as an experimental program for arresting environmental deterioration of the soil resource base in the GNB, with emphasis on agroforestry and soil conservation techniques.

Three objectives were set forth:

Objective 1. Initiate a series of agroforestry activities in sixty villages in the Thies and Diourbel region to--

a. Reintroduce trees in the production system.

b. Demonstrate the role and importance of tree planting in maintaining soil productivity; in satisfying the needs of villagers for fuelwood, construction materials, and livestock and human food; and in improving farm revenue.

c. In connection with forestry, demonstrate the beneficial use of agricultural subproducts in the farming system (that is, compost, animal waste, livestock fodder).

Objective 2. Test and validate agroforestry techniques by conducting adaptive research of tree species, plantation techniques, animal waste use, and crop residue.

Objective 3. Obtain adequate information on the degree of environmental degradation, the interest of villagers, and procedures for effective action on the part of Senegalese agencies in project implementation; obtain information on the technical and economic feasibility of project interventions to permit the elaboration of a long-term, large-scale agroforestry project.

Objective 1.a was a reaffirmation of the important role that trees should play in a heavily farmed and delicate agroclimatic zone, in which the GNB lies. However, given the soil conditions in the GNB, an even stronger statement could have been made, such as "fostering the protection and regeneration of Kad in farmers' fields." Research in Senegal corroborates field evidence that there is no other tree in the region's landscape as important to the agricultural production system. Reintroduction seems to have disposed the project to distribute Kad seedlings when natural regeneration could be stressed as a surer way to increase this species.

Kads are still very much part of the agricultural landscape, although their density in fields has been much reduced from previous times; and crowns have been severely pruned to the point that their soil-enriching potentials are not realized.

Objective 1.b was an attempt to underline the project's need to link the long-term benefits of trees with the immediate activity of planting. However, such benefits are not easily demonstrable by the mere planting of a

tree. This reality is clearly shown in the economic analysis of the PPS. In the analysis, maximum soil-enhancing benefits of Kads are computed from the twentieth to the fortieth year after their planting. This fact made it difficult to get villagers, participating in the project, to plant and protect windbreaks. Weber and Majors, who had foreseen this difficulty, recommended research to find ways to increase the social and technical viability of windbreaks.

Nevertheless, the design for the extension work input included the only realistic way that demonstration could be achieved, namely by organizing visits to other villages where similar activities are well established. This activity was begun in a limited number of villages, with village project committee members exchanging information with members in other villages.

Objective 2 is actually a formulation of the experimental component of PAFOCSE in that it links all experimental work to the validation of agroforestry techniques. As stated, it presumes, for example, a connection between the use of animal wastes and crop residues and the validation of agroforestry techniques. However, a straightforward research problem does not easily emerge from this statement. The listing in the PPS of possible topics to be carried out by means of joint adaptive research between ISRA and SODEVA was more clearly stated, at least in relation to Objective 2:

- Soils analysis to assess the level of soil fertility and degradation.
- Fertilizer trials comparing different combinations of chemical and organic (that is, animal waste, compost) fertilizer.
- Trials of different tree species in a variety of ecological zones.
- Evaluation of the acceptability by villagers of various species for fuelwood and construction materials.
- Evaluation of various types of fencing (living fences, local materials) for performance, cost, and acceptability.
- Evaluation of nitrogen-fixing tree species and inoculum on crop yields.
- Assessment of various planting arrangements for windbreaks.

Objective 3 sought to capture the project's experiences through studies that would guide subsequent formulation of a long-term, large-scale agroforestry project. In fact, this objective reveals a bias for agroforestry plantings as the preferred technical response to environnmental degradation in the GNB. It also explains the importance given to agroforestry plantings in the first two objectives and explains the decision to have technical assistance provided by a forester rather than a soil conservation expert or agronomist.

The project's outputs were cast in quantitative terms as shown in Table 6-1.

Table 6-1

Estimated Project Outputs

Item	1985/86	1986/87	1987/88	Total
Village Woodlots[a]	30	20	10	60
Windbreaks[b]	30	50	30	100
Kad (hectares)[c]	600	1,000	1,200	2,800
Compost Pits	10	12	8	30

[a]Estimated average of one hectare per village.

[b]Estimated two lines of windbreaks per village approximately two thousand meters in length. These figures come from the PPS.

[c]This action includes protecting existing Kad and planting additional ones to achieve optimum density per hectare. SODEVA will list hectares planted and hectares protected in its status reports.

7. PROJECT IMPLEMENTATION

7.1 Project Elements

PAFOCSE officially started on March 31, 1985, in accordance with Amendment No. 4 to the Cereals II project. Annex D displays a chart highlighting the chronology of significant project events, including startup actions concerning the satisfaction of conditions precedent and release of initial funding.

As called for in the conditions precedent, SODEVA made three formal agreements with--

- ISRA's CNRF for forestry and soils research and related technical advisory services.
- The Direction des Eaux et Forets et Chasse (DEFC) of the Ministry for the Protection of Nature for the provision of technical assistance and plants.
- The U.S. Peace Corps for the assignment of four forester volunteers to the project area (two in September 1985 and two in September 1986).

These agreements were made and signed on March 31, 1985, when the project began, thereby satisfying the conditions precedent concerning collaborating entities at the earliest possible moment. The protocols with CNRF and DEF provided for an advance of FCFA 5 million and FCFA 2 million, respectively.

USAID also required the hiring and assignment of a full-time project coordinator and a full-time project accountant in SODEVA.

The first project implementation letter (PIL) authorizing the release of financing for July 1985 through March 1986 was signed on October 3, 1985, and the funds were provided by SODEVA in January 1986. Consequently, all activities in the 1985 growing season were funded entirely by SODEVA, CNRF, and DEF. The first PIL did not provide funds for research, however.

7.1.1 SODEVA/ISRA Agreement

This agreement stipulated that ISRA would--

- Designate a representative researcher to the project.
- Design tree-planting trials and soil studies.
- Conduct trials in six of the sixty villages.
- Provide technical assistance and follow-up monitoring of trials, and participate in meetings.
- Develop a work plan jointly with SODEVA before each planting season.

SODEVA was obligated to coordinate the project, elicit village ideas regarding research problems, evaluate site trial results, and expedite project financing.

An initial on-station research design at Thienaba provided for the testing of various windbreak configurations with two Australian acacias, *Acacia holosericea* and *Acacia linarioides*, on Dek soils.

An FCFA 5-million advance was to be made, and subsequent payments were to be made on the basis of vouchers presented by ISRA to SODEVA, which was responsible for approving the work done and for billing USAID following USAID guidelines. USAID was to pay ISRA directly.

ISRA eventually received the advance in 1986 but subsequently fell into disagreement with USAID over the need for a vehicle to carry out research and monitoring tasks in the project villages. The project design excluded the provision of vehicles. The disagreement was never settled to the satisfaction of the two parties, and, in March 1987, ISRA withdrew its participation in the project.

7.1.2 SODEVA/DEF Agreement

This agreement stipulated that DEF would--

- Designate a project representative.
- Provide technical assistance in the project zone.
- Develop a work program with SODEVA for each planting season.
- Provide seedlings to the project.
- Train farmers.
- Participate in meetings, provide quarterly reports, and manage project monies provided in advance.

SODEVA undertook to--

- Present a provisional work program to DEF and a list of needed seedlings, no later than April each year.
- Direct and coordinate activities.
- Conduct extension work.
- Expedite financial processes.

An FCFA 2-million advance to DEF was requested, with replenishments based on costs incurred. DEF's contribution was relatively successful, as plants were obtained at the regional level from DEF nurseries and a DEF technician was assigned to each regional team to provide technical assistance. DEF agents, however, were not successful in assisting SODEVA in extension work, as so few DEF agents have received training in this area.

7.1.3 SODEVA/Peace Corps Agreement

The project design called for Peace Corps to provide four agroforestry Peace Corps Volunteers (PCVs), two in September 1985 and two in September 1986, as well as a liaison between the volunteers and SODEVA. During the life of the pilot project, there was actually a total of five PCVs, who were assigned to SODEVA to work at the village level as advisors to the village management committee. Technically, they were counterparts to the conseilleurs agricoles (CAs), specifically for reforestation activities.

The PCVs each contributed to the village plantings and nursery work. Most did stove construction. Gardens were marginally successful because of the lack of water. This was the major issue that faced the PCVs and caused limited success in their ability to expand tree-planting activities. Despite this problem, some PCVs were able to obtain donor funding from outside sources to assist their village of assignment in digging or deepening wells.

The Associate Peace Corps Director for Forestry was a member of the coordinating body of the project at the national level and participated in regular meetings and joint site visits to project villages.

7.1.4 Technical Assistance

A contract was made with the International Science and Technology Institute (ISTI), at the time an 8(a) firm in Washington, D.C., to provide long- and short-term technical assistance. ISTI provided a long-term forestry advisor on a two-year contract in September 1985. This technical assistance (TA) advisor had a degree in forestry and had in-depth knowledge of Sahelian forestry, having taught three years at a Sahelian school for forestry technicians in Burkina Faso. ISTI also was to supply the ten person-months of short-term technical assistance.

The accomplishments of the project, particularly the successful plantings, were due in large part to the important role that the TA advisor played in the project. Despite the numerous project bottlenecks, interagency coordination problems, and administrative delays, the advisor was able to help keep the project on schedule and maintain open and postive communication links with project collaborators.

7.1.5 SODEVA Staff Assignment

The initial project director was replaced late in the second year of the project. Regional agents, Responsable Regional de Reboisement (RR), were assigned by SODEVA for both Thies and Diourbel. RRs were to work full time in coordinating the activities of the local SODEVA agents--the CAs--in their region and collaborate directly with the TA advisor. Thirty-four CAs were initially attached to the project; their number eventually increased to more than forty.

7.2 Project Management

7.2.1 Management Structure

The project's technical and financial management was distributed among USAID, the TA forestry advisor, and the SODEVA PAFOCSE director. Leadership for planning and coordinating the project's yearly activities, including research, rested with the SODEVA PAFOCSE director, while technical coordination of forestry inputs and village operations was largely carried out by the TA forester. The project design team had expected that the TA forester also would facilitate interagency coordination. However, this turned out to be a difficult task, one that was not within his mandate or scope of work, and realistically would have only been possible had he held approval authority for project finances related to ISRA's participation.

In USAID/Dakar, project management was under the assistant Agricultural Development Officer with the bulk of the work being performed by an assistant project manager, familiar with natural resource projects and rural Senegal. USAID also undertook direct financial management of many of the project inputs: seedlings production, vehicle maintenance, well drilling and improvement, research, and document procurement. All of these were handled as purchase orders; some were put out for competitive bids, and most were implemented by Project Implementation Orders for Commodities.

USAID staff on this project took limited advantage of the agency's technical resources, using the resources of USDA's Forestry Support Program to help organize some short-term training in the United States. Other possibilities, as the USAID Science and Technology office in Washington, remained untapped during the project. The ten months of short-term technical assistance provided for in the design and budget were used for some short-term training and the rest was used to purchase the services of Senegalese consultants who provided soil, village attitude, and silvicultural surveys.

7.2.2 USAID Management

Financial and contractual management of inputs within USAID resulted in a number of key delays in project implementation. Both contracting and financial matters tended to be subject to the management priorities of USAID's overall program and larger projects, not necessarily the priorities of PAFOCSE. The inevitable consequence was delays in the consummation of contracts and the disbursement of funds. These delays proved crucial for seasonal work, such as nursery work and research with trees and crops.

A number of important field trips and meetings contributed positively to successful project management:

- Internal review and critique of the 1985 season by the SODEVA field staff at the Centre d' Entrainement aux Techniques Agricoles (CETAD), March 1986.

- Field visit for project field staff to the Podor "Projet Gonakie," May 1986.

- Group visits by CAs to participating villages by prefecture to compare results and exchange ideas among CAs and with villagers--June-July 1986.

- A technical field visit made by SODEVA RRs and DEF agents working with the project to the Ziguinchor "Projet de Promotion and Protection des Forets du Sud," November 1987.

Visits to similar projects in other Sahelian countries were planned for 1987 but did not take place because of scheduling problems.

7.2.3 SODEVA Management

The project's technical and financial management within SODEVA was prone to problems and proved to be less than ideal for this kind of activity. The disbursement of monies from the project's SODEVA account had to be approved by SODEVA's director, a process prone to delays and not one that would prevent accounting irregularities.

The project's full-time director was supervised by the overall Director General of the agency and was based in Dakar, not in the GNB, while the contracted TA forester was based in Thies. This resulted in a physical distance that translated into loss of valuable time in project implementation and delays in project decision making and communication.

Lines of authority within SODEVA tended to create ambiguity and resulted practically in two bosses for the field-based agents, the RRs and CAs, working with PAFOCSE. The PAFOCSE project director located in Dakar was one superior and the regional SODEVA chiefs the other. CAs were promoting more than one innovation, each sponsored by a different project, with performance conditions associated with each project. Their approach with regard to the various inputs for each village, including the agroforestry input, tended therefore to be top down. This performance-oriented management mentality is reflected in the initial and subsequent approaches taken in promoting the project.

The top-down approach had two consequences that influenced the stated experimental philosophy of the project and the emphasis on demonstrations. Technically, a top-down approach was employed by insisting on a certain tree-planting formula for every village. Villages were expected to plant a minimum number of trees in a predetermined fashion. Since tree planting was not a top priority in the villages (and millet grinders, gardens, animal-raising projects, and wells and water supply were priorities), the promise of well improvements was used in the early stages of the project as a way of encouraging village enthusiasm and participation. The decision to give a bonus payment to CAs based on evaluated performance helped contribute to the project's focus on measurable achievements as project outputs, as opposed to awareness-raising and technical advice to village management committees. This was meant to solve the confusion created by pegging CAs' salaries to different projects and to solve the problem of multiple indemnification as well. The bonuses were devised as a way to

ensure attention to PAFOCSE's agenda with appropriate monetary reward, while at the same time avoiding the multiple-indemnification problem.

A second consequence is that this top-down, rigid, performance-dominated mode did not allow the flexibility needed by such a pilot project to discover--through an open dialogue with villagers--the constraints of soil and water conservation, and to respond with appropriate trials and interventions that would attempt to overcome these constraints. Some constraints were indirectly revealed in the results of the various plantings and discovered in the explanations for the various failed interventions. For example, uncertain land tenure is a disincentive to protecting naturally regenerating Kad trees. This also discourages other land-regenerating improvements that were not attempted. Another example is the sheer scarcity of land and the consequential reluctance of people to plant windbreaks in their fields. Both of these constraints are rather straightforward and common problems of infield tree planting that need to be taken into account in a village-level project such as this one.

7.3 Project Results

7.3.1 Village-Level Planning and Extension Work

In the 1985 season, planning and field activities were carried out entirely by SODEVA, DEF, and Peace Corps participants. These partners constituted a technical supervisory committee, which selected tree species suited to the villages' needs and soils. Technical sheets for each species were prepared for use by SODEVA's CAs in their extension work, taking into account the novelty of some of the species selected, such as the Australian acacias.

Villages were selected according to the following criteria:

- Two hundred to three hundred inhabitants.
- No serious scarcity of well water.
- Land available for tree planting.
- Fairly central location (to facilitate subsequent spread of successful experiences to neighboring villages).
- Interest in participating in the project.

SODEVA's CAs identified candidate villages in a series of preliminary visits in June 1985. At this time, very few villages met the criterion of adequate water.

In a second round of visits to candidate villages, villagers were encouraged to reflect on the problem of environmental degradation and its solution. The CAs explained the project, which was presented as a package of technologies or interventions, some of which were predetermined by SODEVA planners. The responsibilities of the villagers were set forth, including the requirement of an elected village management committee and fabrication of fencing for plantings and nurseries prior to the rainy season.

Table 7-1 shows the number of villages participating in PAFOCSE from 1985 through 1987.

Table 7-1

Number of Participating Villages by Season

Year	Thies	Diourbel	Total
1985	15	17	32
1986	21	36	57
1987	21	42	63

In November and December 1985, planning meetings were held with SODEVA, DEF, and CNRF to discuss tree species selections for the following season as well as other matters.

7.3.1.1 Village Technical Package

The technical package of planned activities that was presented to the villages changed as experience accumulated. See Table 7-2 for details.

In addition to the planting combinations listed in Table 7-2, border plantings of single lines of trees were promoted, for example, inside the fences of woodlots or village nurseries.

7.3.1.2 Village Management Committees

The village management committees, numbering twelve to sixteen persons, consisted of a president, vice-president, and treasurer.

Individuals were responsible for nurseries; training; woodlots; windbreaks; intercropping (in block plantations); and demonstration equipment, tools, and supplies. Each village committee received a set of supplies for undertaking demonstrations and work as shown in Appendix E.

7.3.1.3 SODEVA Extension Agents

SODEVA extension agents, CAs, accomplished the bulk of the extension work. Most were employees, and some were under contract. Many had previous experience with promotion of village woodlot plantings, with Kad planting and protection; and in the better use of manure, including the use of manure pits in association with the cattle-fattening programs fostered in the early part of this decade. Their ongoing work included management of millet mills and repayment of loans for their purchase, management of cowpea seed and millet seed production and distribution, and management of fertilizer distribution and loan repayment.

Table 7-2

Changes in Village Technical Package

1985	1986
One hectare of woodlot, comprising one-third each of fuelwood, forage, and fruit trees.	One hectare of woodlot without fruit-tree species; community orchards on sites nearer wells or with low-lying Dek soils.
One continuous kilometer of windbreak (sometimes through the middle of fields).	Two kilometers of windbreak adjusted to field layouts.
Infield planting of Kad at twenty-five per hectare on four hectares.	Same.
No regeneration protection.	Protection of natural regeneration of Kad.
Fruit trees on private lands; no limit but sold at cost.	Same.
No single-tree plantings.	Single-tree plantings.
Seedlings provided by PAFOCSE except in villages with sufficient water for their own nurseries.	Same.
Village nurseries located where there is sufficient water.	Same.
No vegetable seeds.	Improved vegetable seeds (cost reimbursable).
One improved wood stove for every multifamily compound.	One wood stove per family.
Concrete-lined compost pits according to the number of cattle (between one and six pits per village).	Compost pits according to production of crop residues, at least five per village.
No erosion control.	Runoff control bunds.

CAs were equipped to extend the project's innovations with written handouts on windbreaks and on various tree species and through agroforestry training sessions at CETAD given by CNRF technicians. Individuals from the various village management committees in charge of training also attended the short courses at CETAD.

CAs and PCVs also were helped in their work by the project's TA forestry advisor and by DEF regional field staff.

7.3.1.4 Other Collaboration

Staff from the Centre d'Etude et de Recherche sur les Energies Renouvables (CERER) delivered popular training sessions to village women throughout Senegal in the construction of the clay one-pot improved wood-burning stove.

It was planned to exploit the recently constructed audiovisual center at Pout (CETAD), set up with Cereals II project support. However, agreements on the scope and nature of the work to be done could not be reached. CETAD was increasingly doing contract work and was unwilling or unable to produce materials for the project at no cost. Also, the appropriateness of videotapes and slides for village work was questioned. A CETAD videotape of village exchange visits was made but remains unedited and unused.

7.3.2 Agroforestry and Other Tree Planting

7.3.2.1 Calendar of Activities

The calendar of activities took place approximately as shown in **Table 7-3**, with CNRF and DEF assisting in the choice of all species except fruit trees. Advice on the latter came from technicians at M'Boro.

Annex F contains tables with the following information:

- The various species distributed by the project in 1986 and 1987.
- The provenance of seedlings for the 1987 season.
- Tree planting, regeneration, and survival numbers for project villages.

7.3.2.2 Seedlings, Nurseries, and Plantings

Seedlings were obtained from numerous sources. In 1985, almost all the project's tree seedlings were provided by SODEVA nurseries, including the one in Louga (which resulted in weakened plants because of the distance traveled to the region). DEF nurseries also provided seedlings in 1985. USAID ordered and purchased seedlings from Direction de la Conservation des Sols et du Reboisement (DCSR) nurseries at FCFA 200 per seedling (approximately seventy-five cents). The agreed-upon number of sixty thousand seedlings per year was produced starting in 1986. Private nursery participation increased dramatically in the project's last year, accounting for 15 percent of the total. There were twenty-one village nurseries, which were beset by numerous problems, particularly damage by termites and

Table 7-3

Agroforestry Schedule

October-November	Contact villages, elicit interest, select.
December	Consultations with DEF and CNRF on species, selected according to soil conditions.
March	Set up and begin nursery operations.
April-May	Villagers locate, clear, and fence sites for woodlots; identify emplacement of windbreaks.
May-June	Mark sites for tree planting with stakes or holes.
July	First rains usually in mid July.
August-September	Plant trees when soils moist to thirty centimeters (fifty millimeters total rain).
September	Weed plantations.
October	Weed plantations; harvests begin.
November	Protect weed plantations; animals roam freely in fields.

rodents, lack of adequate fencing material, and scarcity of water. Nevertheless, village nurseries contributed almost a quarter of the total trees planted.

Plantings of trees in various configurations (woodlots, windbreaks, single line plantings, orchards, individual trees, and more) were monitored by the IAs, who used special forms for recording pertinent data (see Annex F). Periodic reports of the IA forester also recorded progress and results, based on his visits. Also, SOMID Afrique (a local consulting firm) was contracted to evaluate plantings survival and protection measures in seventeen of the project's sixty villages. Originally, this work was to have been done by CNRF, but was contracted out when CNRF declined to continue participating in the project in early 1987.

7.3.2.1 Agroforestry Species

A wide variety of species were propagated and planted, but the most numerous were *Prosopis juliflora* and *Eucalyptus canadulensis*. Most of the eucalyptus were planted in Thies, while most of the Prosopis were planted in Diourbel.

7.3.2.3.1 ***E. camadulensis***. One of five trees planted was a eucalyptus, the popular2demand for which represented a momentum from previous campaigns and projects undertaken prior to knowledge of the low tolerance of this species to the sandy, droughty soils and low rainfall in the project area. Cutting trials and planting experiences in the Sahelo-Sudanian zone since 1983 have revealed that this species is poorly suited to the region's climate. The species' characteristic site conditions in its Australian home are alluvial soils with available groundwater. According to Chun Lai (1984), the species does adjust to aridity by reducing transpiration. Consequently, the species grows best on low-lying soils where water accumulates. Villagers like its straight poles and have learned medicinal uses for its mentholated leaves. The species is heavily attacked by termites.

7.3.2.3.2 ***P. juliflora***. This was the principal species used for windbreak plantings. Although slower growing than the eucalyptus, the species has proven its adaptation to the region's climate and sometimes salty groundwater (which harms eucalyptus germination), and has proven its resistance to termites, Lai claims in a 1984 report on the Diourbel village forestation project. However, according to a 1987 SONED report, Prosopis planted in the PAFOCSE villages on degraded soils were growing poorly. The very low survival rate of windbreak plantings of this hardy species is explained by the impossibility of adequately erecting and maintaining fencing for one kilometer-plus line plantings. Other problems were distrust of field owners by villagers and fear of losing property when "forest species" are planted on them, as well as the fear of losing land to cultivation.

7.3.2.3.3 ***A. holosericea* and *A. linarioides***. Of potential value as forage species, these Australian acacias are among the best adapted of the nineteen Acacia species that CNRF introduced from Australia in 1977. Both acacias have bushy forms with multiple stems, and, in twenty-seven months of growth, they reached 2.5 to 3 meters. *A. holosericea* was observed to be doing well even in slightly saline soils in the area of Tivaouane, the village of Keur Gallo.

These species were planted in windbreaks and in woodlots. Along with *P. juliflora*, they were generally better adapted to site conditions than *E. camadulensis*, except in the better sites where the eucalyptus attained almost double the height of these hardier trees. The bushy, spreading form of these Australian acacias is suited to the requirement in windbreaks for species that slow winds near the ground. However, their spreading nature consumes more space than single-stemmed trees--a disadvantage in this land-short region.

7.3.2.3.4 ***A. albida***. Protection of natural regeneration of Kads on the project was not promoted until 1986; initially, plantings of Kad seedlings were promoted. These did poorly, especially in Thies where only one of four survived. Their long tap roots are easily damaged in transplanting. Natural regeneration showed the best rate of survival (90 percent) of any of the trees. This is important as the Kad is the soil regenerator par excellence of the Sahelo-Sudanian zone. Protection of natural regeneration mostly engaged villages in Diourbel (forty-four villages in years 1 and 2, and fourteen villages in year 3). Only eight

30

villages in Thies attempted protection. The excellent forage value of Kad leaves makes young seedlings especially vulnerable. They must be protected for three to five years. Consequently, durable, strong fencing is a key to regeneration of this species.

Forest laws and customary laws complicate the protection of naturally regenerating Kad seedlings. According to the Social Soundness Analysis, Senegal Reforestation Project Paper 685-0283, 1986, the Forest Code of Senegal makes trees the property of the government, subject to regulations on exploitation, while customary law accords use rights to individuals who plant or protect trees, even if on land not owned by the individual. The Forest Code of Senegal and customary law coincide in granting the individual the right to branches. Thus, mature trees are protected, but their use permitted (for example, pruning of branches). However, seedlings are not claimed by the government, hence natural regeneration is not protected. Saplings can be browsed on by cattle without restriction. In effect, under the present code, if an individual protects natural regeneration of a Kad, it would eventually be claimed by the government. This discourages protection of naturally regenerating native trees.

7.3.2.3.5 Other Local Acacias. These represented less than 10 percent of the total trees produced and planted by the project. *Acacia senegal* was the principal species and the species that seemed best adapted, especially to conditions in Diourbel, where it was planted in greatest numbers. Other acacias planted included *Acacia radianna*, *Acacia nilotica*, *Acacia seyal*, and *Acacia tortillis*.

7.3.2.3.6 The Cashew Tree *(Anacardium occidentale)*. The cashew tree was promoted as a windbreak species, notwithstanding its spreading habit and its need for deep soils and good protection from weeds and animals. It did poorly because of a lack of these conditions.

7.3.2.3.7 Fruit Trees. These were wanted by all the villages, but especially by Thies. During 1985 and 1986, almost all the four thousand-plus mangos were planted in Thies. Most of the fifty-four hundred lime trees, on the other hand, were planted in Diourbel reports Ba (1987). SONED's evaluation found the lime trees to be more tolerant of the region's ecological conditions than mango trees. Mangos do poorly on loose sandy soils or soils with hardpan. The ISTI long-term forestry advisor noted that mangos require screening from harmattans. Screens could be made of individual mats or woven grasses during at least the first year. Reports did not mention whether mangos or citrus were grafted before planting out. Oranges, papayas, and grenadines were attempted. None are suited to the climate of the zone. Nematodes attacked the papayas.

7.3.2.4 Intercropping and Irrigated Crops

Seeds of various cool-season vegetables were distributed to villages with nurseries, and seeds of rainy-season crops were generally distributed. Interplanting of peanuts, cowpeas, and manioc was encouraged among the woodlot trees and orchards. Villagers observed that cowpeas seemed to have a beneficial interaction with plantation trees.

31

7.3.2.5 Plantations

The late arrival of seedlings in 1985 jeopardized their survival. More than one hundred millimeters of rain had already fallen, and planting proceeded into October. Project records did not include rainfall figures for the three planting seasons, so its influence on tree survival cannot be known. Damage by livestock, rodents, and insects (such as termites and grasshoppers) were the main problems for village reforestation work, as was rapid weed growth in plantations. Grasshopper damage was not reported, probably because of the absence of natural forest in the zone.

Termite protection of *E. camadulensis* and other seedlings is typically obtained by dousing the planting hole with a tablespoon of dieldrin powder. This was not done in the 1985 season and termite damage was registered. Project records note that dieldrin powder did not give good protection. Application methods for other seasons and situations were not noted, however.

Rodent damage in village nurseries and in transplanted cashew trees was a problem. Cashew trees require a wire mesh or poison for rodent protection.

7.3.2.6 Fencing

Fencing of plantings to prevent trampling or browsing by livestock was to be entirely the responsibility of the villagers, who were to use locally available materials. Live fencing of locally available *Euphorbia balsamifera* (or "salane" in Wolof), whose milky sap is toxic to animals, was the most effective barrier when reinforced in its lower half with interwoven thorny branches of the Kad. Another native material used for tree protection was Nguer *(Guera senegalensis)*. The project eventally distributed Seneplast Incorporated waste mats (from rubber sandal manufacture) for surrounding trees or fencing woodlots. This solved the widespread lack of local materials for fencing and was popular with the villagers.

A SONED analysis (1987) of the person-days involved in constructing an effective fence was carried out for the project. One hundred meters of fencing consisting of a live hedge of Euphorbia interwoven in the top half with thorn branches and/or Nguer stems would require between seventeen and ninety person-days, depending upon the relative availability of materials. Greater labor would be needed in Diourbel than in Thies. Less labor would be required, of course, if a Seneplast mat were used.

7.3.3 Water Resources Improvement

Arrangements made in 1985 by project staff and CAs to deepen or drill wells in participating villages were instrumental--perhaps key--to ensuring village cooperation in the conduct of the various facets of the program that might otherwise have been difficult to promote (for example, windbreaks and compost pits). This inducement could not be followed through because of delays and false starts in the contracting of well-improvement or drilling work. From the villagers' point of view, this proved to be a source of constant discussion, causing unfilled expectations

that hampered project success and created a feeling of unfulfilled promises among the villagers.

The potentials and needs of every village were surveyed by the Ministere de l'Hydraulique, and costs for deepening or drilling twenty-eight wells were estimated. USAID decided to invite bids from private companies. Requests for proposals were issued in January 1986, and one year passed before a contract was approved by USAID and SODEVA, and signed. The contractor received an advance payment in April 1987 and began work on three wells in August 1987. Toward the end of the project, problems arose between the contractor and SODEVA, and little progress had been made.

7.3.4 Soil and Water Conservation

This aspect of the project consisted of the promotion and the construction of compost pits, initially for manure and subsequently for all kinds of organic matter--crop residues, peanut hulls, goat and sheep manure, and more.

Villagers were induced to dig compost pits one meter deep and one meter wide, of the length that may be needed to accommodate available wastes. The pits were to have been concrete-lined to conserve water. CNRA had already determined that an impervious lining would conserve the humidity needed for bacterial activity, without need for additional water even in the dry season.

A total of twenty-eight pits were dug in project villages in Diourbel and Thies. However, the project was not able to supply the needed materials to line the pits, and many caved in. Some were used nevertheless to make compost for the millet crop. This failed effort was particularly disappointing to villagers visited by the evaluation team.

Preliminary plans for water-conserving bunds or infiltration ditches were made for some villages where this technology could be beneficial. The proven effectiveness of this technique make it an attractive low-cost way to increase agricultural production. However, lack of technical assistance, time, and resources prevented development of this activity.

7.3.5 Improved Wood-Burning Stoves

Although not a planned project activity, this became one of the more popular innovations extended through the project. CERER's effective and informal assistance also made this one of the less troublesome aspects of the project. No formal protocol was drawn up with CERER, which provided its own agents and training models.

In September 1985, one hundred women in five Diourbel villages were trained in stove making, and 121 stoves were built. In 1986, 500 more stoves were built in Diourbel and an equal number in project villages in Thies. Women learned to repair as well as build stoves. This innovation has spread to surrounding villages.

7.3.6 Research and Studies

It was planned and agreed on in preliminary protocols that, under SODEVA supervision, DRPF would undertake certain research work, including intercropping, testing nitrogen-fixing aspects of leguminous trees (that is, various acacias), planting trials, monitoring of project villages, and soils analyses and fertilizer trials.

DRPF planned and initiated some research in 1985, but research funding was not released by USAID until June 1986, too late for work in that year. Subsequently, DRPF withdrew its support for research because of disagreements described earlier.

The research program had been planned to generate specific outputs listed below, and SODEVA and USAID subsequently requested bids for studies locally in Senegal to include:

- Soil fertility and degradation studies at six sites.
- An evaluation of plantings and fencing in fifteen project villages.
- An impact study of villagers' attitudes (see below).

The studies were carried out by contractors in late 1987. The results have been incorporated into this report's text, as appropriate.

7.3.7 Village-Level Results and Reactions

This is an important consideration in a top-down project, such as PAFOCSE, which prescribes the technological package (or at least limited it to certain options) and sets certain conditions for participation, while depending on villagers' actions for ultimate success.

From the villagers' standpoint, the project fulfilled its promises and commitments in a number of areas that coincided with their expressed interests. On the other hand, the project failed to improve wells or dig new ones or to provide cement for lining compost pits dug by villagers.

The most popular activities promoted by the project, in terms of widespread interest among the villages, were the fruit trees and the improved wood-burning stoves. The popularity of fruit trees in the region had already been established during the Africare Village Reforestation Project in the early 1980s; and native fruit trees had disappeared, as grazing reserves (in which they grew) were cleared. Fruit trees were not designed into PAFOCSE, but from the first year they were included in the project.

Also nurseries were popular activities, but had to be limited to villages with adequate water supplies. Even though one of the criteria for village selection for the project was sufficient water, all villages wanted improved water supplies, which were discussed with them in 1985. The inability of the project to deliver on this promise, combined with lack of land and lack of labor, resulted in the reluctance of many villages that

participated in 1985 to undertake new plantings in 1986. Some requested fruit trees only.

The project was unsucessful in extending windbreak technology to participating villages. Windbreaks were difficult to protect, as the low survival rates attest. Perhaps one element that caused this difficulty was the intense competition for farmland in the GNB, and the fact that windbreaks often were planned to traverse fields. Farmers did not want to lose cropland. With protection added on both sides of linear plantations, at least a two-meter swath would be removed from production. Staggered lines had to be adopted because of these objections. In the end, the rate of survival of linear plantations of windbreaks was the lowest of the various plantation modes supported by the project.

Compost pits were not well received in the end, since the project was unsuccessful in implementing this program, a serious setback for a potentially important technology for restoring organic matter to soils.

7.3.3 Project Documentation

Documentation made available to the review team indicated that routine records were kept of field-level operations undertaken by SODEVA. This became a necessity when performance bonuses for CAs were adopted. Project villages were visited monthly and results recorded on special forms (see Annex G), which later became the basis for annual reports.

Monthly reporting forms filled out by SODEVA extension agents were designed with a limited amount of information to be collected. Records were also kept of nursery operations.

In terms of the day-to-day activities of PAFOCSE, excellent documentation was done by the TA forester of each major activity, with statistics on production, survival rates, villages assisted, and more. This documentation was an invaluable source of information to the evaluation team and can serve future project implementators interested in the details of this kind of activity.

7.3.9 Short-Term Training

Many short-term training events were organized and held for the project staff, for CAs, and for individuals from project villages. The training facility at CEIAD was used frequently. A comprehensive plan was developed through December 1986 for village-level to technician-level training activities in the villages, in Senegal, and in other parts of Africa with similar projects. Only some of these activities were carried out because of financial and management problems.

Initial training was concerned with project operations, including project briefing for CAs and representatives of participating agencies held in July 1985 at CEIAD and a village nursery management and tree propagation training program, which took place in January 1986.

Additionally, the following training events were sponsored:

- Two SODEVA documentalists were sent to a stateside course in information management offered by Volunteers in Technical Assistance in Rosslyn, Virginia.

- Four villagers and two regional representatives attended a Catholic Relief Services/Peace Corps seminar on village reforestation in a rural training center in Tambacounda during June 1987.

- Five SODEVA and DCSR technicians toured agroforestry projects in the United States.

- SODEVA project personnel were able to visit a number of forestry and land-use projects throughout Senegal.

- A week-long farming-systems seminar at the University of Arkansas was attended by five SODEVA employees in October 1987.

The majority of these training events took place during the last year of the project. This, in effect, lessened the overall impact of the training on the project itself. The participants did have an excellent chance to learn and be exposed to different approaches. However, the short time left for project implementation lessened the potential benefit of these learnings to the project.

The development of training programs based on CETAD's audiovisual capabilities did not take place because of lack of agreement with CETAD on the terms of work, although the center was used for training-related work. CETAD did prepare illustrated multilingual brochures on the project, for use by CAs; Arabic, Wolof, and French text was included.

A purchase order to acquire a large number of agroforestry publications and materials to be used for training purposes, and to be housed at CETAD, was submitted through the USAID financial offices in 1987. As of December 1987, no action had been taken by USAID.

8. PROJECT ASSESSMENT

8.1 Background

The project realized a number of accomplishments in several areas, especially in tree plantings; however, these accomplishments were not free of problems. In other program areas, especially research, the project did not accomplish the goals as foreseen in the project design. The various program areas of the project, as well as project management and the overall importance of the project, are discussed in this section. Both accomplishments and/or problems are addressed.

8.2 Project Design

To a great extent, accomplishments were determined and limited by the project's design. PAFOCSE was conceived of as an experimental or pilot program that would extend and monitor agroforestry plantings at the village level, as well as conduct adaptive research and support training in agroforestry and in the use of audiovisual techniques in extension. PAFOCSE was to provide results to prove or disprove the efficacy of certain agroforestry and soil and water conservation techniques. In retrospect, the design was limited by the lack of detailed elaboration of key aspects. In the future, key aspects such as research, management of coordination among various participating agencies, and the administration mode of USAID, need to be carefully elaborated.

Two items were absent from the listing of outputs in the project design:

- A formulation of the need to seek qualitatively improved agroforestry interventions.
- The articulation of a project output specific to the objective of promoting the coordination among agencies around a research program.

The project forester's scope of work stipulated that he would work with the SODEVA project coordinator on technical aspects of project interventions, but would only monitor research activities.

Some accomplishments, on the other hand, were actions not foreseen in the project design. For instance, the inclusion of improved wood-burning stoves was considered but dropped during project design; however, during implementation, this element was included with great success, and with the uncomplicated assistance of CERER. Fruit trees also were not a design output but were a felt need of the villagers, and engendered great interest in the project. Thus, in the future, projects of this nature should place greater emphasis on the usefulness of related interventions for drawing villagers into active participation in the project. Accompanying interventions can enhance achievement of development goals by addressing felt needs that are more easily accomplished.

The distinction between the need for soil *regeneration*, as opposed to the need for soil *conservation*, was not clearly drawn in the project design or in subsequent implementation. Soil-conservation actions were limited in the end to windbreaks, the least successful component of the project. In future agroforestry projects, much more than protection from wind erosion will be needed in regions similar to Senegal's GNB, one typified by highly degraded soils.

8.3 Agroforestry and Other Tree Planting

An assessment of accomplishments in agroforestry can only be partial and of an interim and conditional nature. The oldest trees had only three years of growth by the time the project ended. Their survival is still in question and will be until the fifth year at the earliest, especially for the various native acacias grazed on by cattle and goats. Their adaptation to degraded site conditions generally found in the villages and their growth cannot be definitively known until around age five when the possibility of damage done by animals ceases and when root systems are better developed, rendering the trees less susceptible to drought. Until then, survival of trees will be determined by rainfall and protection.

The agroforestry component, the main focus of this project, managed to widely diffuse a considerable variety of trees, both native and exotic, in sixty-three villages chosen according to site conditions. More than one hundred thousand trees per year, comprising more than fifteen species, were raised in numerous nurseries (including twenty-one village nurseries) and transported to many villages over a widespread area and planted--a silvicultural, organizational, and logistical accomplishment.

However, the agroforestry component was not free from technical difficulties common to this enterprise. Difficulties arose regarding adequate nursery procedures, care in transportation and temporary storing of seedlings, timely planting, adequate planting procedures, adequate protection, and more. Although SODEVA had already gained experience in promoting and facilitating woodlot plantations, other types of plantings were entirely new to SODEVA agents, as were nursery practices. Consequently, what may have been a routine matter to government foresters, such as DEF field agents, was a new experience for many SODEVA CAs.

8.3.1 Tree Production

Delays in funding, resulting from a complex of factors, jeopardized nursery operations in 1985 and 1986, prompting the acquisition of seedlings from a variety of sources, in addition to the GOS Forest Service's nurseries. Some seedlings were poor in quality, and some were delayed in delivery to village sites.

Other difficulties were caused by delays in funding or disagreement among coordinating agencies on work to be done, resulting in delayed availability of pesticides for nurseries and lack of technical assistance and monitoring from DEF agents attached to the regional DEF offices.

8.3.2 Outplanting

Initial technical difficulties, such as mismatch of trees with site conditions and incorrect applications of pesticides on termites during planting, were corrected in subsequent years. Initial difficulties can be attributed to lack of experience on behalf of SODEVA and its field agents in forestry and agroforestry, as well as inadequate technical assistance from DEF or DRPF agents during the first year in particular. However, some mistakes could have been avoided, such as the planting of *E. camadulensis*, mangos, and orange trees on sandy soils (the principal soils of the region). The encouragement of natural regeneration of Kad could also have been chosen over the planting of seedlings, whenever that option existed.

8.3.3 Soil Conservation/Composting

Existing tendencies to pile up refuse could be improved upon in the development of composting. Villagers are acutely aware of the necessity of finding low-cost solutions and, presented with the problem and a series of possible options for improving water retention in compost heaps (banco bricks or plastic ground covers versus the proposed time and expense of concrete lined pits), could use their ingenuity and familiarity with local conditions to test alternate solutions. Encouraging composting in already low-lying areas with water-retaining Dek soils could promote soil fertility while speeding composting.

8.4 The Project's Experimental Component

Although nominally an experimental or pilot project, PAFOCSE tended to emphasize extending innovations and technologies rather than testing them. This extension aspect was reinforced by the project's design, which provided more detail on the extension work to be done than on the experimental or research work to be done. Other weaknesses in the experimental component mentioned earlier in this report include--

- Vagueness about the overall program and purpose of the research to be conducted, even though specific research tasks were listed.
- Incomplete research and analyses, which were to be done on station and in villages.
- No follow-up on a research plan with working hypotheses for different trials or inquiries, which was developed in the first year.
- Lack of a village-level survey designed or conducted that would yield answers to technical questions such as adaptation of different species to different sites.
- Lack of study results on the acceptance by the villagers of the project and their views on agroforestry and other measures fostered by the project.
- Lack of information that would account for the good survival of windbreaks in some villages and the total failure in others, or for other widely different outcomes of other innovations.

- Little or no data on rainfall, site-specific land-use characteristics, or other facts other than those pertaining to tree planting.

8.5 Project Management

The project management mode chosen for PAFOCSE showed limited success in producing a model or working relationship for interinstitutional coordination. A number of factors complicated project management:

- The project's small size and innovative nature.
- The diversity of inputs and outputs.
- The involvement of six participating agencies: SODEVA, ISRA's CNRF (later renamed DRPF), the Ministry for the Protection of Nature's DCSR and DEF, Peace Corps, and CERER.
- The direct financial management by USAID/Dakar of numerous project inputs, each subjected to U.S. government regulations concerning contracting and financial accounting procedures.

The first three factors are inherent because of the nature of the project (for example, its combined experimental and extension approach, employing technologies not found under a single institutional umbrella). These factors pose a management context that will arise in all such projects attempting to deal with resource regeneration and conservation at the village level by means of innovative interventions.

The project's interinstitutional management situation required far more skill and effort than was anticipated. The project designers had hoped the TA forester would bring about interinstitutional cooperation. However, he was stationed in Thies, which isolated him geographically and lowered him in the hierarchical order to the status of a field advisor. Even if stationed in Dakar, it is doubtful he could have single-handedly resolved the coordination problems.

Pilot projects need management autonomy especially if they involve applied interdisciplinary, interinstitutional research. It appears that a special project management mechanism was needed to resolve differences and, in particular, provide for a smooth transition in implementation between research and extension.

USAID's active role in financial management of purchased inputs, although allowing more control of each input, was unsuited to this small, innovative project whose operations are closely tied to the seasons. In addition to the lengthy contracting and specific accounting procedures, which require approval at numerous levels and offices, the substance of actions was subjected to scrutiny outside the context of the total project, that is, as isolated events rather than actions whose expeditious disposal was strategically important to the larger program.

Although these USAID procedures ensure accountability, they do not ensure timeliness. Their slow pace delayed disbursements, and therefore project implementation, and resulted in program alterations and in management efforts to compensate for cash-flow problems or delayed inputs.

8.6 Land-Regenerating and Land-Conserving Innovations

The extension approach used by the project was suited to proven technologies that generate beneficial results for farmers. However, some of the project's technologies are unproven in their application to the village situation or are of uncertain and very delayed benefit (for example, windbreaks, line plantings, forage species). Also, the extension approach employed by SODEVA was poorly suited to field trials that seek both technical and socioeconomic adaptation or research results.

From the farmer's or village's standpoint, the adoption of an innovation involves several steps: getting information about an innovation, reflecting upon it, deciding to test it, and then deciding to adopt it based on test results. For innovations in food-crop production such as new seeds or fertilizers, the entire process could take at least two seasons. However, the introduction of trees, whose purposes and benefits are new to farmers, calls for a different decision-making process and different extension approach than that employed for innovation in cereals production.

One cannot test a windbreak on a small scale, nor can a windbreak's effectiveness be demonstrated merely by planting a double line of trees. Effects will not be felt until the windbreak is four meters tall, and, prior to that, the trees may even depress the growth of nearby crops as they compete for water and nutrients. Both landowners and herders are involved in communitywide windbreak plantings.

Classes and talks by extension agents are not adequate for such large-scale, communitywide resource management changes. A more effective alternative would be to arrange visits by villagers to villages or sites where windbreaks are full grown and their benefits are being enjoyed and to let other villagers testify to the effectiveness and benefits.

8.7 Degraded Soils--The Fundamental Problem

The degraded state of the region's dominant sandy Dior soils and the need to regenerate them was the general problem the project was to address. Land degradation is clearly indicated in the results of the Societe Senegalaise d'Etudes Agropedologiques soils sampling and analysis work undertaken for the project in late 1987. This work revealed the seriously degraded condition of the region's Dior soils in particular: structural fragility and related high erodability, low levels of organic matter, low water- and nutrient-holding capacities, high density (which limits root development), acidity to the point of causing aluminum toxicity (by creating exchangeable aluminum), and low levels of nitrogen and available phosphorus. Notably, many horizons showed acidity increasing below ten centimeters, aggravating the low-nutrient status and the aluminum toxicity problem. These characteristics pose severe restriction to root growth and to nutrient and water uptake by all plants.

The data on soils would have been more beneficial during the design stage of PAFOCSE, when its results could have been taken into account in planning the various interventions, research, and trials in the various villages. This would have resulted in a better mix of tree-planting and soil-restoring actions.

Because data was not available on the soils, no allowance could be made for the fact that degraded soils are poor rooting environments for young trees. Tree seedlings, like annual crops, are just as vulnerable in their first years to the poor conditions of the upper soil horizon. Like humans, young trees and plants growing in impoverished soils are malnourished and more susceptible to disease and attack by insects. Growth is poor and mortality higher when soils lack better physical and chemical characteristics.

It appears that limited consideration was given to improving the soil in which the trees were planted. The extra effort of digging larger holes (to encourage root growth), and the expense of adding rock phosphate and granular limestone (both available in Senegal) and compost made in the villages' compost pits, would have been justified for well-protected and easy-to-water fruit trees planted near compounds. At the least, trials along these lines should have been carried out; however, none were foreseen in the project design or subsequently considered in planning with ISRA.

The distinction between the need to conserve existing soils and the necessity of regenerating degraded ones was not made in the project design. Thus, the tree-planting exercise seems to have assumed that the soils were viable, and merely needed to be conserved, or that the young trees could overcome the degraded conditions of the soils in which they were planted and ultimately serve to regenerate them.

ANNEXES

ANNEX A

METHODOLOGY, SCHEDULE, AND INTERVIEWEES

Evaluation Methodology

This evaluation is the only external one done for the Cereals Production II-Agroforestry Pilot Project. It is the final evaluation of the project, taking place the very last month of project funding, December 1987.

Given the pilot nature of this project, the methodology used to gather the necessary information was a combination of limited personal interviews, several sample site visits, and review of the extensive documentation produced before and during the project. This was considered the best approach because the considerable accurate documentation was plentiful but unsynthesized, and only a representative sampling of project collaborators was needed, given the accurate reporting carried out during the activity. The synthesis produced involves a review and summary of this extensive information in a form that is meaningful and useful in the design and implementation of future natural resources projects of this kind.

Since the USAID Mission had already designed and begun to implement the Senegal Reforestation Project, a more general document was needed to help synthesize the experiences of the Pilot Project, PAFOCSE, and to give general guidelines to future project planners in the form of lessons learned. Each technique is described briefly below:

- Personal interviews included a representative sampling of each of the collaborating organizations. This phase took place from December 14 to 19, 1987, in Senegal.

- Project village site visits took place for a brief two-day period in Senegal on December 15 and 16.

- Document review took place before, during, and after the week-long work in Senegal, from December 10 to 20, 1987, and January 2 to 31, 1988.

ANNEX A (Continued)

Evaluation Schedule

December 10-11

Document review

December 11-13

Travel to Dakar

December 14

a.m. USAID Meeting with ADO, Project Officer, and TA Forester

SODEVA visit to Project Coordinator

p.m. Working session with TA Forester

USAID meetings with Evaluation Officer

December 15

a.m. Document review

p.m. Depart Dakar

Arrive Thies:

- SODEVA/Thies Delegation: Delegue, RR, and CA
- Village of Mboufta: Village committee
- Village of Keur Gallo Kebe: Village woodlot

December 16

a.m. Depart Thies

p.m. Arrive Diourbel

- SODEVA/Diourbel Delegation: Delegue, Chef de Secteur, RR, CAs
- Eaux et Forets Regional
- Village of Ndiayene: Village committee and woodlot
- Village of Boustan: Village committee and woodlot
- Village of Wour Coigne: Village committee and woodlot

Arrive Thies

ANNEX A (Continued)

December 17

a.m. Depart Thies

Arrive Dakar

p.m. Peace Corps Senegal, Associate Director for Forestry

December 18

a.m. Document review

p.m. USAID debriefing

December 19

a.m. TA Forester debriefing

SODEVA Project Coordinator debriefing

p.m. Depart Dakar

ANNEX A (Continued)

Evaluation Interviewees

Project Village Committees

Mboufta
Ndiayene
Boustan
Wour Coigne

SODEVA

Project Coordinator: Amadou Cisse

Regional Delegation Thies:

- Regional Director/Delegue: Moustapha Gueye
- Regional Reforestation Agent: Seydou Djeme
- Conseil Agricole: Alioune Diagne

Regional Delegation Diourbel

- Regional Director/Delegue: Oumar Dieng
- Deputy Regional Head: Daouda Dia
- Regional Reforestation Agent: Moussa Massaly
- Mbacke, Chef de Secteur: Gora Ndiaye
- Conseils Agricoles: Falou Mbengue, Mounirou Diop

Eaux et Forets

- Diourbel Regional project agent: Mamar Diop

ISTI

TA Forester: Peter Linehan

Project backstop officer: Patricia Poulton

USAID

ADO Officer: James Bonner

Project Officer: Daby Diallo

Evaluation Officer: Seydou Cisse

ANNEX A (Continued)

Peace Corps Senegal

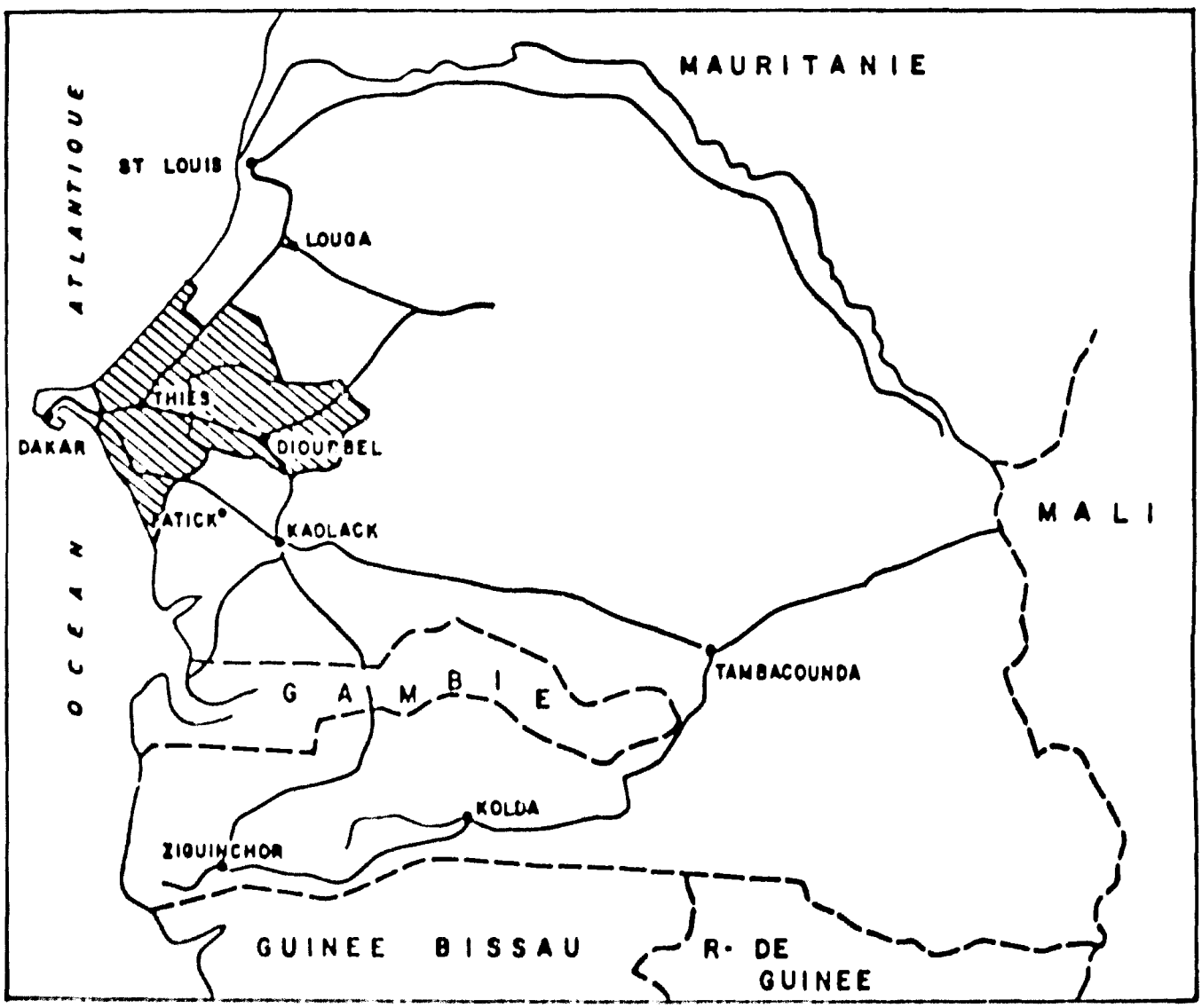
Associate Peace Corps Director: Jack Shea

ANNEX B

MAP OF SENEGAL

PROJECT ZONE:

THIES AND DIOURBEL REGIONS



Scale = 1/4,000,000

ANNEX C

PROCUREMENT IMPLEMENTATION AND PAYMENT METHOD

Item	Method of Implementation	Method of Payment
Technical Assistance		
Long-term (32 pm)	Aid/W contract with 8A firm	USAID Direct
Short-term (10 pm)	Work orders under central contracts, IQCs and inter-agency cooperative agreements	Direct Payment
Commodities		
Water-Lifting Devices	USAID issued purchase order	Direct Payment
Vehicles	USAID issued purchase order	Direct Payment
Training		
Short-term, Local	Organized by GOS agencies who provide materials & stipends	Advance to Local Account
Short-term, U.S. & Other (16 pm)	USAID issued invitational travel orders of PIO/Ps managed by TA firm	USAID Direct
Operating Costs		
Research	Managed by ISRA, Fixed Price Reimbursable Contract	USAID Direct
Demonstration, extension monitoring, and evaluation	Coordinated by SODEVA and carried out by GOS agencies	Advance to Local Account
Wells	Contract between SODEVA and well diggers	Direct Payment
Documentation	Managed by SODEVA	USAID Direct
Seedling Production	Managed by SODEVA & Eaux et Forets	USAID Direct
Soil Analysis	Coordinated by SODEVA and carried out by ISRA	USAID Direct

ANNEX D

CHRONOLOGY OF SIGNIFICANT PROJECT EVENTS

Date	Event/Document
Jan 84	Cereals II Midterm evaluation report
Mar 84	Webber/Major's consultation and report
Jan 85	Project Design completed (PPS)
Mar 85	Cereals II Amendment #4
Jul 85	ISRA/CNRF training for CAs
Oct 85	PIL #25: July 85-Mar 86:
Mar 86	PIL #27: Mar 10-June 86: well-digging
Apr 86	TA Forester progress report #1
Jun 86	PIL #28: Seedling production for mid-July
Jun 86	PIL #26: Research
Dec 86	TA Forester progress report #2
Dec 86	Internal evaluation
Jan 87	SODEVA project coordinator report
Feb 87	PIL #29: Additional operating expenses for planting, SODEVA agents' per diem, soils study, well-digging (water-lifting devices)
Aug 87	TA Forester progress report #3
Nov 87	TA Forester final report #4

ANNEX E

SUPPLIES DISTRIBUTED TO PROJECT VILLAGES

- 2 200 l barrels
- 2 20 m hoses
- * 1 watering can
- * 1 sieve for soil
- * 1 spray adjustor
- * plastic nursery pots
- 1 round shovel
- 1 flat shovel
- 1 100 m cord for measuring plantation
- 1 5 m string for measuring spacing between trees
- 1 plastic pail
- 1 plastic basin
- 1 knife to cut open pails
- * 1 sack of 5 kg Mocap
- 1 sack 10-15 kg dielpoudre
- * 1 sack 15-20 kg rat poison

*Items given to villages with seedling nurseries

In addition, seventeen portable eucalyptus germination beds left over from a previous project were given out in Thies. Note that number of items given to each village did vary, depending on individual needs and the availability of materials. The project also distributed sheets of 1 m by 1.5 m rubber compound matting discarded by a rubber sandal factory following machine stamping of sandal soles, and resembling a very coarse mesh of durable material. These were were wired together and affixed to stakes in order to protect individual trees and groups of trees.

ANNEX F

ADDITIONAL TABLES

Tree Species Distributed by the Project

Percentages of Various Tree Species Included in Trees Distributed to Project Villages in 1986 and 1987

	1986		1987		Total Project
	Diourbel	Thies	Diourbel	Thies	1987
Forestry and Forage Species					
Eucalyptus Camaldulensis	16	62	7	36	20
Prosopis juliflora	62	24	52	34	43
Acacia holosericea	5	6	14	1	8
Anacardium occidentales	6	--	6	7	6
Acacia senegal	8	--	--	--[a]	--[a]
Parkinsonia aculeata	--[b]	--	5	4	4
Acacia linnaroides	--	--	7	2	4
Acacia nilotica	--[b]	--	3	3	3
Acacia albida	--[b]	--	6	2	4
Balanites aegyptiaca	--	--	--	3	1
Leucaena leucocephela	--[b]	--	--[c]	1	1
Fruit Tree Species					
Mango	5	51	9	35	27
Citron	57	23	27	42	38
Goyave	24	7.5	39	17	23
Other[d]		7.5	25	7	12

[a]The above-listed and following species make up 8 percent of the trees used in Thies and 4 percent of the total project in 1987: Flamboyant, *Acacia raddiana*, *A. seyal*, *A. bivenosa*, *Tamarindus indica*, and *Ziziphus mauritiana*. In addition, 200 henna plants were also delivered in Thies.

[b]The above-listed and the following species made up 11 percent of the total used in Diourbel in 1986: *Acacia raddiana* and *A. tortillis*.

[c]Only 250 leucaena were used in Diourbel in 1987.

[d]Others includes mandarines, grenadines, carassoliers, papayas, and grapefruits.

Note: A dash indicates species not used. Percentages are for the category of tree (either forestry or fruit) and not for the total number of trees used.

ANNEX F (Continued)

Sources of Seedlings

Source of seedlings, 1987 planting season

	000's seedlings	% total
DCSR Diourbel	40	35
DCSR Thies	21	18
SODEVA Louga	3	2
SODEVA Diourbel	0	--
SODEVA Kaolack	5	4
Village Nurseries	29	25
Private Nurseries	17	15
Total	115	99

ANNEX F (Continued)

Tree Plantings and Survival

Tree plantings and survival in project villages

Operation	No. villages	Amount: Linehan[a] 1985, 1986 1987	Amount: SONED[b] 1985, 1986	Survival[b] (%) 1985, 1986
Woodlots (bois massif)	53	74.4 Ha	63 Ha	58
Community orchard (vergers comm.)	43	31 Ha	7,403 plants	44
Double line windbreaks (brise-vents)	52	62 km	54 km	34
Single line plantings (plantations en ligne)	24	26	5	62
Single trees (plantation individuelles)	23	104 Ha	6,145 trees	40
A. albida plantings	20		2,242 trees	46
A. albida regeneration	44	1,677 Ha	215 Ha	89

[a]Linehan, Peter. 1987. Final report of the technical assistance to and the achievements of the cereals production II project No. 685-0235, Agroforestry Pilot Program.

[b]SONED. 1987. Etude silvicole des plantations. 33 + annexes. Dakar, SODEVA.

ANNEX G

DATA FORM

PAFOCSÉ - SODEVA
U.S.A.I.D

FICHE DE SUIVI MENSUEL A

Octobre 1987

Date : 20 - 10 - 87

Direction

C A : DLOUNE GAYE

Village : TAMA

Département : TIVAOUANE

92, Rue Blanchot DAKAR

1. REBOISEMENT

	PLANTATION COMMUNAUTAIRE				PLANTATION INDIVIDUELLE			CADD	
	BOIS A	VERGER B	Brise Vent C	Alignement D	Champêtre A	Conces- B	Pure C	Régénération	Planté
Ha/Km	1,10 ha	1 Ha	1 Km	2 Km			0,25		
Nb. plants	1302	445	311	600	800	1393	500		
Nb. sur viv.	1302	445	311	600	800	1393	500		
% réussite	100	100	100		100	100	100		
Besoins									
Remarque observat.	• Clôture : avec 2ème phase pour le bas de Vallée • Les mes sur place de palissades sont nécessaires pour protéger le reboisement à niveau.								

2 Conservation des Sols et des Eaux

	FOSSES FUMIERES					FOSSES DE RETENTION D'EAU			
	Nature M. O	Qt. M. O	Tps de compt	Epandage		Localité distance du village	Quantité Stagnante	Surcreusement	
				Nombre	culture		Exp m peu	temps	Nb x
1									
2									
3									
4									
5									
6									
7									
8									

3. FORMATION : Besoins

Nature de la Formation	Conseiller Agricole	Paysans

ANNEX G (Continued)

FICHE DE SUIVI MENSUEL B

PAFOCSE - SODEVA
U.S.A.I.D

Octobre 1987

Date : 20 - 10 - 87

DIRECTION

CA ALIONE GAYE

Village : Sobly

Département : TIVAOUANE

92, Rue Blanchot DAKAR

Imp. CADO PRESSE Tél. 21-45-73

4. PLANTATION

Espace	Date	qt plantée	Localité CFI	Attaque maladie	Traitement	Survivant nbre	Exploitation	
Forestière		nbre/Kg				%	nature	Quantité estimée
Radiana	87	500	RB. PiB			500		
Prosopis	21.01.87	2 648	RB. PiB					
Balanito	87	200	RB AB RC			200		
Acacia	87	150	PiA			150		
Acacia cassow	87	150	PiA			150		
A. Raviniana	87	RA	RA PiB			150		
Tamarinier	87	100	PiA PiC			100		
Anacarde	21.01.87	736	RA PiC			736		
Eucalyptus	21.87	72	RA PiB			72		
Fruitière								
Manguier	87	225	RB PiB			225		
Papayer	87	250	RB PiB			250		
Goyavier	87	150	RB PiB			150		
Citronnier	87	300	RB PiB			300		
Culture intercalée ou associée								

5. ENTRETIEN ET MATÉRIEL

ENTRETIEN

Nature	Moyen	nbre de fois	Temps de Travail	MATÉRIEL		
				Reçu	Date	Besoins
Traitement Phito						
Desherbage						
Arrosage						

ANNEX H

DETAILED SETTING OF THE PROJECT

1.0 Physical Characteristics

The Thies and Diourbel administrative regions are situated in the middle portion of the Groundnut Basin, to the east of Dakar. With the exception of low limestone outcrops in a few places in the the westernmost portion of Thies, the landscape is gently rolling to flat and near sea level. A mantle of wind-deposited sand covers the landscape and the underlying marine sedimentary rock formations.

1.1 Climate and Weather

Broadly speaking the region occurs within the semiarid tropics. The West Africa climatic designation is Sahelo-Soudanian. An eight-month dry period during November to June is followed by a period of erratic rainfall, mostly falling during July to September and typically occurring as local showers rather than frontal storms. The rainy season is also the season of greatest cloud cover and atmospheric humidity. Average annual rainfall in the region has been in the range of 420 mm to 440 mm during 1971-1986 (SEAGROSOL, 1987). Rainfall in the early part of the century was more abundant; in Thies the annual average during 1918-1965 was almost 700 mm. Temporal and spatial distribution of rains in the region are erratic, and interannual differences are considerable.

Because rainfall intensity is not great, erosivity of rainfall in the region is not high. Most rains do not exceed 20 mm per hour. However, soils are totally bare when the first rains come, and this combined with their lack of a stable surface structure can result in quick sealing by raindrop impact and surface runoff.

Winds are strongest at midday during the hot dry season that precedes the rainy season. These are the Harmattan winds that blow out of the northeast from the Sahara desert, and are at their strongest during April and May.

Annual average maximum and minimum temperatures are 35^{0} C and 19^{0} C respectively. Surface soils can reach temperatures of 60^{0} C or more.

1.2 Land Forms and Soils

In recent geological time (the Pleistocene) sand dunes covered the region from the Saharan south to the Saloum River. These dunes are now smoothed off and the inter-dunal depressions are partially filled in. Over the millenia, these dunes became stabilized by native vegetation consisting of a low open forest dominated by Acacias. The native vegetation is now almost entirely removed except for large trees in village compounds and valuable trees such as *Acacia albida* and *Balanites aegyptica* in the agricultural landscape that give a park-like appearance. Without the stabilizing vegetative cover, these ancient dunes can become mobile once again, as has been observed in places during the latest drought.

ANNEX H (Continued)

A shallow ground-water table found at between 10 m and 30 m is fed by downward percolating rainfall and is the source of water for the region's numerous villages. The water table has descended since the onset of the drought in 1968.

Leached Ferruginous soils is the accepted designation of the region's soils. They are widely found throughout the West African Sahelo-Sudanian and Sudanian zone. Locally they are called Dior soils; a slightly hydromorphic phase occurring in interdunal depressions and with somewhat higher clay content is called a Dek soil. The Dior soils are predominantly sandy (80 percent to 95 percent), of poor structure, of high density and low porosity, neutral to acid (pH 5.0 to 7.0), and have low water-holding capacity (between 70 and 120 mm depending upon the topographic position). The lower-lying Dek soils can hold more water. Because of very low content of organic matter (around 0.5 percent) and clay (3 percent) in the Dior soils, they cannot retain nutrients in a form available to plants; their cation exchange capacity is on the order of 2.0 meq/100 g.

The soil-testing work commissioned by the project (SENAGROSOL, 1987) confirmed the degraded state of the region's Dior soils. Over the years cultivation (which is now a virtually continuous rotation of peanuts and millet) and the loss of organic matter restoration with the disappearance of follows, have made these soils relatively infertile and unproductive. Never considered high-potential soils, their modest productivity has declined. Continuous cultivation destroys their structure and makes them vulnerable to wind erosion, increases density (which impedes root growth), and decreases percolation and water storage. Acidity has increased in relation to reference soils studied in the 1950s and is greater below 10 cm than in the surface layer. SENAGROSOL found acidity-induced aluminum toxicity in some of the Dior soils samples. Values of pH 6.0 and 5.0 were found in Khoube at 0 to 10 cm and 10 to 50 cm respectively (SENAGROSOL, 1987).

Dior soils near *Acacia albida* trees and those Dior soils that are heavily manured and devoted exclusively to millet for household consumption (i.e., the Toll Keur lands) have retained their productivity. SENAGROSOL sampled soils within 5 to 10 meters of *Acacia albida* trees (MB2 at Mboufta) and found total nitrogen to be twice as high as soils not under the crown (0.4 ppt compared to 0.2 ppt). Available phosphorus of 62 ppm was found in the same sample. Available phosphorus in soil samples was on the order of 10 to 30 ppm elsewhere.

Dek soils have higher organic matter and clay content. They are less acid, and are therefore more productive, except for limitations posed by their fluctuating water table, which affect certain plants (e.g., the mango tree). They only comprise 20 percent of the region's soils, however. The SENAGROSOL tests of Dek soils found some of these to be moderately fertile, with neutral to alkaline reaction, and with twice as much exchangeable calcium and magnesium as nearby Dior soils.

ANNEX H (Continued)

2.0 Settlements and Land Use

This is a region of many small villages of 250 to 300 people and high population density, now exceeding 100 persons per square kilometer. Serer, Wolof, and Peul are the principal linguistic/ethnic groups. One usually is preponderant in a village, but some villages have all three groups.

Bushy follows and permanent grazing reserves, usually on poor lands with low forest, are no longer seen. Wild fruit trees are now scarce in the region, as are grazing lands for domestic livestock during the growing seasons when they must be herded away from the planted fields. There is a serious fuelwood shortage.

A continuous rotation of millet and peanuts is the dominant land use. Sorghum may be grown in Dek soils. Cowpeas may be grown as an end-of-season catch crop or instead of peanuts. Manioc has recently been introduced and is grown in Thies. Average yields of millet are on the order of 700 to 800 kg/ha. Yields fluctuate considerably in parallel with the rainfall but have been declining as soils productivity has dropped. The effect of soil degradation on yields has been masked in recent times by the drought.

Crop residues are not plowed into the soil. Cowpea and peanut vines are consumed by local livestock, or baled and sold for fodder. Millet stalks have multiple uses: building material, fodder, and fuel. *Acacia albida* limbs are pruned in the dry season for green forage, and then burned in home fires. The crowns of some *A. albidas* have been dwarfed by excessive pruning. In essence, little organic matter is returned to the soil in the form of crop residues.

During the postharvest season, herd cattle forage in fields and are corralled during the night on millet-producing lands, to concentrate manure there. Manure from local sheep and goats is not traditionally used for fertilizing and accumulates in mounds. Farmers do not use chemical fertilizers (SENAGROSOL, 1987).

Improved technologies suited to this region have been slow in developing. Improved peanut varieties that mature in seventy-five days were developed in the 1970s, and recently short-season, drought-tolerant cowpeas have been developed with the assistance of the AID Bean CRSP. However, better-performing millets and sorghums have not yet been developed and farmers have been unable to buy fertilizers because of a lack of credit and availability.

In recent years, village woodlots and improved wood-burning stoves have been actively promoted in this region, and elsewhere in Senegal. Village nurseries became associated with the village woodlot campaign, and irrigated vegetables are often added to the enclosed nurseries.

ANNEX I

PREVIOUS RESEARCH AND DEVELOPMENT WORK ON DEGRADATION

The problem, defined since the onset of the drought in 1968 as desertification, has concerned the government and the international community for some years. In 1980, USAID/Dakar included environmental rehabilitation of the southern half of the Groundnut Basin in the Country Development Strategy Statement.

Initially seen as the result of tree loss to woodcutters, degradation was countered with projects to increase fuelwood supplies by means of large plantations such as the 1,500 ha-plus plantation at Bandia (the AID-financed PARFOB project) and small village fuelwood plantations. The latter have been supported indirectly by USAID (though Africare and the Peace Corps) as well as the World Food Programme and other donors (Chun Lai, 1984). Also, in 1980 work on improved wood-burning stoves and improved charcoal-making kilns got underway, with support from USAID and eventually other donors as well.

During this period, FAO and FAC were supporting research in soil fertility maintenance and agroclimatology at CNRA, Bambey, including methods of composting, management of organic matter in soil fertility maintenance and soil water conservation. Much of this work was summarized by Freeman for USAID in 1982 in an internal paper on agricultural intensification and environmental rehabilitation in the Groundnut Basin (Freeman, 1982). USAID subsequently authorized PL 480 funding for adaptive village-level research by ISRA on a number of land regenerating solutions, planned and executed jointly with SODEVA, ISRA and the Direction des Eaux et Forets in twenty villages.

Forestry research had also received modest support but important results were accumulating in the early 1980s. CNRF multispecies trials in Bandia, near Bambey, near Kaolack, and elsewhere, had shown the kind of performance that could be expected from various eucalyptus and exotic acacias on different soils. The good performance of *E. microtheca* on heavy dek soils had been noted. The poor performance of *E. camadulensis* at rainfall less than 800 mm had been established in trials and in plantations, including the AID-financed Bandia plantation. At that plantation associated research also examined such questions as windbreak configurations, intercropping, herbicide use in weed suppression, open root planting (barbatelles), and the soil moisture regime under new plantations as opposed to natural forests.

The superior adaptability of *Prosopis juliflora* to the region's climate relative to Eucalyptus also had been rediscovered (the species has been in Senegal for many years). The performance and to some extent the acceptability of a number of Australian acacias had been tested in trials as well as at the village level by U.S. Peace Corps foresters in Diourbel.

Concerning the human element in village agroforestry and forestry much had already been learned, particularly through the USAID-funded AFRICARE/Peace Corps/E&F collaborative work in Diourbel and Thies during the early 1980s, undertaken at the village as well as the Communaute Rurale levels. The results

ANNEX I (Continued)

were recorded in USAID and AFRICARE project documentations, notably Fred Weber's evaluation of the project in 1983 (Weber, 1983). Among the more important lessons in village forestry learned from these and other project experiences were the following:

- Land shortages in Thies and Diourbel severely limit the block plantation approach.
- Village nurseries are very effective in general, but poor-quality ground water (too salty) found in some places may jeopordize germination of some species.
- Protection of planted trees or natural regeneration (e.g., *Acacia albida*) is difficult because of a lack of suitable materials.

ANNEX J

SCOPE OF WORK

ATTACHMENT 1

SCOPE OF WORK

I. THE PROJECT

Project Title: Cereals Production II - Agroforestry

Project Number: 685-0235

LOP:

PACD: 12/31/87

II. PROJECT OBJECTIVES

As revised in the PP amendment dated April 4, 1985, the basic goal of this project is to carry out an agroforestry, soil conservation pilot program in the Thiés and Diourbel regions of Senegal. This pilot program is a precondition to achieving, maintaining and improving agricultural productivity.

The purpose of the Cereals II project is to "improve extension and research capabilities of the Government of Senegal to reach the entire farming community with improved cultural recommendations designed to increase food production and farm income in the Groundnut Basin".

The major activities (as revised in PP) of the project through which these objectives are to be achieved are as follows:

a) Identify, test, disseminate and evaluate a series of agroforestry and soil conservation techniques designed to maintain soil productivity and

b) Improve the capability of GOS agencies to design, implement and evaluate agroforestry and soil conservation programs.

ANNEX J (Continued)

-5-III. PURPOSE OF THE EVALUATION

A major project evaluation conducted in January 1984 pointed out the importance that the Groundnut Basin has for Senegal's economy and the need for long-term solutions to the natural resources deterioration of the zone. The team recommended, among other things, that USAID continue assistance to SODEVA and ISRA and the Service of Water and Forest to promote "crop diversification, related livestock activities, and soil conservation and regeneration activities". Environmental reclamation through the establishment of windbreaks, tree plantings and farming techniques to restore soil degradation have been successfully carried out in various countries in the Sahel (A. Niang, 1983, F.A. Gulick, 1984). Results obtained in these countries suggest that production can be increased by 40-50% for groundnuts and 23-63% for pearl millet. It has also been documented that elsewhere shelterbelts have contributed to improvement and restor action of the microclimates for field crops establishment during the drought years. A number of these techniques have been tried in the pilot project and specific assistance is now needed to evaluate these efforts.

IV. BACKGROUND

This agroforestry pilot phase was initiated with the revision of the original Cereals Productions II Project in April 1985. transfered from the original project funding of to the new project in the form of a PP supplement. SODEVA, the regional development agency in charge of the Groundnut Basin agreed to cooperate with ISRA/CNRF and the Service of Water and Forest to conduct the pilot program. The total duration of the pilot phase was set for 33 months.

ANNEX J (Continued)

V. SCOPE OF WORK:

The contractor will be charged with conducting a systematic evaluation to measure the impact and progress of the project towards achieving project objectives. Included in the evaluation will be an assessment of:

a) the total number of hectares or trees planted;
b) survival rate (by species) of trees planted;
c) number of villages participating and total number of people affected;
d) the quality of data collected for analysis;
e) the quality of research conducted and its relevance:
f) the knowledge of soil type and its capability to support vegetation and related economic feasibility for forestry interaction;
g) the relevance of other commissioned studies and their usefulness in relation to other project components; and
h) the extension methods used by SODEVA's field agents; whether or not these will be able to motivate the villagers to continue agroforestry and soil conversation activities after the project is over.

The evaluation should also assess the effectiveness of working protocols and the effective use of inputs by SODEVA to successfully disseminate the proposed package of interventions. For example, the use of the documentation center, utilization of audio-visual materials and operational linkages between the different agencies should be described.

It is essential that the results of this consultancy provide SODEVA, USAID and other participating agencies, with a definite understanding and guidance to make the appropriate changes which can help redirect other forestry projects towards achieving project goals effectively.

VI. PERSONNEL REQUIREMENTS

The consultancy will be carried out by one person. This person should be a forester or soil conservation specialist with the following specific qualifications:

ANNEX J (Continued)

1) Advanced degree (MS) in an appropriate scientific discipline such as forestry, soil conservation, physical geography, forestry, extension or related fields.

2) Experience in Francophone Africa and preferably experience in administration, project management implementation and extension, coordination, and supervision of technical programs, would be desirable.

3) Background in arid land forestry, forestry extension, village woodlots, windbreaks, soil conservation techniques and soil regeneration, agroforestry, and nurseries development, would be desirable.

4) Familiar with research, documentation and applied research as related to forestry.

5) Background in audio-visual support to instruction;

6) Prior service as a member of AID or international agency evaluation teams;

7) French language ability at FSI S3/R3 level.

VII. REPORTS

Responsibility for preparation of the final report to be submitted by the contractor will rest with the consultant to be engaged under this PIO/T.

The report will contain the following sections:

1. Basic Project Identification Data Face Sheet

2. Executive Summary

No more than two pages single spaced including statement of purpose of the project and of the consultancy, a statement of the conclusions with topics identified by subheadings and recommendations (corresponding to conclusions) and specifying, where possible, who or which agency should take the recommended action.

ANNEX J (Continued)

3. Body of Report

Will include a description of the context in which the project has developed and provided the information on which the conclusions and recommendations are based.

4. Appendices

As necessary and providing, minimally, the contractor's scope of work, and description of the methodology used.

A final draft of the evaluation report should be submitted in English to USAID at least three days before the departure of the consultant from Senegal. During the course of the assignment the contractor will maintain contact with the ADO officer of USAID through the Project Officer. USAID will arrange to have the report translated and typed in French.

VIII. REFERENCES

The contractor should have reviewed and be familiar with, prior to the start of field consultation, the following documents:

1. Mid-term Evaluation Report; Senegal Cereals Production II, 1984;
2. Project Paper Amendment, April 1985.
3. Grant Agreement and Amendments, Project 685-0235.
4. GOS New Agricultural Policy, 1984.
5. USAID CDSS FY 1987.
6. Progress Reports, Peter Linehan, 1985, 1986 and 1987.
7. Protocoles d'Accord relatifs à l'exécution du projet Agroforestorie;
8. Rapport d'Execution du Projet Agroforesterie Conservation des Sols et Eaux, 1985-1986, Jan 1987.

USAID will provide copies of these documents to the contractor.

ANNEX K

REFERENCES

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Hagen, R.T. 1987. An Assessment of the Senegal Cereals Production Phase II Agroforestry Study Tour (September 13-October 12, 1987), Draft Final Report. Washington, D.C., International Science and Technology Institute. 12 p. + appendixes.

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Linehan, P.E. 1986. Progress Report September 1, 1985 to April 1, 1986, Cereals Production II Project No. 685-0235, Agroforestry Pilot Program. Washington, D.C., International Science and Technology Institute. 19 p. + tables.

ANNEX K (Continued)

Linehan, P.E. 1987. Final Report on the Technical Assistance to and the Achievements of the Cereals Production II Project No. 685-0235, Agroforestry Pilot Program. Washington, D.C., International Science and Technology Institute. 37 p.

Linehan, P.E. 1987. Progress Report October 1, 1986 to July 31, 1987, Cereals Production II Project No. 685-0235, Agroforestry Pilot Program. Washington, D.C., International Science and Technology Institute. 14 p.

McGahuey, M. n.d. Impact of Forestry Initiatives in the Sahel: Effect of *Acacia albida* tree on millet production in Chad. Washington, CHEMONICS International. 25 p.

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