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OPPORTUNITIES FOR SUSTAINED DEVELOPMENT

Successful Natural Resources Management in the Sahel

Asif Shaikh

Eric Arnould
Kjell Christophersen
Roy Hagen
Joseph Tabor
Peter Warshall

VOLUME I/MAIN REPORT

Funded by the United States Agency for International Development
Office of Technical Resources and Sahel Office
Bureau for Africa

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Preface

In February 1987, the African Bureau approved the Plan for Supporting Natural Resources Management in Sub-Saharan Africa (PNRM). The focus of the PNRM is achieving sustainable increases in agriculture and rural income where agriculture includes production of food and export crops, livestock and wood. The PNRM grew out of A.I.D. experience indicating that sustainable production is directly linked to the long-term condition of soils and vegetation and to the maintenance of habitats that harbor genetically-diverse flora and fauna. Under the PNRM, agricultural development is necessarily considered a sub-set of natural resources management (NRM). The PNRM reflects growing congressional and public concern about investing for sustainable impacts in Africa. Under the Development Fund for Africa, (DFA) the African Bureau is expected to target 10% of the development budget towards natural resources management activities.

The Sahel Sub-Regional Natural Resources Management Assessment Report (SSRA), including an executive summary, is one of the essential steps in implementing the PNRM. It is the result of several months of Africa Bureau-sponsored field research designed to address an important aspect of the problem of development sustainability.

The SSRA was conducted in the Gambia, Mali, Niger, and Senegal. The scope of work for the SSRA team called for its members to examine first-hand those farmer-based initiatives that were having enduring impacts and to describe the conditions under which the impacts were occurring. Sustainable development, because of its cross-cutting nature, requires us to know more about agriculture, economics, the environment, national institutions and their policies and the socio-cultural milieu under which small producers conduct business. Sustainable development also requires us to have a sound analytical understanding of the relationships among the elements of a production system in order to understand the system's resiliency and ability to withstand shock and stress, both externally and internally imposed.

This report focuses on a host of on-farm agricultural production practices that show promise for sustainable agricultural growth in the four Sahelian countries studied. It was prepared by a team of experts assembled by Energy/Development

International under the coordination of Michael McGahuey, Agroforester, Natural Resources Branch, Agriculture and Natural Resources Division, Office of Technical Resources, Bureau for Africa. Volume One provides an overview and findings of the assessment and presents the recommendations.

Volume Two provides an in-depth description and analysis of each of the seventy initiatives studied. The Financial Analysis Annex (Volume III) provides a menu of potential interventions and a cost and benefit analysis. The Biological Diversity Annex (Volume IV) reports on how interventions affected biological diversity of an area and the potential for integrating biodiversity concerns into future programs.

Compilation of this report would not have been possible without the inputs of many people. Mission personnel in each country contributed countless hours in preparing for the team's visit, facilitating their work in-country, and reviewing their findings. Special gratitude is extended to officials of the government of the Gambia, Mali, Niger and Senegal who provided the team with basic information and guidance. A large number of professionals, inside and outside of A.I.D., also reviewed the draft reports and made substantive contributions.

We intend this report to be the beginning of a process rather than an end product. The wealth of information presented in this four volume report provides a number of lessons for strengthening country action programs for sustainable agriculture. It also should assist the Africa Bureau in its long-term strategic planning and donor coordination efforts. Most importantly, it should be noted that the seventy interventions described represent but a portion of the management strategies being used by innovators who could serve as models for host country and donor investments that help farmers to help themselves.

Dr. Abdul H. Wahab
Branch Chief, AFR/TR/ANR/NR
10/19/88

Acknowledgments

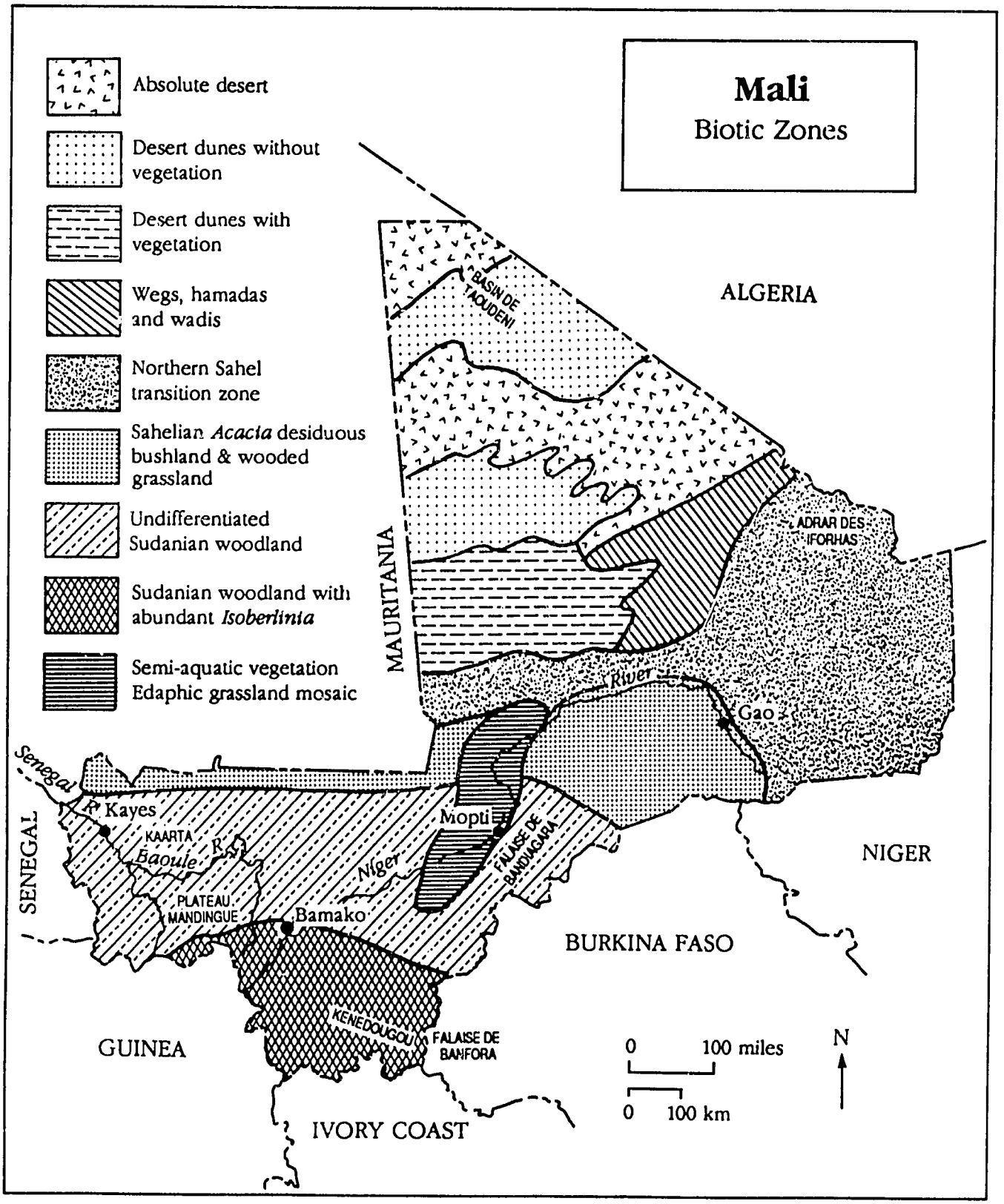
This report was the result of a larger process of conceptualization and field observation in which dozens of individuals played central roles. A large part of the credit for the success of our effort belongs to those who so generously gave us their time, their insights, and most of all, the benefit of their accumulated experience. In each of the many specific areas we covered, we were privileged to be able to learn from colleagues who knew more about the topic than we did. The quality of the intellectual effort which is taking place at every level is itself one of the success stories of natural resources management in the Sahel.

Within A.I.D. Washington, the study was carried out under the joint auspices of the offices of Technical Resources (Agriculture and Natural Resources) and the Sahel Office, both in the Africa Bureau. Abdul Wahab and Phyllis Dichter have provided invaluable guidance, encouragement and support throughout the study. At the working level, Michael McGahuey (TR/ANR) and John Lewis (Sahel) provided close professional interaction and laid the intellectual groundwork for the assessment. In particular, the team would like to note our enormous debt to Mike McGahuey. He participated in the field assessments, as well as in the planning and execution of the study, and unselfishly gave his time and ideas to make it a better product. His vision and knowledge were an inspiration to us all.

In each of the four assessment countries, key individuals from U.S.A.I.D., from government ministries and from extension services guided our field efforts and created a stimulating environment for observing, learning and exchanging ideas. The list of colleagues who worked closely with us is sufficiently long that we cannot mention each one specifically. This is no way diminishes the value of their contributions or the gratitude we owe them.

From that list, we would, however, like to cite Idrissa Samba and Mana Diakite, who participated as full team members in Senegal and Gambia, and in Mali, respectively. Without their outstanding contributions we would have lost much of the richness of the field observations, and without their intellectual stimulus we would have had to settle for a narrower understanding of the underlying processes in the Sahel. In addition, Don Drga, Katim Touray, Sidi Jarju, A. Cisse and Sheriff Jallow travelled with us on site visits and provided valuable insights and support.

The true authors of this report are, of course, the Sahelian farmers and rural populations whose initiative has given us something to write about. In every village and farm, we were welcomed with the graciousness and hospitality unique to the Sahel. If this effort makes any contribution towards justifying the trust our hosts placed in us, it will have achieved its objectives.


Mali
Biotic Zones
Absolute desert
Desert dunes without vegetation
Desert dunes with vegetation
Wegs, hamadas and wadis
Northern Sahel transition zone
Sahelian Acacia desiduous bushland & wooded grassland
Undifferentiated Sudanian woodland
Sudanian woodland with abundant Isoberlinia
Semi-aquatic vegetation Edaphic grassland mosaic
ALGERIA
BASIN DE TAOUDENI
ADRAR DES IFORHAS
MAURITANIA
River
Gao
Senegal
R. Kayes
KAARTA
Baoule R.
SENEGAL
Mopti
Niger
FALAISE DE BANDIAGARA
NIGER
PLATEAU MANDINGUE
Bamako
BURKINA FASO
KENEDOUGOU
FALAISE DE BANFORA
GUINEA
0 100 miles
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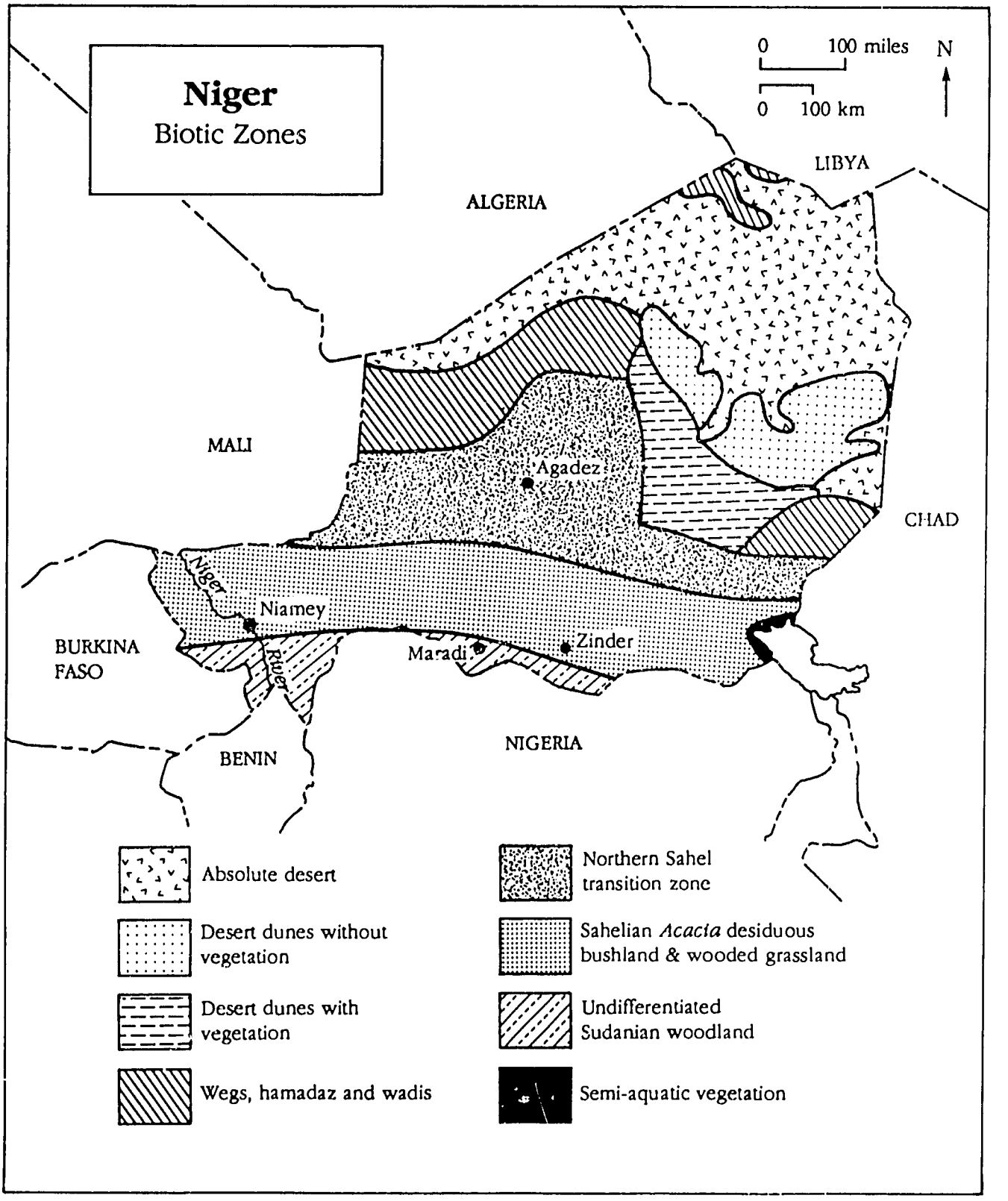
N
IVORY COAST


Niger
Biotic Zones
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N
LIBYA
ALGERIA
MALI
Agadez
CHAD
Niger
Niamey
BURKINA FASO
River
Maradi
Zinder
NIGERIA
BENIN
Absolute desert
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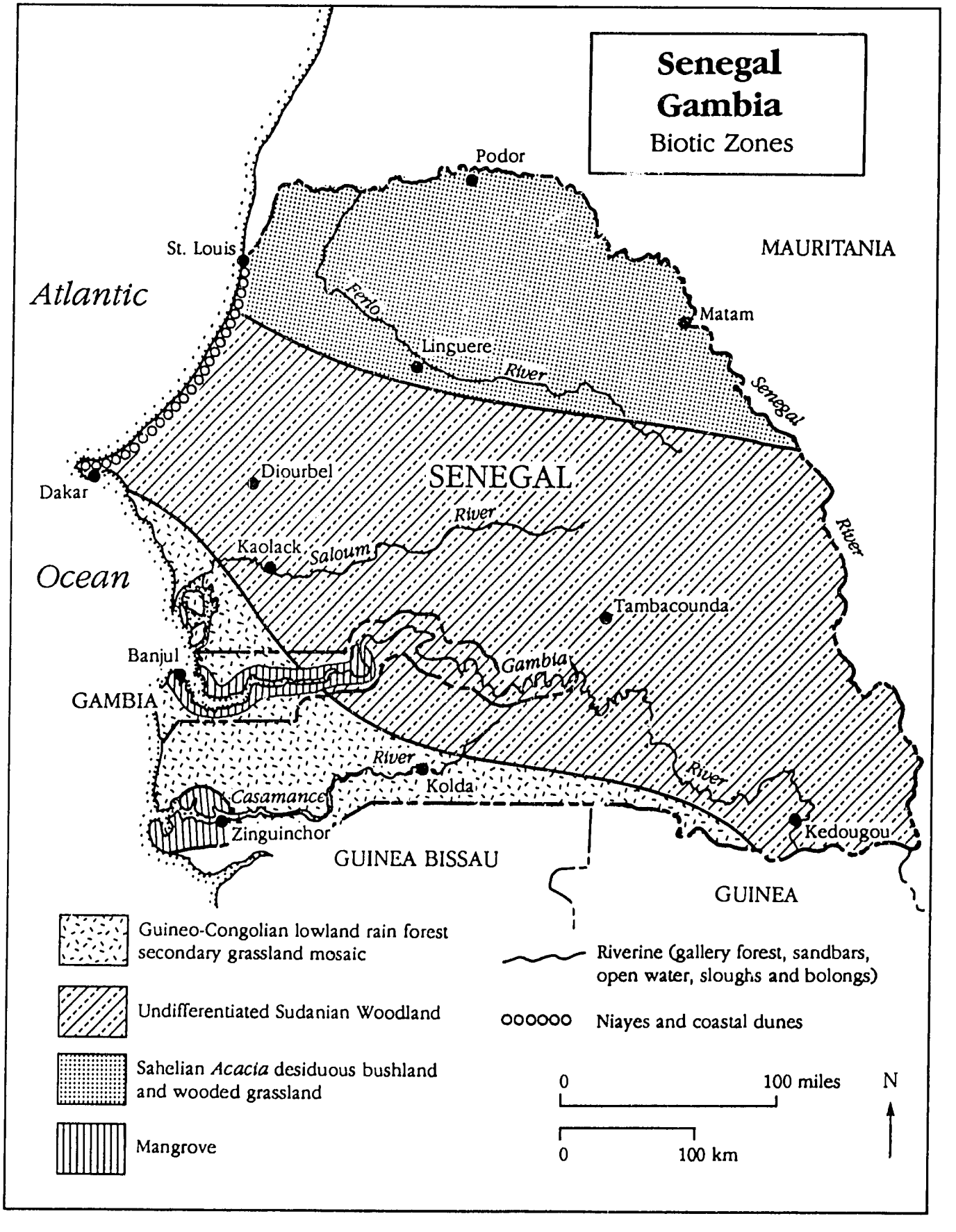

Senegal
Gambia
Biotic Zones
Podor
St. Louis
MAURITANIA
Atlantic
Ocean
Fento
Matam
Linguere
River
Senegal
Dakar
Diourbel
SENEGAL
River
Kaolack
Saloum
River
Tambacounda
Banjul
Gambia
GAMBIA
River
Kolda
River
Casamance
Zinguinchor
Kedougou
GUINEA BISSAU
GUINEA
Guineo-Congolian lowland rain forest secondary grassland mosaic
Undifferentiated Sudanian Woodland
Sahelian Acacia desiduous bushland and wooded grassland
Mangrove
Riverine (gallery forest, sandbars, open water, sloughs and bolongs)
Niayes and coastal dunes
0
100 miles
0
100 km
N

CHAPTER 1
THE RAPIDLY CHANGING CONTEXT

Introduction

Natural resources are the long-term capital on which a nation builds and grows. Every nation starts with a specific endowment of water, soils, minerals, plants and animal life. It must manage this endowment well in order to sustain and improve the livelihood of its human population, including its terms of trade with other nations. The management of natural resources - water supply and water quality; air quality; soil fertility; minerals; vegetative cover, and plant and animal life - in short, the nation's ecology, is inseparable from the nation's economy. When the ecology is stressed by drought and rapid population growth, natural resources management becomes increasingly difficult. Reaping short-term benefits may sacrifice the long-term quality and quantity of the nation's natural capital. This is the situation in West Africa today.

The Natural Resource Management Systems (NRMS) team visited Mali, Niger, Senegal and Gambia. The team searched for successes in natural resources use and management - initiatives or interventions that, in some sense, worked. The team avoided muckraking failures or writing one more catalog of how and why natural resources management has failed in Africa. This is old news and, in part, inaccurate news. Before elaborating on the meaning of success, it is important to describe, at the risk of repeating some well-known facts, what is happening in the Sahelian and Sudanian regions of West Africa. Within the context of the sixteen year drought (see box), our criteria for success must be balanced by the huge ecological and economic obstacles faced by the West African people.

The Drought and the People

The basic parameters for economic development (e.g., terms of trade, job opportunities, kinds of work, community organization of labor, and the rules governing access to natural resources) are no longer the same as in the pre-drought period. For the last twelve to sixteen years, rainfall has remained about 60% of pre-drought levels. The major rivers - the Niger, the Senegal and the Gambia - have shrunk drastically. Saltwater has moved inland, up the rivers and into the groundwater. Wells have dropped as much as 75 feet, dramatically increasing women's work load, since women are responsible for hauling water. Forests and grasslands have become increasingly fragmented. In some areas productive trees and grasses or valuable species such as medicinal plants have

completely disappeared. Brush fires are harder to control. Reduced numbers of pollinators and greater distances between plants have greatly decreased seed production. Seed dispersal by normal means (birds, wildlife, cattle) has become less frequent. The loss of pollinators and seed dispersers as well as increased grazing pressure have made natural forest regeneration difficult. Many species of plants and wildlife that were traditionally major fallback foods or supplements to local economies can no longer be found in quantities large enough to harvest (e.g., *fonio, bourgu, bushmeat*). The Sahel's natural bank account is now depleted. In some areas, the loss of shrubs and trees has been so severe that it has been accompanied by a loss of knowledge of horticulture, plant uses, and grazing routes, with diminished opportunity for mothers to instruct daughters or fathers to teach sons local ecological knowledge.

THE DROUGHT REVIEWED

The decline in rainfall in West Africa began 13 to 16 years ago. It has been most severe in Senegal, Gambia, Mali and Niger - from west to east. This is long enough to kill off some native vegetation and permanently block certain agricultural practices. Within the sixteen years, 1972/73 and 1982/83 had the lowest rainfall values. These years received much media attention. But, in between these extreme low rainfall years, the Sahel and Sudanian zones of West Africa have never returned to the pre-drought norms.

To make matters worse, the rainy season has shrunk. It begins later (16 to 21 days) and ends earlier (6 to 8 days). The rainy season has averaged 22 to 27 days shorter than long term averages, undermining the ability of farmers to grow existing crop varieties to full maturity.

The two accompanying maps show the old view of rainfall and the new view. The Saharan desert has effectively moved south. Note that the "new" Sahel is now 61 to 133 kilometers south of the "old" Sahel (38 to 70 miles). This means the sorghum/millet zone and the erratic grazing zone (200 to 500 mm) must replace part of the maize/sorghum/millet and groundnut zone further south (the zone of 500 to 900 mm rainfall). In turn, part of this second zone will replace portions of the cotton/commercial crop (e.g., fruit tree) zone in Senegal and Mali. Similarly, riverside rice cultivation has had to retreat both upstream and uphill to avoid intruding saltwater. In other areas, rice is then be replaced by sorghum.

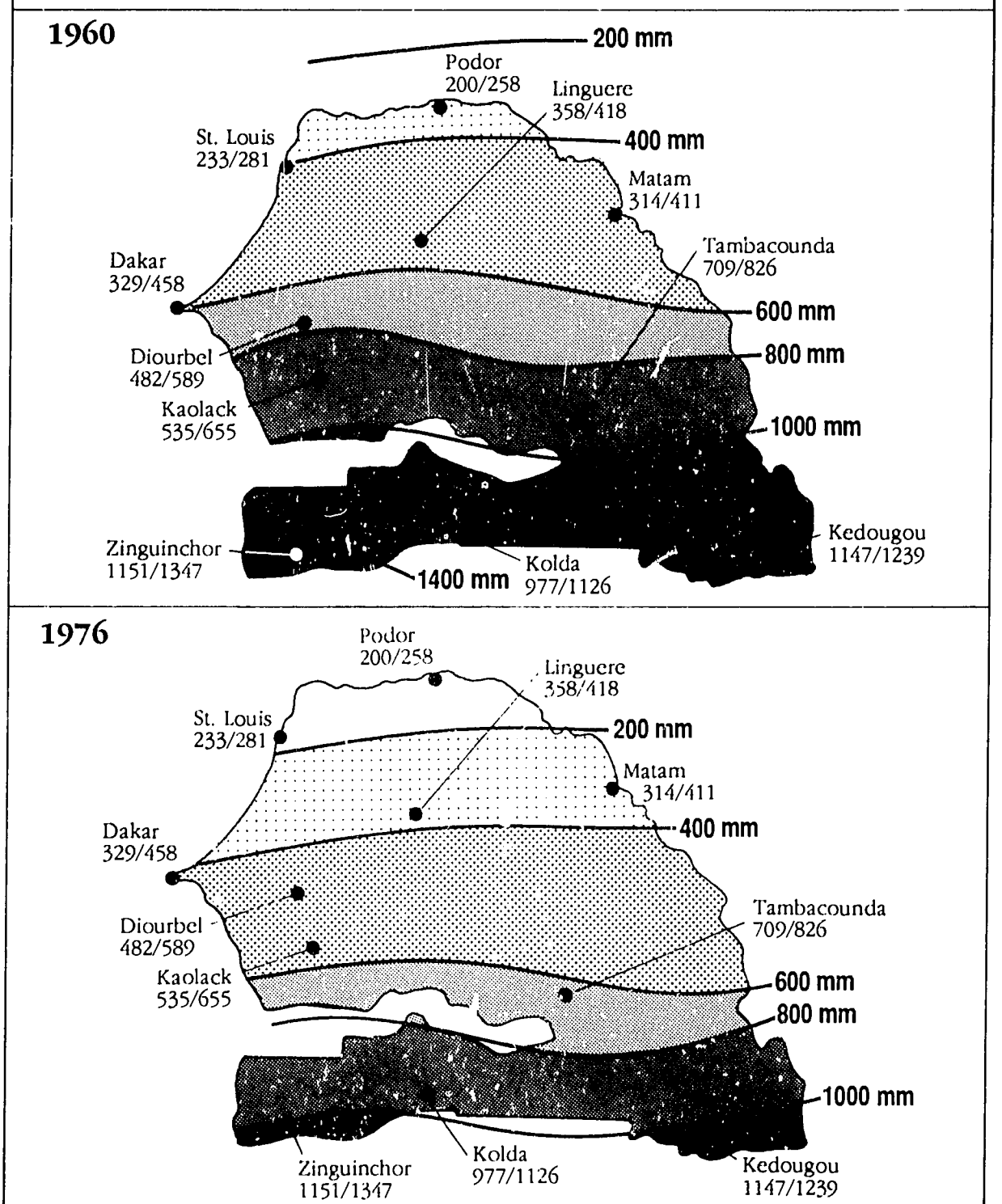
The Drought Reviewed

From the point of view of economic development planning, there is one clear conclusion: *Don't use old rainfall normals.* Many plans for Sahelian projects have doomed themselves to failure by hoping the drought will be over as soon as they start their project. Runoff, irrigation, crop mixtures and grazing schemes have been planned on rainfall data that are simply out-of-date. In the coming years, no one can prophesy the return of the pre-drought rains and projects should be planned on the rainfall averages of the last sixteen years.

To counter the current disaster, human energy is compensating for natural processes. For example, a major exchange of seeds has begun. People are trading, selling or carrying northern, more drought-adapted species, to the south - to areas that must now be called part of the Sahel. Others are bringing north seeds of southern species that have been killed during the drought, and replanting them with supplemental irrigation to compensate for the reduced rainfall. This massive exchange of seeds is a populist attempt to restore biodiversity and to adapt to the new and, compared to human life spans in West Africa, permanent drought condition. The desire for drought-adapted fruit trees and other cultivars appears universal. Tree planting, with varied degrees of appropriateness and success, is now widely accepted as both economically beneficial and ecologically important.

Throughout the Sahel, many herders have lost livelihood. Cattle herders are switching to goats. Access to water, grazing lands and browse by transhumant pastoralists has become difficult as local land holders increasingly conserve these resources for their own sustenance. Many traditional rules of access have broken down or become complicated by the nationalization of pastoralist commons. Grazing and browsing pressures are extremely intense in the locales where the drought and/or access rules still allow livestock exploitation. Of all sectors of the economy, this has been the most cantakerous and unwieldy. Successes have been rare.

Sixteen Years of Climatic Change in Senegal



Isohyets of mean annual rainfall in 1960 and 1976 showing southward migration of drought by 113 km. Each city shows the mean amount of rainfall for the last 16 and the last 30 years. The last 16 years show reduced mean rainfall at all stations.

1 The Context

Throughout the Sahel and even further south, many farmers have had to abandon rainfed or riverside farmland where the river's waters have become too salty. Farmers have a great desire for short-season cultivars of rice, millet and maize to match the constricted rainy season - another characteristic of the drought. With a smaller land base, fallow periods on still arable sites have been shortened - in some places from over a decade to only one year. In an attempt to increase fertility, burning of the brush has become more frequent and intense. But, this "band-aid" technique has not worked. Lower soil fertility and increased soil erosion are typical consequences of the shortened fallow period. In many parts of the Sahel, total food production has fallen even as the area cultivated increases. The long-term benefits of diverse and productive forests as well as stable, improved soils have become elusive.

Farmers' enthusiasm for new techniques such as micro-basins and water catchments to increase water supply is widespread. Wells with irrigated gardens now occur throughout West Africa. In these irrigated gardens as well as in higher rainfall zones, where risks are relatively low, farmers are for the first time using phosphate and petroleum-based fertilizers. The purchase of fertilizers and, in some cases, drought-adapted seeds, has enmeshed farmers in the market economy and accentuated the need for credit.

Drought has exacerbated the conflict between wildlife and agriculture; elephants, warthogs, baboons, hippopotami and many bird species are increasingly viewed as pests. Lack of water has forced many larger mammals to migrate away from national parks and to enter agricultural areas, where they are shot. There is a urgent need for pest management to expand its horizons beyond locusts and granivorous birds and seriously consider how to maintain both farming and biodiversity in West Africa. The status of most large mammal populations is desperate.

Generational misunderstandings are widespread as the younger generation increasingly believes that traditional methods of farming, fishing and herding are no longer as viable as they once were. Because of the environmental crisis, West Africans are more open to innovation than in pre-drought or early drought periods. The social organization of economic life has loosened in order to incorporate new innovations and techniques to handle the problems of depleted and poor soils and lack of water. Innovative individuals who adopt methods to meet drought conditions, who find new ways to increase cash income and short-term productivity through soil conservation, or who know how to save human labor and energy, are themselves important natural resources. Large-scale interventions, such as capital and maintenance intensive anti-desertification projects or river basin development with dams and large-scale irrigation, have not produced the expected returns.

Migrant seasonal labor to the cities and other countries (even France) has greatly increased as the land and water base shrinks and cash economies increasingly substitute for the local production of necessities. As West Africans move into cities, they (like the urban public in general) often lose their understanding of the intimate connection between soil, water, trees, firewood and food. This alienation from their nation's ecology has hindered most attempts to conserve natural resources by more efficient usage (such as wood-conserving stoves). Increasing urbanization has stimulated a new need for environmental and conservation education to re-teach these connections and to re-enforce the necessity for urban households to reduce pressure on the nation's resource base. The drought itself has fostered a great thirst for more knowledge about the environment and how to live with the new conditions. Young West Africans, born after most wildlife had disappeared from their environment, want and need to know what pre-drought Africa and the animals in their parent's stories were like.

In summary, the human ecology and economy of West Africa has gone through a major shift. The environmental crisis has created a situation open to innovation and to interventions that can deal with drought and the increased pressure from a growing population. The challenge is to re-establish and to restore a resilient and productive agro-sylvo-pastoral economy that, at minimum, maintains the natural resources base - especially soil fertility and water quality. The greater management challenge in West Africa is to improve the natural resources base by practices that both increase long-term productivity of the soils and help to diversify the vegetative cover - steps to prevent a worse human and economic crisis during future droughts.

The team looked at the West African Sahel as a cup half full, not half empty. Everywhere we saw people substituting their own imagination, technical skills, physical energy and knowledge for what were once the naturally occurring gifts of rain, dependable crop yields, grazing pastures, forests, rivers and groundwater, game, fish, and medicinal plants. Persistent drought and economic crisis have changed West Africa permanently. One can look at the massive deterioration of the environment and predict doom, or one can look at the bold and creative acts of individual small farmers, fishers, and herders and see what a difficult, but not impossible, future might bring.

BIODIVERSITY: THE NEGLECTED NATURAL RESOURCE

Biodiversity is a name for a recently "discovered" natural resource. In simplest terms, biodiversity is the natural resource scientists call germplasm. Most people know germplasm as packages of genetic materials called animals and plants - everything from rice to elephants, mushrooms to aardvarks. But biodiversity means more than just the species. It also includes the maintenance of these species in populations large enough to ensure their existence into the future. Maintenance of biodiversity is easiest and safest by maintaining the community of species which supports it and which it helps support. In West Africa, this includes five major biotic communities: the Sahara desert; the Sahelian shrub/tree drylands; the Sudanian dry forest; the coastal estuaries and near-shore islands; and the freshwater rivers. Within each of these communities can be found a food web and vegetation that is significantly different from the other communities. Within each of these communities, there may be finer distinctions which are also unique complexes of self-supporting germplasm. For instances, the Sahel has dunes, *reg* (truncated hills), plateaus, closed water basins and depressions - each an obvious variant of the Sahelian biotic community.

Biodiversity has become best known for one of its focuses: threatened and endangered species and varieties. This focus helps illustrate the two-pronged concern of biodiversity. On one hand, there is need to maintain species that may not have immediate or clearly understood human uses. In West Africa, almost all known animal and plant species have some human use but the list might include certain animals like the wild dog, pygmy kingfisher or ground hornbill; or plants which have as yet not been studied for medicinal or industrial uses. These species or communities may continue to exist only in protected areas set aside by the national governments. In these cases, the immediate goal of biodiversity is a sanctuary in which citizens can view a part of their African heritage that has otherwise disappeared; as a reference biotic community against which we can compare the changes wrought by humans;

and as an educational setting in which children and adults can study the ecology, natural communities and biology of the Afro-tropical realm.

On the other hand, there is also a great desire to maintain diverse species that have human uses. These include animal species such as the endangered manatee which is also a drought fallback food, and sacred within numerous local religions; and plants such as disappearing millet varieties that may be resistant to disease, drought or bird predation or trees endangered by the drought and over-exploitation like *kouf*, which has long a tradition of medicinal and religious uses. For the purposes of this assessment, biodiversity addresses the maintenance of variety in both the natural and human environments. It can be contrasted with activities that reduce species richness and population abundance. The three broad focuses of concern are: habitat types, species and crop varieties (germplasm). In reality, it is impossible to separate the human and natural environments of West Africa. In most all cases, the human ecology of biodiversity is crucial for both conservation and sustainable development.

CHAPTER 2
METHODS AND CRITERIA FOR DEFINING SUCCESS

Introduction

During the months of November 1987 and January 1988 a multidisciplinary team composed of individuals with substantial experience working in the West African Sahel toured four countries: Mali, Niger, Senegal, and The Gambia. The team was charged with documenting and assessing successful natural resource management initiatives in the four countries. The team was asked by the Africa Bureau of U.S.A.I.D. to define criteria for success, to identify successful field efforts, to document and analyze their success, and to derive lessons which increase the options for developing a natural resources strategy in the Sahel.

Assessment Methodology

The team evolved the following approach: Prior to each country visit, team members sought evidence of ongoing successful natural resources initiatives from knowledgeable professionals. We also sought to identify key sites with A.I.D. mission personnel. From the master lists, the team then selected sites representative of the major natural resources, donors, regions, and ecologies.

Team members spent considerable time determining the kinds of information that should be collected on each site, and the criteria by which success should be defined. After several iterations, a standardized approach to collecting information at each site was developed. Standardization was important to the efficiency and consistency of site visits. However, we considered it equally important to use a format which allowed unstructured discussion of the specific factors which may have contributed to success at a given location, and the reporting format reflects this need for flexibility (Table 2.1).

Table 2.1
Data Recording Form Natural Resource Management Systems

I. Basic Information

A. location
B. participants in the visit
C. major characteristics of the location (soils, vegetation, water)
D. number of hectares affected
E. special characteristics of the case
F. traditional land use practices
G. nature of the initiative

II. Description of the Initiative

A. technical measures taken
B. social organization of the initiative
C. economic incentive system
D. socioeconomic data

III. General Discussion of the Initiative

Upon arrival in each country, the team spent a few days meeting with national officials, A.I.D., and other key contacts in the capital cities. These meetings enabled the team to choose the sites to be visited, to consult key documents, to make appointments for site visits with field personnel, and, when appropriate, to integrate A.I.D. and/or ministry staff into the field teams.

The final choice of sites depended upon several criteria. The team sought a balance of private initiatives and interventions supported by A.I.D., other bilateral and multilateral donors, and NGOs. The team determined that each intervention visited should have been on-the-ground for at least three years, and preferably more. We attempted to sample interventions affecting each major natural resource: water, soil, floral diversity, faunal diversity, and human energy. Logistics was a final consideration. The team could not visit the Second Region of Mali, the Ferlo and Senegal River Valley in Senegal, and the northern and eastern provinces of Niger, due principally to time limitations, the difficulty of travel, or the distances involved. We sought to assure, however, that the regions we did visit captured, in their sum, the major ecological and economic variations within each country.

2 Methods and Criteria

In each country the team divided into two or three teams to conduct its site visits in accordance with the number of team members available in that country. Placing natural and social science professionals on each team facilitated richer and more rapid data gathering. The team visited over 70 different natural resources management interventions in four countries. We focussed on interventions, not projects, and sought to overcome the tendency towards project evaluation, as well as to capture both private initiatives and publicly financed ones. Interventions reviewed were often parts of larger projects. It was common to find successful initiatives within projects, which, when judged as a whole, were not a success. In many cases, the interventions were at very early stages of development and could not yet be judged truly successful. Finally, the focus on interventions rather than projects also meant that if some novel initiative caught a team member's attention en route, it could be documented.

The team is confident that, while limited in space and time, the survey covered a broad range of natural resource interventions underway in the Sahel. Transects covered the northern and southern parts of the Sahel, the historic Sudano-Sahelian, Sudanian and Sudano-Guinean areas. Within each zone, sample sites encompassed considerable ecological, economic, and social diversity. Thus, the survey encompassed plateaux, plains, and river valleys, and we explored interventions affecting agricultural areas, forest reserves, and wildspaces. Team members' previous experience in other contexts in the Sahel provided useful complementary examples to those observed as a group.

The team passed from a few hours to a half day at each site visited. We began each visit with a review of general information with project or extension personnel. Then, often in the company of project or extension staff, we visited one or more sites of field activity, where interviews with participants were conducted. Often the interview began in a village house or center and proceeded to the field. Both staff and villagers were interviewed. Frequently, the team split up to get village participants away from assistance personnel in an effort to obtain opinions more freely. In cases where a private initiative was investigated, these steps were often compressed into a long discussion with the entrepreneurs involved.

The site report outline reproduced in Table 2.1 above helped to structure the team's inquiries and reports to A.I.D. country missions. In addition, team members employed lists of key topics or questions to help further structure their field discussions. Data were collected manually and transcribed in the field notes of each member. Each team member sought to capture and represent in as accurate and fine detail as possible the phenomenon encountered. Each of the members of the research team had a slightly different style in describing field observations, but each aspired to the goals of comprehensiveness and accuracy.

Over time, evolving team "culture" served to sharpen our attention in pursuing these goals and developing a comprehensive snapshot of each initiative. Team members shared notes at the end of each field day. In addition, members worked together to produce the composite snapshots of each initiative during writing session conducted at the end of every week in the field.

Defining Success

The team began its assignment with a mandate to determine which technical interventions (e.g., *Acacia albida*, windbreaks, contour dikes, living hedges and the like) had been successful for smallholder natural resources management, and to rank these technical interventions on the basis of their effectiveness. However, very early in the assessment, we found that initiatives which met the criteria of being sustainable and replicable resulted from the combination of social, financial and technical factors. We therefore placed increased emphasis on the *observational* content of the site visit reports. That is, we did not want to see only what we were "looking for", but rather to understand the underlying factors at play as fully as possible.

In searching for success, the team did not necessarily look at the goal of the intervention or project. At times, success was unexpected and different from the original intent of the activity. We tried to focus on what occurred and not to evaluate a project by its terms of reference. Interventions could thus be technical (energy efficient stoves, channel protection, microcatchments), social (conflict resolution over access to a common resources, formation of a village cooperative) or economic (food-for-work, seed capital, cash, credit).

For our purposes, an intervention was called a success if it did one or more of the following :

- improved soil fertility or stopped its further degradation;
- improved water use or water quality management;
- increased vegetative cover, especially with plants that helped stabilize soil, improve soil fertility or manage water supply;
- maintained or improved conditions for biodiversity, including horticulture and agricultural varieties, and native species and habitats;
- saved or reorganized human energies (productivity enhancement) so individuals or communities had more time and/or income to take natural resources management under consideration.

2 Methods and Criteria

The rural poor are not against protecting their natural resources and, when informed, appear to want to improve resource management. But, in many cases, impoverished and resource-poor economies have reduced farmer concerns to those of procuring short-term subsistence. Both "la conjuncture" (sustained economic crisis), and the rapid pace of ecological deterioration inhibit farmers, herders, and city dwellers from considering the long-term natural resources costs and benefits of their behavior. Successful, natural resources management was often tied to general improvements in national and local economies and to family planning efforts.

The criteria for success developed with the team's experience. The point in time at which an intervention is evaluated leads to different conclusions. In Mali, energy efficient stoves took many years to "take off" as a self-inspired enterprise. Stove projects in Mali were judged failures after five or even seven years of extension. After ten years, the stoves can be seen in most rural Malian homes. Many villagers now manufacture their own. There were no set periods for the incubation time, extension time and "full acceptance" time for various ideas or technologies; we found it detrimental to long term resource management objectives to prematurely label initiatives failures. In some cases, interventions have become successful when funding continued a few more years to let acceptance mature within a village or region. *Acacia albida* regeneration and windbreak planting in the groundnut basin of Senegal are two examples. In other cases, it was difficult to predict when to judge success or failure. In general if an intervention met other criteria (economic incentive, low risk, consistent with recognized values, technical soundness, technically "capturable", etc.), it appeared that a ten year time horizon was minimally required to achieve success.

Success also changes with context (i.e., was context sensitive). For instance, tree planting in Senegal is very successful when compared to the situation just a few years ago. Perceived risks are lower; incentives exist; techniques are being transferred; some conflict with values and local social organization have been resolved; tree tenure is secure. But, from the point of view of species diversity and long-term reforestation, these tree plantings fall short. Some species (e.g., *Eucalyptus, Gmelina*) have strictly short-term and single purpose uses (construction poles). Eucalyptus, for example, does not have the soil fertility benefits of *Acacia albida* or *Cordyla pinnata*. Gmelina makes poor firewood. While we believe that the first stage effort (tree planting) now needs to be modified to add species diversity and multi-purpose trees with greater capability of improving soil fertility, we felt it misleading to classify the first stage of tree plantings as a failure. In fact, planting for construction poles in some areas may be the best (i.e. most profitable) land use. The general enthusiasm for short-term benefits

from tree growing is probably a necessary intermediate step on the way to the more refined second stage of enrichment and enhancement of biological and economic diversification.

Success varies with the observer's perspective. Customary cost/benefit analyses were not always a sufficient approach to measuring a success. In interventions involving biodiversity, it was almost impossible to place an economic value on maintaining a bird species or a unique habitat. Only some of the technical interventions produced immediate results (e.g., water retention dams increasing crop yields). Others, especially national parks, living fences and watershed management, will pay off over longer time scales than the team could reasonably measure, predict or observe in a brief visit. For the cultural ecologist, increased land tenure security is an obvious element of success that has promoted better natural resources management but it is difficult to analyze economically. Similarly, certain aspects of the process, such as villager participation in project design and site selection are critical to long term success, even if particular technical initiatives fail. Participation creates a sense of self-esteem, self-confidence and self-reliance -- all important aspects of sustainable natural resource management and of development. A single resource or sectoral view can blind the observer to ongoing resource use dynamics. In a few cases, for example, villagers increased the intensity of one kind of land use at one location, thereby relieving the pressure at another location.

Limitations of the Study

The team limited its own scope of work because of time, the desires of U.S.A.I.D., and its own expertise. We therefore ignored certain fundamental issues. The team did not look at family planning. This is, of course, a major gap in any natural resources survey since resources are often stressed by population pressure. It did not learn if women were trying to reduce their family size to meet drought conditions and food production limitations. The team did not include a women in development consultant, which would have allowed a better dialogue on issues of family planning which particularly affect women. In addition, the team ignored the potential impacts of *AIDS* (Acquired Immune Deficiency Syndrome) on the future quality of life and human energy supplies in the Sahel.

We had very limited contact with marine or freshwater fishing interventions. Only one aquaculture and one shrimp culture project was visited. Nevertheless, the drought has caused massive reductions in freshwater fish and some estuarine-dependent species. Catches have dropped 80% in the Niger River (Niger) since 1960, many fishermen have abandoned their traditional activity along the Senegal and Niger rivers, and remaining fishers have been forced to fish undersized fingerlings in many areas. There is an embryonic interest in fish farming to compensate for these losses. But, a first generation of these projects has come and gone and a second generation of activities are too

new to comment upon. Fisheries have not been a major focus of U.S.A.I.D., and for this reason were not part of our terms of reference. Other countries and organizations, especially Canada and FAO, have been more concerned with this resource.

The team simply did not look at forage and livestock interventions. This has been a major focus of A.I.D. in the past, but the Sahelian experience has been particularly bleak as far as maintaining, improving or designing good management schemes for grazers and browsers.

Finally, the team did not look at minerals, though phosphates are particularly important in Senegal, Mali and Niger because they have entered the small farmer fertilizer economy. All four countries visited are producers of rock phosphate but for lack of a regional production and distribution strategy, remain importers of petroleum-based fertilizers. Livestock, fisheries and minerals are complex natural resource management concerns requiring extensive micro and macro-economic analysis. They deserve detailed consideration in the formulation of a comprehensive natural resources strategy for the Sahel.

CHAPTER 3
SUCCESSFUL NATURAL RESOURCE MANAGEMENT INITIATIVES IN THE SAHEL

SUMMARY MATRIX NATURAL RESOURCES INITIATIVES IN THE SAHEL

INITIATIVES	IMPACTS: Soils Fertility	Texture	Retention	Water Quantity	Quality	Flora Quantity	Diversity	Fauna Quantity	Diversity	Human Energy	OUTCOMES: Policy	Management	REPLICABILITY: Organization	Time to Impact	Benefit/Cost	Compatibility	Complexity
Water retention dams	▒	▒	▒	■	▒	▒	▒	▒	▒	■	▒	▒	▒	▒	▒	■	▒
Dams for Irrigation	▒	▒	▒	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Salt Barriers	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	■
Micro catchments	■	■	▒	▒	▒	■	▒	▒	▒	■	▒	■	■	▒	▒	▒	■
Channel Protection Dams	▒	▒	■	■	▒	▒	▒	▒	▒	▒	▒	■	■	▒	▒	▒	■
Small Channel Dams	▒	▒	■	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Vegetative Strips	▒	▒	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	▒	▒
Contour Plowing	▒	▒	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Diversion Bunds	▒	▒	■	▒	▒	▒	▒	▒	▒	■	▒	▒	■	▒	▒	▒	▒
Tree Lines	▒	▒	■	▒	▒	■	▒	▒	▒	▒	▒	■	■	▒	▒	▒	▒
Live Fences	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Border Plantings	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Dune Stablization	▒	▒	■	▒	▒	▒	▒	▒	▒	■	▒	■	■	▒	■	▒	▒
Compost Pits	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Compost Stables	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒

■ = High ▒ = Medium ▒ = Low. Note that "■" generally implies the most positive result (i.e. high positive impact on soil retentions, etc.). There are 2 exceptions: "Time to Impact" and "Complexity", where "■" is the least desired result (long time to impact, high complexity) and "▒" is the most positive result.

INITIATIVES	IMPACTS: Soils Fertility	Texture	Retention	Water Quantity	Quality	Flora Quantity	Diversity	Fauna Quantity	Diversity	OUTCOMES: Human Energy	Policy	Manage-ment	Organi-zation	REPLICA-BILITY: Time to Impact	Benefit/ Cost	Compati-bility	Complex-ity
Wells and Gardens	▒	▒	▒	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	▒
Natural forest Management	▒	▒	■	▒	▒	■	▒	■	■	▒	▒	■	■	■	▒	▒	■
Industrial Plantations	▒	▒	■	▒	▒	▒	▒	▒	▒	▒	▒	■	▒	▒	▒	▒	■
Infield planting	▒	▒	■	▒	▒	▒	▒	▒	▒	▒	▒	■	■	▒	▒	▒	▒
Cooperative Woodlots	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Private Woodlots	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	▒	▒
Nurseries	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	▒	▒
Fire Management	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	■	■	■	▒	▒	▒	▒
National Parks	▒	▒	▒	▒	▒	■	■	▒	▒	▒	▒	■	■	■	▒	▒	■
Sacred Woodlots	▒	▒	■	▒	▒	■	■	▒	▒	▒	▒	▒	▒	▒	■	■	▒
Crop Introduction	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	▒
Gardens for Trees and Shrubs	▒	▒	▒	▒	▒	▒	■	▒	▒	■	▒	▒	▒	■	▒	■	▒
Community Develop-ment Associations	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	■	■	▒	▒	■	■
Improved Stoves	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	■	▒	▒	▒	■	▒	▒

■ = High ▒ = Medium ▒ = Low. Note that "■" generally implies the most positive result (i.e. high positive impact on soil retentions, etc.). There are 2 exceptions: "Time to Impact" and "Complexity", where "■" is the least desired result (long time to impact, high complexity) and "▒" is the most positive result.

Introduction

Overview

This chapter synthesizes the team's observations from seventy successful natural resource management initiatives visited in the four countries. We have attempted to convey not just the factual content of the site visits, but also a flavor of the underlying factors that contributed to success at each location. Because there is much more information in the site reports (contained in Volume II) than the reader can reasonably assimilate in one reading, observations are grouped into three main categories: technical initiatives, socioeconomic initiatives and policy measures. Each category is briefly defined in the appropriate section. Some of the characteristics and determinants of these successes are then summarized in the conclusions.

In order to retain the richness and diversity of the field interventions, the discussions within these categories are coupled with specific, referenced examples (italicized references within horizontal boxes at the end of the relevant discussion). In addition, we offer the reader the expedient of fourteen one-page summary case examples which are reproduced in this chapter. Whenever possible, text and box references draw from these fourteen cases. Familiarity with this more limited set of field observations will provide the reader accessible but concrete points of reference for the discussions and examples contained here. The fourteen summary cases were selected because they are representative. However, they are not a substitute for the much more complete discussions of each initiative contained in Volume II.

Has Anything Worked?

Has anything worked? The simple answer is yes. We saw some striking successes which have had visible impacts, sometimes on large populations. We include in this category several aspects of the Guesselbodi natural forest management project (Niger), the Maggia Valley Windbreak project (Niger), and improved earthen stoves programs (Mali). Typically, these successes involved many things happening at once. No single factor leads to the success of a given

intervention; no single type of intervention is sure to succeed. Guesselbodi, for example, is more a set of initiatives than a single intervention: use of paid labor for land reclamation, forest management, planting and harvesting of grasses, organization of village woodcutters' cooperatives. Similarly, the Mali stoves effort involved training, mass publicity, technology development, and mobilization at both the social and political levels. In these three examples, the initiatives are not just successful on their own terms, but show considerable promise of being replicable in other contexts.

Table 3.1
Fourteen Natural Resource Management Cases

Operation Haute Vallee Check Dams (Mali)
Microcatchments and Check Dams (Niger)
Water Retention Dams and Soil Conservation (Gambia)
Private Nurseries (Senegal)
IUCN conflict resolution techniques (Mali)
Environmental Education (Mali)
Private Gardening Projects (Senegal)
Short Cycle Rice Introduction (Gambia)
Integrated Rural Development Associations (Senegal)
Natural Forest Management (Niger)
Guesselbodi Woodcutter's Cooperative (Niger)
River Fisheries Management (Niger)
Bignona Women's Fire Control Committee (Senegal)
Natural Resources Farmer Training (Mali)

Technical Resources Management Initiatives

Water Conservation

Water conservation techniques are used throughout West Africa. In the Adar Doutchi region of Niger and the Bandiagara Plateau of Mali, for example, Hausa and Dogon farmers, respectively, customarily construct stone lines to collect runoff from crusty, lateritic soils. In the Senegal River basin of Mauritania, Haalpulaar farmers construct brush fences across small drainage ways so that windblown sand (accumulating along the fences during the dry season) forms a water retention dam. Jola rice farmers in Senegal and the Gambia have long collected rainwater runoff and captured river water to practice irrigated rice cultivation. On the Jos Plateau (Nigeria) and in the Mandara mountains (Cameroon), terracing was highly developed in the pre-colonial period. All these techniques of runoff capture provide supplemental water to crops.

Many examples of *recently introduced* water conservation techniques were seen during the assessment (See Table 3.2). These include:

- water retention dams for human and animal use (Cases 1 and 2, Volume II);
- water retention dams for increasing agricultural production (Cases 3, 4,and 5, Volume II);
- water harvesting catchments for crop and tree production (Cases 6 through 9, Volume II);
- channel protection dams (Case 10, Volume II);
- contour plowing, vegetative strips and tied ridges (Case 3, Volume II);
- windbreaks (Case 13, Volume II).

Table 3.2
Successful Soil and Water Conservation Measures

Private Farmer Initiatives	Donor Led Initiatives
Mini check dams	*Channel Protection*
Living hedges	*Gully check dams*
Water retention dams	*Dune stabilization*
Contour and tied ridges	*Contour ridges and dikes*
	Microcatchments
	Sheet erosion reclamation for agriculture

Water conservation measures such as the Operation Haute Vallee (Mali) check dams and Swissaid check dams and microcatchments have reduced the risks from inadequate rainfall, allowing farmers to use land more intensively, as well as to save time and human energy. Farmers are eager to experiment with these techniques, since little capital was required, and increased moisture availability improves potential returns when coupled with fertilizers. Intensification of production reduces the number of hectares required per household, thereby relieving pressure on marginal agricultural, range and forest lands.

Case: Operation Haute Vallee (OHV) Check Dams

Water catchments have transformed wasteland into productive fields, yielding in excess of 600 kg/ha of cereals with only 250-300 mm of rainfall (Case 7, Volume II). Microcatchment applications on abandoned, degraded land have shown cereals yields of 0.5 kg/m2 (500kg/ha) on 320 mm of rainfall (Case 6, Volume II). Construction of microcatchments requires considerable input of labor which is often a scarce resource for farm households. However, opening degraded land to agriculture through more intensive forms of management provides land to the land poor, reduces tenure disputes, and reduces pressure on a fragile resource.

Case: Enadoujoum Microcatchments and Ourihamija Check Dams

Interviews with farmers in Mali's Haute Vallee region, in Tahoua, Niger, and in the Gambia suggest that large-scale water conservation efforts often surpass local technical, financial and organizational capacity. Nonetheless, spectacular demonstration projects sometimes catalyze local organizations to undertake further works themselves, with some outside technical help and financial assistance. The Gambian Soil and Water Management Unit, and the Keita Integrated Rural Development Project, are good examples.

In the water conservation projects we visited, the timely availability of inputs, credit, and competent, flexible technical assistance were critical to success. Perhaps most important of all was transfer of techniques implementable with local resources. Swissaid's catchment technique (Case 7, Volume II), which stresses methods farmers can implement with a minimum of outside assistance, and its extension by the Forestry Service of the Tahoua Department, Niger provides a case in point.

Soil Conservation and Fertility Improvement

Soil conservation is as difficult to achieve in the Sahel as elsewhere in the world. Benefits of soil conservation are less obvious and immediate than those from water conservation. Soil conservation is often expensive in terms of time and labor and may require short term sacrifices in production. Both of these costs will limit its extension in the absence of bridging mechanisms and other incentives.

Explosive population growth, expanded commercial agriculture production, and declining rainfall place an unrealistic burden on the Sahel's fragile soils to produce food, forage and fiber under present management practices. Throughout the Sahel, land clearing and declining fallows have subjected soils to wind and water erosion and the effects of heightened evaporation and leaching. Declining rainfall has also reduced river levels and increased saltwater intrusion along coastal waterways. All these processes depress fertility. Erosion increases the sediment load in the water and air. Reservoirs fill quickly with water borne

sediment. Sterile sands are deposited over once productive fields. Gullies dissect formerly fertile valleys, limiting access and making agriculture impractical. Gullies in stream channels carry away storm flows and reduce the frequency and duration of floodplain flooding. Gullies lower water tables, and in some places kill forests which require high water tables and seasonal flooding.

In higher rainfall zones, excess water is often a problem such as around Sikasso, Mali in a 1200 mm zone. The risks of gullying and sheet erosion provoked by excess water is an especially serious problem on crusted soils from which the tree cover has been removed. In these cases soil conservation becomes a priority.

Farmers are aware of the benefits of soil conservation to maintain soil nutrients and organic matter. Traditional fertility improving practices on sandy loams are linked to water conservation and/or agroforestry efforts (see below). Inter cropping with legumes or nitrogen fixing trees are examples. Seasonal flooding along lakes, ponds, and river courses also allowed farmers to engage in permanent cultivation without depleting soil fertility.

Where erosion directly threatens crop production, farmers have adopted soil conservation measures, often with project extension support. Examples include contour ridges extended by OXFAM in Burkina Faso. by the Dutch-funded DRSPR farming systems research project, and the semi-public CMDT in the cotton-producing Sikasso region of Mali; comprehensive watershed management techniques extended by the Keita project in Niger; and dikes, protection dams and contour berms extended by the Soil and Water Management Unit (SWMU) in the Gambia. All of these projects have achieved widespread adoption of simple and low cost soil conservation measures.

Other successful soil conservation interventions spreading through the Sahel include windbreaks (Cases 13 to 15, Volume II), check dams (Case 11, Volume II), diversion bunds (Case 12, Volume II), channel protection dams (Case 10, Volume II), and water harvesting (Cases 1 through 9) (See Table 2.2). These interventions sometimes require significant labor and capital outlay; in some cases competent technical assistance and foregone short term benefits of resource use are required. Donor and project support have been used successfully to mitigate these obstacles to improving soil conservation.

Case: Sintet Village Area Water Retention Dams and Soil Conservation Measures

• Windbreaks are successful multipurpose soil conservation interventions, which are used by private farmers in all four countries. The best available data on the benefits from windbreaks are from the Maggia Valley in Niger, where a CARE project has been in operation for well over a decade and has stimulated a good deal of analytical attention. In the Maggia, windbreaks increase net agricultural yields by as much as 20%, and provide wood and other forest products. Windbreaks improve agricultural productivity in several ways: reduce sand blasting of young plants, improve stand establishment, and decrease time and energy devoted to replanting. Windbreaks increase humidity and decrease wind speed and temperature, thus allowing more efficient transpiration and crop water use. This reduces crop demand on stored water and allows crops to better withstand longer drought periods without stress. Windbreaks also protect crops from storm winds and minimize lodging.

Similar benefits, although not quantified, were observed for farmer-planted windbreaks elsewhere in the region. The Maggia experience itself has had a strong demonstration effect. The CARE project in Koro (Fifth Region of Mali) took 14 farmers to Niger to observe the Maggia success first hand. The resulting adoption rate has been over 70%. Other small farmers have planted Eucalyptus in windbreaks (Case: Angel Togo, Volume II), getting both soil protection and commercial sales of poles as benefits. The farmers interviewed often emphasized the multipurpose advantages of windbreaks.

Windbreaks are not without their limitations. They require high labor inputs for planting and some continued protection in the early years. They may displace women's livestock from pasture on field stubble. Tree and shrubs provide shelter for granivorous birds and encourage them to nest. Also, poor selection of windbreak tree and shrub species may lead to higher groundwater uptake than recharge with consequences on water quantity and quality. Perhaps the most troublesome aspect of windbreaks are land and tree tenure issues, particularly cutting rights. Major projects, including the Maggia Valley Windbreak Project in Niger and Coastal Dune Stabilization Project in Senegal, have yet to study these effects. Fortunately, lines of perennial grass, Pigeon peas, and dead brush are moderately successful multipurpose interventions that can serve as windbreaks where trees and shrubs are found technically inappropriate.

Case: Maggia Valley Windbreaks

Successful soil conservation interventions include channel protection dams such as those built by Swissaid (Niger) and SWMU (Gambia). They restrict storm flows and cause water to spread over floodplains, thereby spreading silt as well as increasing infiltration and water storage. Slowed stream flows promote increased sedimentation. Increased infiltration along channels and on floodplains helps to recharge the aquifer. Secondary gullies that form off main channels and threaten to dissect floodplains become stabilized.

The intervention is equally appropriate in the 1200 mm rainfall zone of Mali and in the 250 mm rainfall zone of Niger. However, in many cases, channel protection dams need to be constructed in series. This effort may surpass the abilities of a single village. Outside technical assistance plays a valuable role in overcoming organizational obstacles by helping villages plan, construct and maintain these dams (as in the OHV, Swissaid, and SWMU cases).

Fertilizer use, which improves agricultural soil fertility, depends on water availability, risk of drought and value of the crop grown. In drier zones, where rainfall variations are also very great, farmers limit chemical fertilizer application to irrigated crops. In higher rainfall areas, like Sikasso, farmers rotate cotton with cereals so that the latter benefit from the residual effects of fertilizer applied to the former. Mulching contributes to soil fertility in the Guesselbodi natural forest. One of the few cases where farmers have begun to experiment with simple compost pits and composting stables is in Ouelessebougou, Mali through OHV extension efforts. Such techniques seem a broadly applicable alternative to expensive fertilizers in higher rainfall zones.

Case: Operation Haute Vallee Extension

Even where soil conservation and fertility improvement measures have been successfully introduced to smallholders, the team saw potential for further improvement. In many of the cases, including coastal dune stabilization in Senegal, inland dune stabilization in Niger (Dakoro, Maine Soroa), and watershed management in Keita, Niger, technical knowledge and management responsibility remains with project staff. Greater skills and authority transfer to farmers themselves would, in the team's opinion, lead to more self-help. We saw examples of smallholders and local intermediaries who have developed potentially useful techniques. In Kayes (Senegal), coastal forests are crucial for dune stabilization and increasing productivity of the soils. A nurseryman there had excellent ideas for rendering the forests economically self-sufficient through controlled cutting and stand management. Unfortunately, he had neither the resources nor the authority to implement them.

Forestry and Agroforestry Initiatives

Forestry interventions in the Sahel today are especially diverse. Examples of traditional systems of agroforestry exist along with modern initiatives. The mix includes: protection of nitrogen fixing and moisture retaining species (*Acacia albida*); field plantings of *Acacia albida* and other local species; natural forest management; cooperative, village, and individual woodlots (and woodlot schemes); village and private nurseries; private orchards; and voluntary fire

control measures. Of particular interest to the team were the numerous examples of integrated management of trees and shrubs in the agriculture system.

Table 3.3 Successful Agroforestry Initiatives
Private Farmer Initiatives
Pole plantations
Private nurseries
Private woodlots
Sacred woodlots
In-field protection
Living hedges
Inter cropping orchard trees in fields
Donor Led Initiatives
Village woodlots
Nurseries
Water harvesting catchments for trees
Windbreaks
Forestry management for firewood production
Inter cropping field trees
Forest reserve management

Remnants of many traditional agroforestry management systems were seen in all four countries. Such systems feature permanent agriculture in association with protection of dense stands of the nitrogen-fixing, fodder-producing tree, *Acacia albida*, and manuring with livestock. They persist around Thies in the Serer country of Senegal, in parts of the Dallol Boboye in Dosso, Niger and in Mirria arrondissement, Niger, for example. Locally dense stands of this multi-purpose tree occur in many other parts of the Sahel as well. Preservation of established stands is much easier and less costly than artificial regeneration. Natural regeneration of A. albida occurs easily enough as the team witnessed at project sites in Koro, Mali (CARE), in Dosso, Niger (UNSO), and Thies, Senegal (U.S.A.I.D.), for example, but protection of young shoots from plowing and livestock poses serious difficulties in these cases, particularly as demographic pressures increase. Nonetheless, farmers are well aware of its importance.

Popularly initiated living hedges of sisal and euphorbs persist throughout Mali's Third and Fifth regions, in the Senegalese peanut basin and in the Casamance. While declining rainfall has decreased the northern range of sisal, and while traditional hedges are not always well maintained, farmers have

planted vast numbers of new hedges around gardens and orchards in these regions. However, alley cropping with living hedges is in its infancy. Prosopis, neem, cashew, and even eucalyptus are associated with euphorbs, sisal, and sometimes pigeon peas in these hedges. Irrigation systems, both public and private, are increasingly protected with windbreaks and living hedges. Species selection is not always optimal. Curiously, the team saw few innovative hedges in the Gambia. In one drier Sahelian region of Niger (Filingue arrondissement), the team saw numerous small gardens protected by living hedges of Prosopis. A few experiments with euphorbs are also underway for dune stabilization in sites in Niger (Dakoro).

Perhaps the most successful small-scale initiatives in forestry are the proliferation and diversification of village and individual wood and pole lots in the peanut basin of Senegal and, to a lesser extent, in the Tahoua department of Niger. Farmers in these areas have captured technologies extended to them by large projects (PRECOBA, PAFOCSE, PARCE, CARE-Niger) and increasingly adapted the techniques of propagation and transplanting to their own organizational and economic needs. Private woodlots help to relieve pressure on scarce natural forests. In the higher rainfall zones and in low lying basins, private fruit orchards proliferate. In the better watered south, few projects offer new information to farmers about fruit orchards, even though a significant opportunity exists there.

Case: Nurseryman Mr. Ka

Maggia Valley windbreaks in Niger have successfully taught farmers the value of windbreaks for improving productivity (stand establishment, moisture retention), and of tree cultivation generally. The Maggia experience now serves as a demonstration site for farmers visiting from Maradi, Niger and even Dogon farmers from Mali's Fifth Region. The latter have begun to establish windbreaks on their own windswept plateau as a direct result of a CARE project-sponsored trip to the Maggia. However, the long lead time to payoff with windbreaks, especially when limited purpose trees are used, land scarcity, impacts on the water table, and uncertainty about tenure and cutting rights require resolution not only in the Maggia but in other contexts (e.g., PAFOCSE in Thies, Senegal) as well. Resolution of these issues is a key to the replicability of this intervention.

Farmers interviewed in the forested Sikasso (Mali) and Kolda (Senegal) areas are not motivated by reforestation objectives per se, despite Forest Service campaigns to inculcate the rudiments of tree propagation and cultivation. They were, however, anxious to learn about the propagation of cashews, fruit trees

(Senegal), teak, nere, and karite (Mali). This emphasis appeared to be at least partially a response to negative past experience with the Forest Service (fines for cutting and burning), tree tenure rules which recognize ownership of orchard species but not other trees, and the positive experience of migrants with orchard crops. More could be done to integrate local agroforestry priorities with Forest Service programs; cashews can be used as living fire and windbreaks in well-watered areas of Mali, for example, as in some parts of Senegal. Field experience in this area provides excellent examples of the differing public and private motivations in resource management, but also of ways in which they can complement each other.

Wherever well-irrigated gardens have been established in response to declining yields from rainfed agriculture, farmers purchase, and are anxious to learn more about how to care for fruit trees and hedges. Farmers in Senegal wanted to learn new techniques not taught by Forest Service or project staff about propagation of natural species (Catholic Relief Services (CRS) / Peace Corps Forestry Program, Thially, Diourbel Region), and proper methods of thinning and pruning (Koumpentoum Entente).

Among successful contemporary large-scale natural forestry management interventions the team includes Guesselbodi, Niger (400-600 mm), Sikasso, Mali (1000-1200 mm), and Dinderesso, Burkina Faso (800-1000 mm). At Guesselbodi, reclamation and regeneration techniques to increase tree and grass cover have been perfected. Historically, integrating neighboring farmers with forest management has been the weak link in forest management. The U.S.A.I.D.-financed FLUP project's work has been most successful in this regard as discussed below and in the cases. In Sikasso's forests, detailed information on natural species regeneration is being compiled, and techniques that involve villagers in fire control explored. For example, this Swiss-financed project offers village fire brigades -- set up in villages around natural forests -- cash awards which vary with the percentage of forest not burned at the end of the dry season. The project is lobbying for permission to engage in protective early burning although the president of Mali has theoretically banned burning entirely. In the Dinderesso forest, a project experimented with successful techniques of fire control involving contract pasturing and early burning.

Overall, comparison of the experiences of these large reforestation projects suggests that fire and construction timber can be produced economically on a decentralized basis using native species and selected exotic species. Some projects in Senegal (PARCE, PRECOBA) and the Gambia (GTZ) are less advanced in their thinking on this issue, but are tracing similar paths. All of these multipurpose forestry and land-use interventions are promising successors to industrial plantations, involving monocropping of exotic species, which have failed throughout the Sahel.

Biodiversity Initiatives

For the purposes of this assessment, biodiversity addresses the maintenance of variety in the natural and human environment. It can be contrasted with activities that reduce species richness and population abundance. Three broad levels of concern are habitat types, species, and germ plasm.

Clear cut biodiversity successes include innovative pest management techniques (hippo control in the Gambia), seed conservation and regeneration (Lamin rice project), valiant attempts to protect national parks (Niokola Koba Park, Senegal), conflict resolution incorporating sanctuary for non-human species (inner delta, Mali); publications and education to restore a holistic ecological sense to villagers and students (Walia, Mopti, Mali), water projects which unintentionally become water holes (Sintet, the Gambia); a few woodlots that provide shelter (rarely food) for other species (coastal dune stabilization, Senegal), reinforcing traditions of sacred groves providing sanctuary for all species (Basse Casamance Park, Senegal), and reintroduction of locally extinct species (Djoudj, Senegal). The team found overwhelming evidence of great awareness of ecological deterioration among Sahelian farmers. Farmers in diverse locales are often able to identify different sets of a dozen or more tree species which have disappeared or have diminished in occurrence since the droughts began in the late 1960s. Herders can similarly chart degradation of pasture species. Most adults are cognizant of the loss of large wildlife.

As drought and permanent cash cropping deplete the land base, the team observed that farmers are encroaching more natural habitats, intensifying pressure on game, fisheries, and other freely gathered goods as dietary supplements. Sharpened boundaries between agricultural and more natural habitats, and reduced wild zones have turned wild animals into "pests". Baboons, warthogs, elephants in Mali, or hippos in the Gambia are now rarely viewed as necessary parts of the local ecology.

Maintaining biodiversity, the team found, whether agricultural, floral or faunal, is not a high priority among governments in the Sahel. Biodiversity is often seen as an alternative, rather than a complement to economic development. The necessity and desirability of natural reserves as biotic references, educational tools, national heritage "museums", or germ plasm "larders" is understood by only a handful of people in any country. Some senior park service agents in Senegal, however, were remarkably keen on these points.

Local farmers value biological diversity especially horticultural or agricultural species diversity, but the team found that few work actively to maintain the diversity of wild species. Nonetheless, ligneous species provide important

"soudure" and famine period food resources. Indeed, a high proportion of the vitamins, minerals and even proteins in the rural diet come from gathered plant resources on a daily basis. In a given area, different ethnic groups also exploit different parts of the available floral resources. Fulani may emphasize fruit, while Mandinka may favor leaves (Bergeret 1986). However, the team found that the notion that farmers can successfully intervene to preserve or restore biological diversity is still novel to most villagers.

A few individuals and groups encountered by the team, as well as by other researchers, have grasped the necessity and possibility of intervention to preserve floral diversity (Montagne 1986). The Gandiolas gardeners, Koumpentoum nurserymen, and Bignona fire control committeewomen (see cases) are three examples among others. However, the high incidence of uncontrolled burning, over fishing, and poaching in the Sahel shows that current attitudes towards game and forest management are inadequate to cope with modern economic and political pressures on natural resources. For example, sacred forest groves, widely scattered among the Mande-speaking populations (Banama, Senoufo, Mandinka, Jola) preserve biodiversity, but are as subject to drought- and fire-caused species loss as other forests.

In a few cases, positive feedback relationships between increased production and biodiversity are being made clear to local people. In the IUCN Bouna intervention, for example, preserving nesting trees for cattle egrets and storks helps locust control on farms, and increases fertilization of waters beneath nesting areas, which in turn, increases algal production and fish. Through IUCN extension, local groups have begun to understand these relationships in new ways.

Case: Bouna Agreement

In other cases, such as Walia magazine (a publication on ecology and people in Mali's Fifth Region), it is harder to directly tie sustainable development to natural resources management. But, there are indications that consciousness raising ("sensibilisation") of young people will be helpful in the future as it has been in Kenya, for example.

Case: Walia

During the current transitional period -- between breakdown of traditional understanding and respect for non-human creatures and the development of a new environmental ethic -- lies the greatest threat for rare and internationally endangered species. In the area of protection of such species: manatee, elephant, hump-backed dolphin, chimpanzees, and the like, the team concludes that the participation of international donors is crucial to success. During this

period of hardship in the Sahel, international funding to finance protection can do the most good. Despite government generosity (Senegal pays more to maintain its national parks that it receives in direct tourist revenues), the task is so enormous, that fewer clearly successful cases of natural biodiversity maintenance than soils or water conservation or agricultural biodiversity maintenance occur.

In virtually all the cases observed, where biodiversity was threatened, so too was food sustenance (e.g., the Inner Delta fisheries and pastures or drought fallback game in Niokola Koba Park) and/or income generation (e.g., tourism revenues in Basse Casamance or Sine Saloum Parks). The two are really inseparable. Among the most successful biodiversity sustaining or improving initiatives were those integrating economic incentives with biodiversity themes. Thus the small park reserve near Banjul pays for itself with entrance fees. Likewise the Canadian-sponsored diversified gardening project in Louga, Senegal integrates productivity and biodiversity concerns. Finally, the FAO-sponsored Niger fisheries project aims to improve productivity and preserve species diversity through a combination of management initiatives and limitations on permissible equipment.

Case: Gandiolas Garden Project

The inseparability of sustained development and biodiversity conservation as exemplified by the cultural ecology of the national parks of Senegal is discussed at greater length in the Biodiversity Annex.

Socioeconomic, Policy and Income Enhancing Initiatives

Socioeconomic Incentives.

Throughout the region, access to cash benefit, where available, has been a major stimulus to natural resource management activities. In these cases, cash return, rather than improved resource management, was typically the motivating factor. In general, where cash returns are available, technical assistance and other outside inputs are required primarily as a "trigger" mechanism to overcome initial technological or organizational constraints. Demand for recurrent inputs of external assistance is low. Market incentives (polewood lots), direct cash payments (UNSO *Acacia albida* regeneration) and direct employment of

villagers (Guesselbodi and Keita Project reclamation) for resource management programs are three subsets of this category which have succeeded in having strong visible impacts on the initiatives team members saw.

Market incentives. With declining agricultural productivity, increased urbanization, development of transport infrastructure and the growth of regional and even local markets for products from construction poles to food and clothing, increasing numbers of small farmers are turning to markets for sources of off-farm income. The proliferation of woodlots in Senegal, and of Eucalyptus planting in the Fifth Region of Mail, was directly tied to the high cash value of poles in local markets. Private pole lots have "taken off" in Senegal because of the lucrative home and construction market for eucalyptus poles. A single pole can sell for between $2.33 to $3.60. Cutting a quarter hectare of poles a year can bring in $ 300. A hectare of Eucalyptus can be cropped almost continuously after the third or fourth year.

By contrast, village woodlots have made far less progress in the northern Sahel where conditions for growth are poorer, and higher labor inputs are required for artificial plantings. The success of the Guesselbodi natural forest management scheme is based on the ability of the village cooperatives to sell fodder and naturally regenerated firewood at the high market prices of Niamey, which is 30 km away on a paved national highway. Market incentives have been foremost in the success of orchard and garden projects.

Similarly, soils conservation and reclamation efforts have begun to make good economic sense in Keita arrondissement, Niger, because there is virtually no more farmable dune or bottom land. There is no alternative to reclamation of the eroded slopes and sheet-eroded floodplains.

In these and similar examples, macroeconomic conditions and market demand has opened opportunities for income which can be realized through investment in the land. There is no substitute to such incentives for driving broad-based improvements in natural resource management in the long run. Thus, reforestation efforts have yet to catch on in the Sahelo-Sudanian zone (e.g., Southeastern Senegal; Sikasso) where many people still perceive no economically burdensome wood shortage.

Direct payments. While they raise many questions regarding sustainability and may create dependency relationships, payments for work performed have been very successful in attaining visible impacts. UNSO's *Acacia albida* regeneration project in Dosso, Niger, and the Methodist Mission's garden project in the Gambia are cases in point. In the Dosso project, farmers are paid 30 CFA francs per *Acacia albida* tree planted or protected. In five years, over 380,000 trees have been regenerated, costing about $2.00 per tree suggesting that there may

be a useful role for such schemes in stimulating urgently needed resource protection measures, especially when they are combined with education and outreach.

Food-for-Work incentives have been effective under certain conditions. In cases of extreme deprivation, where villagers have few other resources to draw on, as in the northern Tahoua department (Swissaid), it was used as a bridging mechanism to help local populations initiate more sustained resource management. Food-for-Work has also been effective in helping bring about participation when a climate of suspicion and distrust between farmers and officials has limited other forms of popular participation. Finally, it has been successfully used to implement large-scale public works or infrastructure development, as in the Keita Integrated Development Project, Niger. On the other hand, Food for Work schemes share the drawbacks of direct cash payment schemes and may foster a spirit of dependency upon donors.

Direct Employment. We saw several examples in which employment of villagers to implement natural resource investments was successfully used as an initial stimulus to a more active local role in resource management. The best of these cases occurred in Guesselbodi, where villagers were hired to dig square water catchments and contour ridges, to plant grasses and to initiate management of surrounding forests. After this initial paid effort, the upgraded land is turned over to a village cooperative, which is provided the technical skills and advice necessary to realize a cash profit from its continued management.

Table 3.4 Types of Socioeconomic Initiatives
Direct payment of villagers for forest management and fire control
Direct payments for tree planting or protection
Upgrading village infrastructure as an incentive
Free distribution of seedlings, nursery equipment and extension advice
Farmer visits to "model" sites
Long term NGO commitment
Food-for-Work
Extension supported diffusion
Organization of village cooperatives for firewood sales
Market incentives
Productivity sustaining incentives
Reinforcement of local institutions
Alignment with core values
Distribution of educational resources focussed on biodiversity
Prizes in kind for performance
Public awards and honors

Single purpose or one-time benefits have also stimulated resource management efforts. Visits to model sites by villagers from other areas triggered project participation in the CARE-Mali Koro windbreak project and the SWMU's activities in the Gambia. Distribution of seedlings has helped to generate interest in planting trees in Sikasso and many other locales. In Guesselbodi, negotiating access to farmland within the forest preserve played an important role in convincing some farmers that the FLUP project was serious about their commitment to collaborative improvement in villagers' standard of living. Presidential awards have encouraged nurserymen and women in Senegal. Subsidized self development and training of school leavers in improved farm management at the Caamen center in the Gambia provides another example. Commemorative plaques and public presentations, featuring US representatives of the Soil and Conservation Service, helped to institutionalize the Gambia's first Soil and Water Conservation District.

Multiple Incentive Systems. The most complex incentives systems we saw were the extension-based incentive systems elaborated by community integrated rural development associations in Senegal (AJAC, CADEF, Koumpentoum). An essential feature of these systems, successfully employed in other contexts as well (OHV, SWMU), is the village level diagnostic exercise, often conducted with extension personnel. Village groups then work out sectoral goals and the time frame and means needed to reach those goals. Many association projects have successfully integrated group and individual benefits to ensure successful follow through. In these examples, two kinds of incentives operate. Economic incentives (improved agricultural production, market income opportunities) are a motivating factor, but not through direct payments. Instead, expensive inputs

are obtained through collection, collective projects, or NGO assistance and are used as a catalyst to assist villages in their own self-help programs, such as woodlots. Collective projects with shared or rotated benefits such as granaries, stores, woodlots, wells, herds (milk, manure, offspring), improved housing, and the like also reinforce moral incentives to participation. The Koumpentoum Entente case is typical of the organization of these associations. Irrigated gardening along the Guiers Lake, Senegal, the Guesselbodi woodcutters' cooperative, and the Damana (Niger) IDA-sponsored village antidesertification efforts are moving the the direction of such multi-incentive systems.

Case: Koumpentoum Entente
Case: Guesselbodi Natural Forest Management

Policy and Income Enhancing Incentives

Successful technical interventions were best sustained in a context of appropriate market conditions and favorable value systems, of which national policies are one type.

Policy interventions conceived solely by ill-informed outside planners, "experts", or administrators, and imposed unilaterally on Sahelian communities have left a legacy of distrust and disrespect among farmers, herders, and fishers. Thus, national bans on cutting timber, burning the bush, and hunting are widely ignored, but they have poisoned relations between administrators and the people and have frequently created a climate favorable to bribery and corruption. Thus many projects must redress this negative policy climate through retraining and interactive extension programs as part of efforts to achieve tangible results.

Case: Guesselbodi Woodcutters Cooperative

When national policy reform has come about in response to felt need, it has sometimes had a catalyzing effect on resource management, influencing the spread of innovative practices over a broad area (See Table 3.5). Exempting Guesselbodi woodcutters from normal cutting permit fees, and granting them a measure of autonomous management control over their forest is the best example. The FAO has initiated a similar effort through its village territory management project in Banamba, Mali.

Table 3.5 Successful Policy and Income Improvement Initiatives
Exempting local cooperatives from wood cutting permit fees Exempting project areas from repressive forest service fines Renegotiating multi-sector resource management legislation Permitting local organizations to form non-government institutional structures Increases in woodcutting permit fees Transferring tenure over planted trees to the planters Law mandating use of simple, known, improved woodstoves Rising value of resources Enlisting local values in natural resources management

Perhaps the most valuable policy changes are those which allow local communities the freedom to organize natural resources management systems within general resource-sustaining guidelines. Essential to this effort have been regulations 1) transferring land and tree tenure to these groups from the state (which still asserts centralized tenure virtually everywhere in francophone West Africa); 2) allowing for the formation of organizations outside of state institutional structures; and 3) empowering local authorities that can better monitor changes in soils, water and plants than central authorities.

Case: Niger Fisheries Management

New initiatives towards "village territory management" (gestion de terroir villageois) in Mali are a promising step towards responsible local control which has born some fruit in the Banamba region (400-600 mm) under FAO auspices, and in the Inner Delta (200-400 mm) under IUCN auspices. Conflict resolution techniques between herders, farmers, and other players have sought to relieve pressure on grazing lands within the village territory. Discussions between the technical assistance and villagers have begun to define the range of biotic diversity in the territory, and different land use types as part of an overall management plan. Policy change has been effective when built on a strong base of public support.

The impacts of a number of successful policy initiatives were observed in the field. One example is a recently promulgated Malian law mandating the use of improved mud stoves for domestic use. Improved mud stoves are now in use in practically every village and every compound in the Third and Fifth regions. Of course, this law, while important, is just the final stone in an edifice built upon a decade of experimentation with, and extension of the improved stove idea by extension personnel, volunteers, NGO and public projects. Other factors

contributing to the success of this policy are difficult to quantify. They include: a national publicity campaign involving projects and the National Union of Malian Women; changes in household economics such that women's wood gathering time has become more valuable; increasing wood prices and wood scarcity; and changing values in the face of persistent drought.

Another example comes from Niger. The Prefect of Tahoua saw the Swissaid sponsored microcatchments while on tour in his region. Impressed by the dramatic results on tree and millet production, he ordered that a technical sheet on microcatchments be prepared. The Prefect then instructed his Forestry agents to use available Food-for-Work resources to construct microcatchments and plant trees wherever appropriate. With minimal technical knowledge, and local awareness, at least one young agent has achieved several hectares of successful microcatchments on completely denuded lateritic slopes around Malbaza. Seedling survival rates for Prosopis average around 80 percent in the microcatchments.

Crucial to good policy is sound research. The A.I.D.-financed PIRT land use planning maps in Mali and the FLUP forest classification maps in Niger are good examples. These useful planning and policy tools are now widely used in these countries for developing new natural resource management programs.

Discussion of Initiatives

Cultural Ecologies

Site visits enabled team members to encounter communities and individuals representative of the major ethnic groups in the four countries, groups whose distinctive cultural ecologies are documented historically (See Table 3.6).

Under the impacts of both economic development and environmental degradation, the team noted a trend towards homogenization and simplification of Sahelian cultural ecologies. As resource diversity decreases, econiches contract. Thus, for example Diola (Jola) who once concentrated on rice production, have been forced to grow more millet, sorghum and peanuts like the Wolof and Mandinka neighbors as water becomes more scarce. Similarly, Fulani nomadic cattle pastoralism as a way of life is declining in favor of localized goat herding as pastures diminish and degrade. Human competition for shrinking natural resources and limited markets among ethnic groups, which once exploited distinct econiches, increases. Concomitantly, this renders human ecosystems more vulnerable to further climatic and economic stress, and increases pressure on limited human energy resources.

Table 3.6 Major Ethnic Groups Represented in the NRMS Assessment			
Mali	**Niger**	**Senegal**	**Gambia**
Bambara *Senoufo* *Dogon* *Fulani* *Bozo*	*Hausa* *Zarma* *Buzu* *Wogo*	*Wolof* *Lebou* *Serer* *Diola* *Bassari* *Mandinka* *Fulani*	*Wolof* *Jola* *Mandinka*

The team found significant, if subtle variations in knowledge, strategies and organizational capabilities for resource management between these groups. Such proclivities constitute opportunities for creative public and private investment in resource management. Capitalizing on cultural ecological specialization contributes demonstrably to more successful management of the Basse Casamance Park, Niger River fisheries, and pasture lands in Mali's inland delta. Neglecting, ignoring or denigrating traditional resource use results in lost opportunities. This varies from the frustration experienced by the Bignona, Senegal women's fire control committee, to the bloody state of war between poachers and park rangers in the Niokola-Koba Park.

Scale, Intensity and Time Frame of Initiatives

The team found that successful interventions vary enormously in geographic scale, intensity (dollars/hectare or per capita) and time frame. Overshadowing all other initiatives in Senegal and the Gambia for example, are the river basin development schemes, the natural resource implications (especially biodiversity issues) of which have either been underplayed or neglected. Dams will affect thousands of hectares in multiple ecosystems touching thousands of lives. Impacts are measured in generational, even inter-generational time.

At the other end of the scales of time frame, scale and intensity, a private farmer near Djenne has reclaimed an abandoned millet field for diversified garden and agroforestry production over a few short years. Another, near Sikasso, has planted a private three hectare plantation in teak and gmelina that has a five to ten year payoff period.

While well-funded, effects of the seven regional forestry projects visited (PRECOBA, PAFOCSE, PARCE, FLUP, Swissaid-Sikasso, GTZ-Gambia, IDA-Damana) are spread lightly over tens of thousands of hectares. The time frame for the shift in emphasis from industrial plantation and forest reserve

protection schemes, to small woodlot and natural forest management schemes is from three to ten years. Some of these projects are still searching for workable extension strategies for sustained resource management.

Of small scale, intermediate intensity, but of profound impact are the AJAC and Koumpentoum villages associations. These ongoing enterprises are now twelve to fifteen years old and affect several thousand people and several thousand hectares each. Natural resource management concerns are integrated into other sectoral concerns and, more importantly, into daily life. The CARE windbreak project in the Maggia took ten years to produce tangible results and required ongoing extension and policing efforts. Transplanting this model will require as much time, but may require less extension and policing because of demonstration effects.

In general, the team found that density and intensity of extension contact tends to vary inversely with project size and geographical extension. Despite their large size, the Guesselbodi experiment (Niger), the Operation Haute Vallee (Mali), and the Soil and Water Management Unit (Gambia) projects provide exceptions. Their extension work, frequently employing local staff, has been localized, intense, and thorough. In addition, the natural resources impacts of interventions and the transfer of knowledge are proportional to the number of years of extension follow-up, and inversely proportional to scale of the project.

Types of Technical Assistance

All kinds of technical assistance (TA) have proven successful in NRMS interventions. In quantity, TA varies from none in the case of some private forestry initiatives to massive in the case of the river basin development authorities. Diverse public and private financing formulas exist. Private formulas include NGO sources, but there are other unusual models. In the Sikasso region of Mali, an international African civil servant paid his entire village's head tax, and in return, villagers organized voluntary labor for a model village reforestation plot he supported. In the Gambia, the Baboon Island chimp rehabilitation project functions almost entirely on private funds and voluntary expatriate assistants. The Senegalese village development associations seek assistance from NGOs, the Peace Corps, and collect an annual tax from members to help defray expenses for elected village coordinators as well.

Beneficiary populations express their appreciation for the intense, frequent, and long term interactive extension work usually associated with NGOs. In the Gambia, one village area even thanked the SWMU project for bringing disputing village factions together for their common benefit. The team found

that more novel initiatives in terms of local knowledge and values require more intensive extension efforts to succeed. Paternalistic extension methods, and extension of themes which conflicts with local knowledge and economic incentive systems are less successful than interactive approaches to extension.

Technical assistance interventions on some large bi- and multi-lateral projects is evolving from directive extension approaches typical of these projects historically to more interactive approaches. Technician concern with achieving tangible project impacts in anticipation of project evaluation often motivates this change. The OHV project in Mali, and the Swiss-managed component of the Sikasso Reforestation project, the PAFOCSE agroforestry project, the FAO fisheries project in Niger, and others provide examples. However, host government technical services have little incentive to adopt such approaches where personnel evaluations and salary incentives are not linked to project outcome. Thus tying personnel evaluation more tightly to favorable natural resource management outcomes might improve technical assistance performance generally.

Source of the Initiative

No single source of ideas or "trigger mechanisms" is tied to the successes observed. Top down, bottom up, policy to field, and field to policy successes can be cited. The Prefect of Tahoua's (Niger) ban on cutting green vegetation, and exhortation to create half-moon microcatchments for reforestation are examples of top-down initiatives which have enjoyed limited technical success. Senegalese village development associations and private woodlot and orchards are examples of bottom up successes. Decrees establishing the Senegalese parks have protected biodiversity in some cases, while the Malian improved stoves law has fanned a popular movement. These are examples of initiatives moving from the policy to the field. Establishment of Guesselbodi's forest management cooperative, and its exemption from certain forms of taxation provide examples of popular initiatives impacting national policy. It is the first case of local groups in Niger obtaining management rights over natural resources. Joint management (government/fishers associations) of Niger river fisheries in Niger is another example of a popular movement impacting policy. Nonetheless, and regardless of the source of the initiative, some sort of external "facilitator", "culture broker", or technical assistance lobby usually intervenes to motivate interested parties to change the status quo in resource management practices. The IUCN conflict resolution work in Mali's Inner Delta is an extreme example.

Conclusions

This chapter has provided a summary perspective on 70 field interventions. The information presented establishes that there is a broad range of successful natural resource management activities in the Sahel. They have occurred in the context of a rapidly degrading environment, however. Individual battles have

been won, but we are losing the war. For these still isolated examples to be useful to policy makers and field personnel in developing a more successful strategy, we must address the question of what has worked. At one level, the diversity of the successes we have seen suggests that many things can potentially work. While appealing in its simplicity, this conclusion is only a half-truth, and provides little useful policy guidance.

The process of extracting useful conclusions from such a diverse set of observations is based partially on judgement and partially on analysis. We have exercised both in formulating the findings contained in Chapter 5 and the recommendations contained in Chapter 6. The findings discuss underlying trends which should form the basis for future policy. The recommendations distill, using our best judgement, the major approaches which meet the criteria for defining success set forth in Chapter 2.

Attributing Success

The most important conclusion which emerges from our field observations is that initiatives have had the greatest impact when they have broadened the definition of what constitutes a natural resources management intervention: that is, when approaches have resolved the problems of the populations involved rather than of the "environment" per se. The basic concerns of rural Sahelian populations center around achieving at least a stable and, hopefully, improving standard of living. This in turn has historically depended on the status of the principal rural production systems: agriculture, livestock, fishing. Precisely because environmental degradation now visibly threatens these production systems, populations have turned to natural resources management to accomplish two things, both of which directly affect their income: first, to protect the soil and water resources on which their production depends (e.g., the full range of soil and water conservation, soil fertility improvement and related measures) and second, to provide new opportunities for income (pole production, orchards and gardens, firewood and fodder sales, etc.) to compensate for declining and uncertain yields in customary productive activities.

Creating opportunities for income generation (by stimulating local markets, providing secure land tenure, rationalizing agricultural or forest products pricing systems) from natural resource management has been as much a successful intervention as the introduction of specific technologies like windbreaks, *Acacia albida* or contour dikes. Where both technology and opportunity have been present, we have seen sometimes dramatic responses by smallholders, either on their own initiative or with initial stimulus through the public sector. In the most successful cases we saw, public and participant objectives were often not the same: the stoves program in Mali seeks to save the forests,

but women have adopted them to save their time; the Guesselbodi management schemes aim at reclaiming degraded land and increasing forest productivity, but villagers have participated because it provides cash income; farmers have planted Eucalyptus because they can earn as much from the sale of poles as from agriculture, even as projects have unsuccessfully attempted to convince them to establish woodlots for production of firewood.

Defining Objectives

Attributing success to an intervention also depends upon how objectives are defined. The UNSO *Acacia albida* project in Dosso is a success from the standpoint of the objective of planting and protecting acacias. Although 380,000 trees have been planted or protected in four years, only 10 % of farmers profess willingness to continue regeneration without the direct payments which the project provides. However, it may well be that the only way to get Zarma farmers in Dosso to regenerate trees is through direct payment. This intervention is replicable in many contexts in the Sahel where the economic and ecological crisis is severe. But one would certainly not wish to pursue this formula in Senegal, or in the Maggia Valley, for example, where tree planting has taken off on the strength of other incentives less dependent on external support.

Timeframe

Attributing success is time frame dependent. The team was surprised to find improved mud stoves, a long standing "failure" in Mali, suddenly commonplace in 1987. The Maggia windbreaks were not successful in the first six years and caused a multitude of managerial problems and caused economic hardships to displaced herders. But after 10 years, a threshold of success has been crossed. After five years, Swiss and PARCE project industrial forest plantations in Sikasso, Mali and Kafrine, Senegal respectively, failed, but new natural forest management experiments they are conducting may well become models for success in these regions. In four years, eucalyptus pole lots become profitable for Senegalese farmers. If evaluated in terms of their contribution to biodiversity or soils fertility they could be deemed a short-term failure. But they may lay the economic foundation for more diversified investments in the long run. Finally, the IDA forestry project in Damana, Niger has little more than some check dams, field and shade trees to show after years of work. However, the approach to village territory management being worked out there promises to lead over the next several years to the kind of sustainable, replicable resource conserving initiatives needed in drought-stricken Filingue arrondissement, Niger.

Many promising initiatives in the Sahel are simply too new to evaluate. CARE-sponsored windbreaks in Koro, Mali based on the Maggia model; village territory management (amenagement de terroir villageois) in Banamba, Mali; a

fish culture project and a diversified horticulture project on the Guiers Lake, Senegal; planned reintroduction of gazelles at the Djoudj Park, Senegal, and many other initiatives fall into this category.

In general, a minimum ten year time frame is required for natural resource management initiatives to mature. The time needed to achieve visible impacts appears to increase with the novelty of the techniques, competition for resources, and inexperience of technical assistance. Time requirements have been shorter in the presence of market incentives and supportive values, policies and social structure. A systematic region-wide monitoring effort could collect comparative data on interventions at different stages of their life cycles in order to avoid their premature termination or, conversely, unwarranted continuation in particular cases.

The Importance of Process

The team visited some initiatives which have unclear natural resources impacts. Well and garden projects are typical. They improve access to water and they may improve agricultural productivity in the short run. However, the longer term impacts of gardens on water tables, on water and soils quality, on land tenure, and on the organization of production remains uncertain. Furthermore, in only a few cases were gardens being used to conserve or restore biological diversity. On the other hand, wells and gardens may improve the nutritional status of communities thereby making more human energy available for other investments in natural resources management. Unfortunately, few, if any garden projects had been conceived with this holistic long term end in view. The Gandiolas project is an exception. The team's assessment of the limited natural resources management implications of garden projects brings out the fundamental difference between short-term, productivity improving uses of natural resources, and long term natural resource management improvement.

Many projects like garden projects, woodlots, dune stabilization, watershed management, forest management projects, and the like, should be conceived of as components of a process which both heightens local participation and contributes to donor expertise in natural resource management. Projects which sometimes offer little tangible product, but in which a process of mutual accommodation and adaptation of techniques and extension methods between implementing agencies and participants is permitted to occur over time, often seemed to the team to be the most promising (e.g., Bouna Agreement, Maggia windbreaks, Guesselbodi, Gandiolas, PRECOBA forestry, IDA Forestry - Damana, Niger Fisheries). Often "doing something right", building sustainable, incremental change from the ground up, is as important as "doing the right thing".

Using Local Values

Values play a critical role in sustained success, and are critical to replicability. Preventing bush fires among Diola populations in the Basse Casamance is merely a question of providing equipment and organizational incentives, for these people feel so strongly about their forests that bush fires were once virtually unknown. Charcoal cutters have even been run out of the town of Oussouye by outraged citizens. Radically different strategies are called for among the Senoufo of the Sikasso region for whom burning the bush is an ancestral, quasi-religious obligation. Similarly, cooperative woodlots or diking projects which work well among Mandinka populations for whom voluntary association for public works projects is second nature, are unthinkable among the more individualistic Zarma in Niger.

Case: Bignona Women's Fire Control Committee

Natural Resource Management Themes

Stemming from descriptive material presented in this chapter a series of themes or lessons about success emerge. We have divided them into four sets and present them here without further comment. In a summary matrix in the Appendix, these themes and the interventions which illustrate them are presented in graphic form. An integrated discussion of the most important themes emerging from the Team's assessment is presented in Chapter 5, "Principal Findings".

Themes Emerging From the Sahel Assessment
Values, Interest, and Knowledge
Information transfer must harmonize with local experience and knowledge.
There is popular interest in productivity stabilizing and improving NRM activities.
Value changes in NRMS springs from rapidly changing environments and economic contexts.
There is thirst for NRM knowledge generally and information about agricultural biodiversity specifically.
Cultural/religious context plays an important role in NRMS.
Long term success of NRM activities is dependent upon improved conservation education.
Conflict Resolution
Conflict resolution is an important, under-emphasized and under-funded aspect of NRMS.
Resolution of resource tenure issues is critical to NRMS success.
NRMS has not found an institutional home in Sahelian government structures.
Coordinate program activities with existing governmental activities.
Involve farmers in the design implementation, management, and evaluation of the program.
Human Energy for Natural Capital Formation
People are substituting their energy for natural capital formation processes.
Current forms of NRM financial analysis have not captured the dynamics of the rural economy (agro-sylvo-pastoral-artisanal).
Employ people from the local area for program staff.
Use technologies that can be taught by one farmer to another.
Initiatives and Techniques
Many workable appropriate techniques of NRM exist in the Sahel.
It is often better to intervene at several levels or in several sectors than at a single level or in a single sector.
Multiple benefit, risk-minimizing interventions produce tangible results.
NRMS initiatives can catalyze local organizational development.
All other things being equal, choose small-scale, incremental, diversified NRM projects.

Long-term, adaptive commitment to projects increases chances for success.
No single factor leads to the success of a given intervention; no single type of intervention is sure to succeed.
Productivity increasing NRM activities may stabilize rural populations and lead to investment in more intensive forms of resource use.
The human ecology of biodiversity is a critical factor in both sustainable economic development and biodiversity conservation.
There is no simple way to coordinate long term natural resource benefits without providing short term benefits to participants.
Use adaptable technologies that build on traditional practices to increase the chances of success.
Ensure that programs have time horizons which increase proportionally with the novelty of proposed innovations in NRM techniques.
Use visuals, demonstrations, and site visits in the extension process.
Insist on collective diagnosis, monitoring, and follow up visits by technicians and potential adopters.

FOURTEEN CASE EXAMPLES

Summary Matrix of Fourteen Case Examples

CASE	LOCATION	SCALE OF IMPACT	TIMEFRAME	INCOME EFFECT	SOURCE	EXTENSION INTENSITY
Operation Haute Vallee Check Dams	Mali 3rd Region	Medium	Short	Moderate to High	External Traditional	Moderate to High
Microcatchments in Enadoujoum and Check Dams in Ourihamija	Niger Tahoua Department	Various	Short	Moderate	External Traditional	High
Water Retention Dams and Soil Conservation in Sintet, Gambia	Gambia Central River District	Medium	Short	Moderate to High	External Traditional	Medium to High
Mr. Ka, Private Nurseryman	Senegal Tambacounda Region	Small	Medium to Long	Moderate to High	Private, External	Low to Moderate
The Bouna Agreement	Mali Inner Delta	Medium	Medium	Moderate	External, Traditional	High
Environmental Education in Mali's Fifth Region	Mali Fifth Region	Medium	Medium to Long	Low Indirect	External	Low to Moderate
Gandiolas Garden Project	Senegal Fleuve Region	Small	Short	High	Private, External	Low to Moderate
Lamin Seed Multiplication Project	Gambia Upper Niumi District	Medium	Medium	Moderate	External, Traditional	Moderate
The Koumpentoum Entente	Senegal Tambacounda Region	Medium	Medium to Long	Variable	Mixed	Moderate
Guesselbodi Natural Forest Management	Niger Niamey Department	Medium	Short to Medium	Moderate to High	External, Private	Moderate to High
Guesselbodi Wood-Cutters Cooperative	Niger Niamey Department	Small	Short to Medium	Moderate to High	Private, External	Moderate
Niger River Fisheries Management	Niger	Medium	Long	Moderate	External, Private	Moderate to High
Bignona Women's Fire Control Committee	Senegal Bignona Commune	Small to Medium	Medium	Indirect	Private, External	Low
Operation Haute Vallee Extension System	Mali 3rd Region	Medium to Large	Medium to Long	Indirect Moderate to High	External	Moderate to High

Operation Haute Vallee Check Dams

Basic Information

Location: The Third Region of Mali.

Major Characteristics of the Location: Gently accented, forested savannah terrain cross-cut with seasonal watercourses. Most soils are thin with a high sand and/or lateritic gravel content. Receives some 800-1000 mm of rainfall annually.

Area Affected: Several thousand hectares.

Special Characteristics: In some places, check dams are already familiar to villagers, having been initiated by the White Fathers years ago.

Traditional Resource Use Pattern: Primarily rainfed agriculture on piedmonts with some natural submersion irrigation.

Nature of the Initiative: Systems of rock and earth dams in a number of areas crossed by shallow water courses.

Description of the Initiative

Technical Measures Taken: In the village of Fadjibougou, 60-70 people organized themselves for 17 days to build a 70 m long, two meter high dam in accordance with technical advice from project staff. Villagers hauled the rock and earth on carts and bicycles. Construction techniques are relatively simple and all materials are local.

Social Organization of the Initiative: The large AID-financed OHV (Operation Haute Vallee) project has begun developing these dams in response to local demand. Project staff, having adopted a more interactive extension after some eight years of experience, have sought to use dam development as a point of departure for other natural resources management activities. Labor is deployed through the traditional *tonw* or age grade work organization. The work was directed by a leader of the senior *tonw* in whom villagers expressed confidence.

Economic Incentive System: Small dams provide immediate benefits, but additional dams can be added as resources and energy permit. Farmers recognize multiple benefits: improved water levels in village wells (5-6 meters, up from 6-9 meters), reduction in water lifting and hauling outlays; restoration of rice production; more reliable fruit tree production; improved animal access to water; increased fish harvests.

Socioeconomic Data: Benefits are broadly distributed to upstream landholders, women, and leaders. Effects are long lasting with proper maintenance. Demonstration has increased local awareness of dams' effectiveness, and reinforced the credibility of OHV extension workers and technicians. Success with check dams, along with other project benefits such as rural feeder roads, encourages farmers to experiment with contour bunds, composting, village woodlots and other project activities.

General Discussion of the Initiative: This case illustrates the importance of mixing short and long-term benefits in technical interventions, and project responsiveness to local needs.

Microcatchments in Enadoujoum and Check Dams in Ourihamija

Basic Information

Location: Northern Tahoua department, Niger

Major characteristics of the Location: 200-250 mm annual rainfall Sandy lowland soils with lateritic plateau tops, hillsides and alluvial "glacis" which have lost most of their thorny Sahelian vegetation.

Area Affected: Several hundred hectares.

Special Characteristics of the Case: Over-cultivation and herding during the past 20 years has led to serious degradation. Most floodplain fields had not flooded for many years because of the deeply gullied stream bed, and remaining valley bottom fields were threatened by the bare eroding slopes.

Nature of the Initiative: Construction of gully check dams and half-moon Microcatchments

Description of the Initiative

Technical Measures Taken: Checkdams have caused over two meters of sediments to be deposited in gullies around Inadougoum in only two years. The streams thus flood the bottom land fields. Construction of fields of half-moon microcatchments have brought abandoned slopes back into forest and cereal production in Ourihamija. Astonishing yields for this rainfall zone of 500 kg/ha from the microcatchments are reported. Tree survival rates have been high, nearly 100 percent.

Social Organization of the Initiative: Swissaid began working in the zone over ten years ago; intensive activity began three years ago. Villagers asked Swissaid for assistance in 1985, when they were considering abandoning the villages. Swissaid provided hand tools, and technical assistance in collaboration with the local Rural Engineering Service. Initially, Food-for-Work was provided to villagers to encourage them to stay in place during the dry season and to install the new infrastructure.

Economic Incentive System: Checkdams and microcatchments have provided good harvests of millet for the first time in years. 60 families will soon benefit from cutting poles from the plantations where tree are already two to three meters tall. Swissaid has also helped villagers form a cooperative to produce wire fencing for which there is a growing demand from local reforestation efforts.

General Discussion of the Initiative: Villagers were familiar with the soil conservation work of a French priest who lived in Ourihamija for about 20 years, and whose work the Swiss have continued. The priest took some farmers to visit similar sites in Agadez department which provided impetus to villager participation. This case illustrates how dramatic situations can be improved throug long term, labor intensive, incremental technical solutions implemented through face-to-face extension. Some technical problems with the placement of infrastructure have emerged, but there has nonetheless agriculture has experienced a miraculous recovery from a desperate situation.

Water Retention Dams and Soil Conservation in Sintet, Gambia

Basic Information

Location: Sintet Village Area, Central River District, The Gambia.

Major Characteristics of the Location: Receives 700-800 mm rainfall annually. Affluents of the Gambia River dissect the zone. Gallery forest remnants and tree savannah vegetation dominates. Long, relatively cohesive political history.

Area Affected: 3000 ha of watershed affected by soil erosion, deforestation, and sand and saltwater intrusion in a 700-800 mm rainfall zone. Forty-five hectares are directly affected.

Special Characteristics of the Case: The Foni Jarrol district has a distinctive agro-ecological and geopolitical identity dating back to the pre-colonial period. The regional leader or Sefo is a very influential individual whose support of the intervention SWMU staff judged crucial to success.

Traditional Resource Use Patterns: Rice culture, predominantly a women's crop is cultivated on small plains seasonally flooded by rain and river water. Upland cultivation consists of field crops of peanuts, millet, sorghum and maize. Animal traction is common.

Nature of the Initiative: Water retention dams, contour berms, and small ravine check dams have been key technical interventions. Villagers have been encouraged to organize themselves into a conservation management unit.

Description of the Initiative

Technical Measures Taken: Water retention dams, contour berms, and small ravine check dams have been key technical interventions. "High tech" land surveying procedures are used to place conservation structures. Tractors are used only to rip compacted soil and transport rock.

Social Organization of the Initiative: The six-year old Soil and Water Management Unit, housed in the Ministry of Agriculture, the Gambia, actively publicizes its soil and water conservation services. It then responds to requests for help by villages to assist them funneled to SWMU from the villages through District Agriculture Officers. After reconnaissance of districts requesting assistance, SWMU staff decides what villages are most in need, and priorities the work to be done. Village committees organize the physical work, while SWMU provides technical support.

Economic Incentive System: Villagers who would otherwise have gone on dry season labor migration, now stay around to work on infrastructure. Food-For-Work inducements have been avoided because people recognize deleterious environmental effects of salt intrusion and erosion, and dramatic yield increases achieved through conservation. Plaques and rewards have also received from the U.S. Soil Conservation Service.

Socioeconomic Data: Economic analysis of water retention dams estimates internal rates of return at between 26 and 34 percent. Multiple benefits occur in the first year after installation. They include: increased rice and forage production; increased water availability; reemergence of "lost" plant species; habitat protection; and reduced soil erosion and sand intrusion.

General Discussion of the Initiative: The case illustrates how integrated watershed management can be achieved through a combination of local organizational development and sound technical services, on the basis of resource conserving values. Sintet now provides a model site for other village areas who visit.

Mr. Ka, Private Nurseryman

Basic Information

Location: Tambacounda Region, Senegal

Major Characteristics of the Location: The region is an extension zone for the peanut basin and its forests suffering from pressure from human cultivation and drought. Average rainfall has decreased to between 600 to 700 mm since the onset of the drought period. Soils are sandy to lateritic.

Area Affected: Several thousands through a combination of private nurseries, natural forest management, and plantation production.

Special Characteristics: Reliance on market incentives to spur sound natural resource management.

Traditional Resource Use Practices: Recent practices have focused on extensive peanut production using capital intensive inputs.

Nature of the Initiative: 157 private nurseries have been established through the efforts of the PARCE project based in Kafrine.

Description of the Initiative

Technical Measures Taken: The project finances 50 percent of nursery establishment costs. Trees are promoted in whatever econiche they can fill. Choice of species is not imposed but the project provides technical advice to promote appropriate species for particular conditions.

Social Organization of the Initiative: A network of project trained extension agents teaches villagers nursery management and forestry extension techniques. The project also provides some marketing brokerage services to the nurserymen.

Economic Incentive System: Seedlings cost 15 CFA francs to produce and are sold for 35 CFA francs. Some local governments have begun buying from the private nurserymen to fulfill their own reforestation goals. Mr. Ka sold at least 2500 seedlings in 1987 to groups outside his village at 35 FCFA per seedling. Villagers have learned that trees can be economically competitive with peanut production.

Socioeconomic Data: Mr. Ka, the nurseryman met in the village of Thoune, (one of three in the village) has established his nursery in a corner of his compound. He has produced 2400 seedlings in 1986 and 5000 in 1987 respectively. (The total production of the three nurseries in 1987 was 9000 seedlings). Mr. Ka manages the nursery production for his own village on a voluntary basis but much of the routine work is shared by those villagers that have ordered seedlings. He is recognized as a leader in promoting tree planting in the area. For his work as a nurseryman and his leadership qualities, he was decorated by President Abdou Diouf in 1987.

General Discussion of the Initiative: This case illustrates how a project intervention can provide a "trigger" for improved resource management.

The "Bouna Agreement"

Basic Information

Location: Mali's Inner Delta Region.

Major Characteristics of the Location: One of the few inland deltas in Africa. Rainfall averages 200-400 mm. Populations of animals, plants, and people are seasonally dense. Highly diverse ecosystem and economy traditionally.

Area Affected: Several hundred square kilometers on the Niger River.

Traditional Resource Use Practices: Complex, overlapping systems of herding, fishing, agriculture, and hunting. The rules that prevented overuse of forests and range have become clouded by rapid historical and climatic change.

Nature of the Initiative: Through several years of negotiation, employing conflict resolution techniques, the interested parties have signed an agreement on common resource use.

Description of the Initiative

Technical Measures Taken: The Bouna Agreement will create a new series of common property laws to replace the current contradictory mix of local village lineage claims, rules promulgated by the Fulani Dina in the nineteenth century, French colonial law, and more recent national common property access rules.

Social Organization of the Initiative: In essence, IUCN is helping goat herders, fishers, local traditional authorities, and national authorities who use a series of small, seasonally flooded forests in the Inner Delta of the Niger. The agreement: 1) vests rights of forest ownership to local villages; 2) places power of local management into the hands of the dioros and village chiefs who are the managers historically; 3) formalizes fishing rights that already exist; 4) enforces a no cutting policy of trees for enclosures or browse; 5) forbids harvesting of heron nestlings for two years; 6) restricts entry of goat herds (destructive overgrazing of the bourgou grass and trees); and 7) obtains backing for the agreement from the appropriate administrative entities of the Malian government.

Economic Incentive System: The interested parties have been shown that through proper management bird guano will increase algal growth and fish production for fisherfolk; goat herders will be assured better forage and assured access to the bourgou grass in exchange for ceasing to cut *Acacia tortillis*, (var. *kirkii*) branches for enclosures and forage; farmers will have more reliable flocks of storks to help with locust control; the Mali government will fulfill its RAMSAR agreements to protect wetlands. Finally, local control will be more effective because of constant monitoring by the controllers. In January 1988, this multi-dimensional agreement still needed approval of local administrators and the Forestry Service to become fully binding.

Socioeconomic Data: The total cost of this initiative, the related *Walia* publication, and other Inner Delta projects is only $712,000 spread over four years.

General Discussion of the Initiative: The "Bouna Agreement" exemplifies a non-technological intervention to improve common property management, including biodiversity, through conflict resolution. It also shows how a disinterested NGO can serve as a neutral facilitator in a negotiation process. This approach to common property management is unique in the Sahel.

Environmental Education in Mali's Fifth Region

Basic Information

Location: Mali's Fifth Region.

Major Characteristics of the Location: *Walia*'s headquarters are in Mopti. The Fifth region has the most complex ecology in Mali because of the seasonal flooding of the Niger River into a series of vast plains and lakes. Over nine ethnic and/or linguistic groups share the area practicing distinctive economies and exploiting discrete economies historically. In a context of environmental deterioration and economic crisis, wildlife and habitats diversity has decreased catastrophically through over-exploitation, open access rules, and/or unenforceable limited access rules.

Area Affected: Some 78,000 square kilometers.

Special Characteristics of the Initiative: *Walia* aims to teach improved resources management, reconciling long-term and short-term gains, as well as harmonizing rural development goals with conservation.

Nature of the Initiative: *Walia* is a mimeographed, illustrated magazine distributed to 25 schools in the Fifth region of Mali.

Description of the Initiative

Technical Measures Taken: IUCN, Centre Canadien d'Etudes et de Cooperation (CECI), CARE-Mali, and the regional branch of the Forest Service cosponsor the magazine. *Walia* is published three times yearly. IUCN mimeographs and delivers the magazine to the schools since the postal system is unreliable. Its articles cover geography, wildlife, Malian environmental and health concerns, traditional stories, ecology, and natural resources issues.

Social Organization of the Initiative: Individual issues are passed around so that the 4000 copies produced for each issue and destined for a school age target group are most probably read by over 10,000 Malians. In fact, its popularity is so great that *Walia* is now read throughout Mali. Each issue is followed up by two day teaching visits to each school by the head of the IUCN project and her Malian counterpart/translator. Each round of visits takes three months to complete.

Socioeconomic Data: IUCN spends $40,000 annually on the project.

General Discussion of the Initiative: *Walia* has brought natural resources issues to the fore in the Delta region. Children often talk to their parents about ecological change. Teachers incorporate *Walia* into their curricula. Contests, games and projects based on the *Walia* material raise consciousness about natural resources matters. Similar efforts have been critical to the improved climate for preserving biodiversity in East Africa.

Gandiolas Garden Project

Basic Information

Location: Fleuve Region, Senegal

Major Characteristics of the Location: In this area of Senegal soils are loamy sands with low organic matter. The water table is shallow. Average annual rainfall is only 300 mm, marginal for rainfed millet production.

Area Affected: One hectare directly affected.

Special Characteristics of the Case: Diminished rainfall has resulted in the loss of many useful plant and tree species and isolation of remaining individuals.

Description of the Initiative

Technical Measures Taken: Small gardens of perennial shrubs and trees are planted on a one hectare plot. There are no special criteria of selection other than expressed need. The Canadian Volunteer travels around Senegal to find preferred seeds. Species chosen include those useful for medicinal, cosmetic, food, and condiment purposes.

Social Organization of the Initiative: A forestry Agent works directly in training and extension with a Canadian Volunteer and women's groups in 25 villages to establish horticultural priorities. The women's group of Leona (53 members) established, and now maintains the garden. Subgroups perform different tasks particularly watering during the dry season, and intercropping with cowpeas during the rainy season.

Economic Incentive System: The project provides no direct economic incentive. Villagers participate because they recognize the benefits of the plants grown. For example, reestablishment of medicinal plants may lower expenditures for medicine. In addition, species loss has been accompanied by a loss of first hand ethno-botanical knowledge among the younger generation of women. The project helps redress this problem.

Socioeconomic Data: The project has benefited from the energetic seed research of the Canadian Volunteer and the programmatic flexibility of Mr. Faye, the local forestry agent. Against the wishes of his superiors he changed the direction of the initiative from a conventional fuelwood project to its current form. In addition, species loss has been accompanied by a loss of first hand ethno-botanical knowledge among the younger generation of women. The project helps redress this problem.

General Discussion of the Initiative: On a small scale, activities of the Canadian-sponsored, Gandiolas garden project in the village of Leona, Louga, Fleuve Region, Senegal is another example of successful wedding of biodiversity and productivity sustaining or increasing concerns. This intervention contributes to floral diversity and is based on the simple idea of a project meeting local needs through local participation.

Lamin Seed Multiplication Project

Basic Information

Location: Lamin Village Area, Upper Niumi District, The Gambia ,

Major Characteristics of the Location: Rainfall varies between 600 and 800 mm. Soils are diverse with slightly evolved sandy upland soils, and low lying colluviums and reclaimed swampy soils subject to acidification and salinisation along the bolongs under drought conditions. Populations densities are high but stabilized through southerly outmigration.

Nature of the Initiative: A program to introduce a short cycle rice variety into Lamin Village Area.

Description of the Initiative

Technical Measures Taken: A new 90-day Pekin variety helps restore rice cultivation in drought-affected lowlands areas, and expand production into upland fields. The USAID-financed GARD project provides certified seed.

Social Organization of the Initiative: Save the Children Fund (SCF) staff have brought a number of individuals and organizations together in this program. The GARD project operates a demonstration plot near the village of Bakindig. Members of Lamin's women's group visited this plot and chose Peking and other varieties of interest to test in their own fields. SCF monitors fertilizer and pesticide use. The Grasshopper Control Unit in Lamin provides the pesticide. SCF purchases some seed for distribution in other villages and a small amount is sent to the Sapu Research Station for testing.

At the beginning of the rainy season, the community development agent visits Lamin and tells people when to plant. The village development committee sets the day for communal sowing. The agent also provides villagers information on cultivation practices. He tells villagers when to weed as well. The agent is well-liked and trusted. Villagers have even renamed Peking variety rice after him (Danjomano). An agricultural extension agent provides pesticides and sprays twice a year against blister beetle. The women's group grows the seed under contract to SCF in order to have the seed certified for distribution. They provide the bulk of the field labor.

Economic Incentive System: SCF guaranteed the 1985 crop and has subsidized fertilizer and seed supplies for six villages for two years. The Lamin group sold 16 bags of rice on the open market in 1986 and received 2000 Delasis (approximately $250). This was turned over to the treasurer of the village development committee (VDC). This money has been banked and is available for community uses. SCF also purchases rice from individuals at a price deter- mined by the village up to a maximum of 10 to 20 kilos per village. SCF is helping Lamin to become registered with the Sapu center as a multiplication center for the Peking variety. This entails a transfer of new technical and administrative knowledge. Finally, SCF has provided materials for a storage building, while the VDC provides the labor.

Socioeconomic Data: The new rice variety grows well under prevailing technical conditions, tastes good, and matures in less than three months. Women are well aware that monocropping Peking makes them vulnerable to disease and are actively experimenting with new varieties to renew biological diversity. Men are beginning to grow rice in the more upland fields and will start using this variety a way to expand crop lands.

General Discussion of the Initiative: The people of Lamin have accepted the reality of a permanent change in rainfall conditions. They are eager to adjust to these conditions. This case illustrates how biodiversity and productivity increasing goals can be integrated.

The Koumpentoum Entente

Basic Information

Location: Koumpentoum Arrondissement, Tambacounda Region, Senegal

Major Characteristics of the Location: Historically in an 1000 mm rainfall zone, the sixteen year rainfall average since 1968 has been only 700 mm. Diam Diam is located on gravely soils overlying sandstones in which ferruginous crusts are to be found. Lightly evolved sandy soils occur. All are erosion prone. Diam Diam is located just south of a foret classe in which a degraded natural forest occurs. Over use for charcoal, construction, and tools provoked the loss of *Cordylia pinnata*; climatic degradation accounts for disappearance of other species. The water table has fallen to 55 m causing the drying of some wells.

Area Affected: Several hundreds scattered over the arrondissement The total membership of the Association is 1,240, roughly ten percent of member village populations.

Special Characteristics of the Initiative: The Koumpentoum "Entente" was founded in 1974 in the aftermath of the first wave of modern Sahelian drought by an exceptional group of concerned local villagers to do something about their environment. Participation is voluntary; some activities are self-financed. The association has received support from at least half a dozen NGOs and other donors, but for 10 years has received consistent backing from Catholic Relief Services.

Traditional Resource Use Practices: The land is currently used for mechanized cultivation of millet, sorghum, and peanuts. Under higher rainfall conditions, cotton was also grown.

Nature of the Initiative: Community-initiated, integrated rural development project.

Description of the Initiative

Technical Measures Taken: The village of Diam Diam has undertaken a series of natural resource management initiatives. In 1981, the village set aside 250 ha of village land for reforestation activities. Seven hectares of fenced plantations for Eucalyptus, Australian acacias, and local species have been planted. Five additional hectares of land are fenced for a future village orchard. A twenty-five acres woodlot and windbreaks have been planted by the Coordinator of the Entente as demonstrations. Both the youth group and the women's group have planted 50 acres of Eucalyptus. The village nurseryman has gathered seeds in a more southern zone to begin to regenerate lost or scarce native tree species. In addition, six hectares of fields per year are fertilized through a planned, staggered program of animal stabling of collectively managed, but individually owned herds.

Socioeconomic Data: In addition to the natural resources initiatives, the village of Diam Diam has built a collective granary, a cooperative store, a small, unstaffed, health clinic, a warehouse, and is stocking bricks to build a mosque. The Entente purchased a millet thresher for the village of Diam Diam, and the village association itself purchased a millet mill. A clever scheme by which co-owned goats and cattle are used to create the nucleus of individual herds is also underway. The subcommittee expects to receive new technical assistance to launch an improved stove production program in the village again.

Funding was originally generated from collective fields and this mechanism is still used. Both the Entente committee and village subcommittees stock cooperative granaries, "in kind cash boxes", in Diam Diam. Recently the Entente has instituted a compulsory cooperative savings scheme. Every year each male member must contribute 10,000 CFA and each woman member 2,500 CFA to the fund. The Entente has over 1000 members and membership grows yearly.

Social Organization of the Initiative: The small nucleus of the organization received help and encouragement from a famous Senegalese extension worker named Mahamadou Cissoko. After ten years of experience, virtually every activity is planned by the villagers themselves before seeking outside financing. The initiative bears similarities to the AJAC project in the Casamance region. A formal, representative umbrella organization embraces numerous village level projects and sub-projects organized by voluntary interest groups. Each Entente project has a responsible person in charge. Each project is overseen by a subcommittee. Each project searches for separate technical and financial assistance, if needed, either from an NGO or a government service. Committee-wide decisions for the use of committee resources are taken by an executive committee composed of officers and delegates from the subcommittees.

Economic Incentive System: Diverse incentives exist within Entente projects. For example, from the proceeds of collective fields, threshers and mills have been purchased which diminish women's labor bottlenecks. Buying at the well-stocked,local cooperative store reduces individual customer travel time. Store manager(s) receive an annual percentage based indemnity. Polewood has been sold from the Bamba Thialene village's woodlot. Sales are expected to be made from Diam Diam village woodlot soon. Although prices are low, 200-300 CFA per pole, income from the seven hectares plot will be significant. Livestock multiplication projects provide both immediate benefits (milk), medium term benefits in the case of cattle (manure), and long term benefits (integrated agro-pastoralism) to participants.

General Discussion of the Initiative: Sources of aid are diverse. Catholic Relief Services provided fencing and inputs for the forestry component in the form of grants. A Peace Corps volunteer gave forestry technical assistance for two years. NGOs finance most capital costs, but traditional labor group structures are mobilized for collective work, and fines (double the initial outlay) are imposed on persistently delinquent participants.

Among the most interesting things about this intervention are its basis in an analysis of natural resource deterioration, and the determination of villagers to do something about it. Continued flexibility and adaptation to the needs and requirements of participants, and integration of activities into village life are its hallmarks. Natural resource management is not an isolated activity in Koumpentoum.

The Guesselbodi Natural Forest Management Experiment

Basic Information

Location: The Guesselbodi natural forest 30 kms east of Niamey, Niger.

Major Characteristics of the Initiative: Zone receives 400-600 mm of annual rainfall. Barren, crusted lateritic surfaces subject to sheet and gully erosion with aeolian deposits in low lying areas. Fifty percent of the forest's vegetative cover has been lost since 1950.

Area Affected: Five thousand hectares.

Special Characteristics of the Initiative: Labor intensive reclamation and regeneration techniques have been used to revitalize a severely degraded natural forest, and the project has negotiated the relative independence of a local woodcutters' cooperative from the forest service.

Traditional Resource Use Patterns: Conflict ridden pattern of opportunistic resource use by local populations, coupled with efforts at resource preservation and repression of unauthorized use by the Forest Service.

Nature of the Initiative: Creation of a multi-resource, multipurpose management system for the forest that is cost-effective and that relies on popular participation.

Description of the Initiative

Technical Measures Taken: Division of the forest into management parcels. Project focused on an intensive soil restoration program including contour walls, mulching with branches and twigs, earthen water catchments, mechanized erosion control, and cutting of mature, natural stands of Combretum to promote regrowth. Agroforestry on agricultural land, plantations within reclaimed areas, and natural range management for regeneration complete the inventory of activities. Use of natural regeneration and direct seeding may greatly reduce reforestation costs in Sahelian forests.

Economic Incentive System: The immediate, significant benefit identified by the villagers is the employment of local people to carry out tasks defined by the work plan. The public works reclamation program continues to evolve. The farmers appreciate the employment which obviates the need for dry season labor migration. The project director appreciates the patronage possibilities. But the high price of firewood in Niamey makes it possible for the forest to become cost-effective on a sustained yield basis. Forest guards realize a cash income of 40,000 CFA per month. The forest service has gained 600,000 CFA francs from cutting permits for its forestry fund.

Socioeconomic Data: Early in the project, with forest service permission a 40 ha parcel of bottom land within the forest was divided up into twelve cultivation units for local farmers who had long claimed the land. The farmers only responsibility was to protect windbreaks. This transfer of immediate benefits demonstrated that the project was serious about its claims to want to "help" local farmers. This benefit transfer paved the way for acceptance of management strategies with longer term payoffs. Individuals have realized increased cash incomes from wood-cutting; new cutters continue to take out permits. Thus, there is a spread of substantial benefits over a number of different interest groups. Increased fodder production in protected areas, and agricultural activity in formerly off limits has also been realized.

General Discussion of the Initiative: Policy reform has come about as a result of 10 years of intensive negotiation between the project, local farmers, the Forest Service and the national administration. Current plans call for extension of this model to several other donor-managed sites. But many questions remain. Would the program be as successful with technical assistance only 50 percent as efficient? Without the dry season public works opportunities, would farmers be equally enthusiastic? Could a program of harvesting natural stands serve as an equal inducement in other contexts? Without technical and political support, would woodcutters be able to successfully organize and maintain control over their resources?

The Guesselbodi Wood-Cutters Cooperative

Basic Information

Location: The Guesselbodi natural forest 30 kms east of Niamey, Niger.

Major Characteristics of the Initiative: Zone receives 400-600 mm of annual rainfall. Barren, crusted lateritic surfaces subject to sheet and gully erosion. Fifty percent of the forest's vegetative cover has been lost since 1950.

Area Affected: Five thousand.

Special Characteristics of the Initiative: Labor intensive reclamation and regeneration techniques have been used to revitalize a severely degraded natural forest, and the project has negotiated the independence of the woodcutters cooperative from the forest service. CLUSA has overcome formidable cultural and administrative obstacles to establish the local cooperative among Zarma farmers.

Traditional Resource Use Patterns: Conflict ridden pattern of opportunistic use by local populations coupled with efforts at resource preservation and repression of unauthorized use by the Forest Service.

Nature of the Initiative: The USAID-funded Forestry and Land Use Project (FLUP), with help from CLUSA (The Cooperative League of the USA), encouraged seven villagers to form a woodcutters, forest management cooperative.

Description of the Initiative

Technical Measures Taken: A program of selective cutting reflecting stand density, topography and site susceptibility to erosion is worked out by technicians. Selective cuts of three target Combretum species within stands are based on minimum stem diameter. Wood-cutters harvest the trees. A locally staffed sales lot adjacent to the main national highway has been set up.

Economic Incentive System: The woodcutters' cooperative makes money in many ways. It profits from sales of permits and wood to transporters at its roadside woodlot. In 1987, the cooperative realized its first collective dividend of 200,000 CFA francs from forestry and other permits. The Forest Service shares in the profits which are contributed to its natural forestry management fund. Profit-sharing partially compensates the Service for the loss of lucrative fines previously imposed in the forest for illegal cutting. Transporters buy from the cooperative because the wood is cheap and because receipts obtained from the woodlot resolve their tax requirements. Mounted guards impound animals that enter protected parcels and owners are fined.

The improved management techniques introduced into this severely degraded forest provide long term increases in forest and fodder productivity. Strict control of pasture plots along with replanting of forage species has allowed the cooperative to increase its income from cut fodder. The cooperative rotates grazing on the five 1000 ha forest blocks, and may fine violators.

Social Organization of the Initiative: Extraordinary, intensive extension efforts begun in 1983 provide a vital feedback link and a mechanism to transfer responsibility to the forest cooperative. Participants in the cooperative must participate in the natural forestry management techniques

perfected by the FLUP project. In return, only local woodcutters may buy cutting permits (1000 CFA francs per renewable permit) from the cooperative. These renewable permits allows them to cut and sell natural timber to the cooperative at the roadside woodlot.

Socioeconomic Data: The cooperative has used forest resources as collateral for loans to buy carts for transport. Woodcutters may buy permits, cut and sell their wood to the cooperative and pocket the cash immediately. Or, they may buy wood back from the cooperative, transport it with their carts to market themselves and resell it there at a profit. Armed with the requisite papers, they need fear no repression from the Forest Service.

General Discussion of the Initiative: The Nigerien government decision to allow a wood cutters cooperative to form around the Guessselbodi forest is one of the most successful policy reforms encountered. Wood marketing appears well-organized, but the persistent pressure of the expatriates to sustain and improve the program in the interests of replication is evident.

Niger River Fisheries Management

Basic Information

Location: Insular villages along the Niger River in the Niger Republic

Major Characteristics of the Location: Annual capture of 4500 metric tons in 1960 declined to only 900 metric tons in 1985 due to lower annual river flows, less variety in seasonal flows, and the exploitation of the river basin floodplains for irrigated rice culture. Over the same period, daily catch per fisher has dropped from 13 kgs to 3.3 kgs. Some species have virtually disappeared. In the southern zone shared by Benin and Niger, where over 80 percent of the capture is immature. Furthermore, lack of organic matter, limited sources of feed, periodic drought and competition with other activities for water resources limits future aquaculture development. However, research results from the UNDP and U.S.A.I.D. financed FAO Niger Fisheries Development Project suggest that proper resource management can double riverine production within three to five years to 2000 metric tons annually.

Area Affected: Five hundred kilometers of the Niger River.

Special Characteristics of the Case: The policies of Niger's "Development Society", created in 1979, are based on revitalization of local authority and popular participation. The "Development Society" is responsible for regional and sectoral development. The FAO-sponsored Fisheries Development Project exploited this policy opportunity in order to start forging a new relationship between the Niger Fisheries Direction and fishing communities.

Traditional Resource Use Patterns: Ethnic specialization in fishing utilizing a range of seasonally varied techniques. Management and control of fisheries in the hands of hereditary quasi-ritual authorities.

Nature of the Initiative: Development of new fisheries resource management plans within the framework of an infrastructural development project.

Description of the Initiative

Technical Measures Taken: Proposals for a fisheries management plan are the fruit of two years of frequent debate between FAO project staff, Niger Fisheries Direction personnel, and the fishers. Management proposals include legal measures to be institutionalized nationally and local measures identified by the associations. Legal measures prohibit specific gear and restrict seasonal uses of certain areas and species. Local measures cover implementation and monitoring, limiting "stranger" fishers participation, education of fishers for an ecologically sound catch, and the identification of fish sanctuaries reserved for growth and reproduction.

Economic Incentive System: Plans were designed for gradual implementation in order to minimize further disruption of the local economy. Plans aim to stabilize resource base.

Social Organization of the Initiative: In 1985, fishers started creating their own professional associations in consultation with project staff. They selected senior leaders, balancing regional, ethnic and "national" representation. Senior officers in each community are also the successors to ancient, still-respected traditional senior offices for each regional fishery.

General Discussion of the Initiative: Another example of policy reform leading to improved resource management is provided by fisherman's associations in Niger River fisheries in Niger. Further progress and institutionalization of reforms depends upon the fruit of further dialogue to be carried out under a planned second project phase.

The Bignona, Senegal Women's Fire Control Committee

Basic Information

Location: Commune of Bignona, Senegal

Major Characteristics of the Location: On the plateaux, are well drained slightly ferralitic soils, while others include leached tropical ferruginous soils, and weakly evolved aeolian or alluvial soils. Of note in the environs of Bignona is a complex mosaic of vegetation types: primary forest, clear humid forest, open woody savannah, and bushy secondary savannah. The remaining mangrove swamp vegetation is in regression. Rainfall in this zone historically varied between 1,000 and 1,400 mm annually. Since 1969, rainfall has averaged considerably lower.

Bignona lies within the old Mandinka division of Foni, but the population is virtually entirely Dioula.

Area Affected: Determining the area affected is difficult, since this is primarily an intervention with didactic implications. A small plot has been reforested, and the women plan to install a collective orchard. However, an undetermined number of hectares have been protected from burning thanks to great vigilance of the population.

Traditional Land Use Practices: The upland areas are devoted to the cultivation of peanuts, millet and sorghum with the fallows tending toward the open tree or bush savannah. The clear humid forest is the zone of oil palm and irrigated rice production. Uncontrolled grazing of cattle is practiced in the dry season. With groundnut cultivation, mechanization has become more significant. Controlled early burning was a traditional part of the their land use practices as was strict protection of numerous sacred groves.

Special Characteristics of the Case: Created by the Departmental Service of Eaux et Forets, it responds to the concerns of women in several wards of Bignona. The idea to form the group sprung from publicity given to the problem of desertification in Senegal, the women's own recognition of the seriousness of the problem, and President Diouf's call for a national program to fight against desertification.

Nature of the Initiative: The Bignona, Senegal women's fire control committee is an unpaid group of volunteers with didactic and lobbying goals dedicated to preservation of the remaining forest.

Description of the Initiative

Technical Measures Taken: The committee has planted a communal woodlot in Bignona. They have been instrumental in extinguishing fires within the commune of Bignona which has both overgrown open spaces, and thatched huts susceptible to fire. The group receives seeds, plants, technical advice, and sometimes food aid from the Forest Service. It receives financial support to conduct consciousness raising sessions, small tools for fire-fighting, and occasional grants in kind from the Canadian Fire Protection Project (PPPFC), based in Ziguinchor.

Social Organization of the Initiative: The women emphasize that technical success is largely a matter of organization. The group consists of 47 core members who have maintained their interest in the face of limited resources. The committee has an executive committee, and two sections based in two village wards. Over the past three years, the difficulty of work and the

constraints of space and material have discouraged many participants, but now those who are left have decided to go forward. The women organize themselves. Small jobs such as watering are handled by ward level or smaller sub-groups of women. Bigger jobs such as bush clearing were carried out by the effort of the full group or by young men who have been induced to help them. Fire control mobilizes the entire group, some of whom draw water, other apply water, others still use rakes and beaters to control the flames. Over a three year period, the committee has also organized extensive consciousness raising sessions with women in many rural communities during the annual "Women's Fortnight" (Quinzaine de la Femme). Concerned about the attitude of the young towards the environment, the women have asked the directors of the town's schools to integrate environmental concerns into their curricula.

Economic Incentive System: At this point, incentives are primarily moral and socio-political in nature. The committee receives support from the administration and enjoys the respect of the people. In addition, the women are inspired by deeply held cultural beliefs in which the forest is a key symbol of bounty. (A sign read, "La foret, notre mere nourriciere"). Women quite correctly stated that their most distant ancestors recognized that the great trees were instrumental in maintaining soil humidity, promoting infiltration, and protecting the land from dessicating northerly winds.

Currently, the women volunteer their time. However they look forward to economic benefits from their woodlot and from a planned orchard. The women say they would like to be trained in nursery management techniques. They have already asked the prefect for four hectares in town on which to plant trees; and they have already begun to diversify their tree planting efforts.

General Discussion of the Initiative: Values can play a leading role in mobilizing populations for sound natural resource management, although successful interventions require that new knowledge and inputs be wedded to core values. The Women's Fire Brigade Committee of Bignona Senegal, located in an area of drought devastated Guinea Forest, provides an example of the leading role of values.

The main constraints faced by these women seem to be have to do with the contradictory goals of their supposed "encadreurs," the Canadian fire control project, which is uninterested in reforestation. Similarly the administration, and Forest Service officials seem mainly interested in the propaganda value of the Women's committee rather than addressing the women's goals. The women are frustrated by the lack of funding and would like to obtain help from an NGO or U.S.A.I.D.'s small enterprise development project for start-up capital.

Operation Haute Vallee Extension System

Basic Information

Location: The Third Region of Mali.

Major Characteristics of the Location: Gently accented, forested savannah terrain cross-cut with seasonal watercourses. Most soils are thin with a high sand and/or lateritic gravel content. Receives some 800-1000 mm of rainfall annually.

Area Affected: Several thousands.

Nature of the Initiative: In recent years, the OHV project in Mali's Third Region has successfully conducted grass roots training.

Description of the Initiative

Technical Measures Taken: Training occurs at three levels. Professional training of trainers (field agents) takes place at the Polytechnical Institute at Katibougou. The second level of training is directed at villagers. The project offers training in several forms. First, there is mass contact through the media. Second, intensive, small group training in a particular extension theme takes place. Villagers are trained by an agent in a set of techniques and training is timed to coincide with the appropriate moment for application. Finally, individual contacts between extension agents and farmers and village demonstration or model site plots are organized. Several technical "how to" course modules have been developed in response to observed needs.

Course modules include: soil conservation techniques -- small dikes, microcatchments, dams, contour planting, etc.; preparation and use of animal and other organic matter as fertilizer (compost pits and compost stables); planting density for crops; use of chemical fertilizers; alternative crop varieties and improved seeds; chemical pest control; improved adobe wood stoves; seed production and improved seed use; seed preservation and crop conservation. All of these courses have been taught in the field, and according to OHV representatives the spread effects have been substantial.

Social Organization of the Initiative: OHV staff then constantly monitor field agents to detect any insufficiencies in this training and to correct them. Training is especially effective when linked to development of organized village associations (*tonw* villageois). In small group training, six to fifteen village volunteers are recruited on the basis of their interest in a particular extension theme. Once perfected, village groups (*tonw*) apply the techniques in the field, and, if results are favorable, other villagers are likely to follow their lead.

Economic Incentive System: Dramatic differences in cotton yields between fields where the extended techniques were applied and ordinary fields have been observed by farmers. Savings of time and energy, and increased safety of improved stoves were mentioned by farmers.

General Discussion of the Initiative: Discussions with farmers allowed the team to see concrete results of training activities: dams, compost pits, improved stoves, and the like. Recognition of the importance of grassroots training is a major hurdle for many donor-funded initiatives and is the major success of the OHV program. Follow through is often neglected even in well-intentioned training programs. In the OHV area extension impacts are limited, and farmers are still suspicious of technician's honesty and diligence in processing credit and cotton marketing. On the

other hand, technicians often overestimate farmers' basic knowledge of inputs and markets, even as they underestimate their sophistication in evaluating technical proposals. By contrast, logistical problems associated with training and extension are more easily resolved.

CHAPTER 4
THE FINANCIAL VIABILITY OF SUCCESSFUL INITIATIVES

Introduction

This chapter summarizes the results of the financial analysis of twelve separate or combinations of natural resource management interventions. Only the basic elements of the approach and the results of the analyses are presented here. A complete discussion of the assumptions, methodology and issues is contained in the Financial Annex (Volume III) of this report.

The Problem

The problems with which this chapter is concerned are:

- *Does it make financial sense for the farmer to undertake the land improvement investments necessary to increase crop yields?* What would induce him to forego alternative uses of his time during the off-season, or to increase his workload during the peak season, in order, for example, to build contour ridges in his fields?

- *What should the appropriate role of the donor be?* Faced with the severity of desertification and resource degradation, it is clear that donors have ample opportunity to play a major role in helping smallholders make rational resource management decisions and in the implementation of those decisions. What is the appropriate level to which donors (and the public sector in general) should share the costs of natural resource investments with participant farmers?

Initiatives Analyzed

Six major intervention types, summarized in Table 4.1, are analyzed. They cover the three principal types of technical interventions the team observed: soil and water conservation, soil fertility improvement and agroforestry.

Table 4.1 Interventions Analyzed
Windbreaks *Acacia albida* Live fences Agricultural chemicals Organic fertilizer and compost Contour ridges

These interventions are analyzed both separately and in combination to test which management packages appear to be the most financially attractive. In total, 12 cases were treated, the results of which are presented in later sections of this chapter.

Methodology

A key premise underlies the approach to the financial analysis: that an initiative is financially successful if it provides sufficient incentive for farmers to continue implementation after "project" or other outside inputs have ended, and if it creates a demonstration effect which motivates other farmers to adopt the same techniques. *Any approach can be financially attractive to farmers if they are paid to do it.* For measures which have strong favorable impact on the environment but which do not offer sufficient financial reward by themselves, government may want to share costs and risks with farmers by making such payments. This chapter, and The Financial Annex, however, seek to discover which measures are financially attractive on their own terms.

The use of straight forward benefit-cost analysis assumes the availability of sufficient and reliable data. For small farmer initiatives, such data rarely exist, especially on the benefits side. For costs, we use the best available estimates of the inputs known to be required for the investment (labor time, seedlings, fertilizer, etc.). For benefits, the methodology uses a two-part approach, as shown below. A generic modeling framework has been developed, to allow each intervention to be analyzed separately or in combination with each other.

If the benefits (increases in crops yields) are not known, the results are expressed in terms of the minimum crop yield increases the farmer must obtain in order to recover his investment cost, based on the estimated value of his time. The framework allows comparison of estimates of the value of farmers' time during the off-season and during peak planting periods.

In cases where more quantitative information is available on benefits, or where benefits can reasonably be estimated, the results are expressed in terms of net present values (NPVs).

In this chapter, the results of the financial analyses are summarized for the general audience. Readers interested in the analytical details including methodology, assumptions on discount rates, crops, yields and prices, impacts of interventions on yield increases over time, timing and mixing of interventions, crop sequencing and associations and valuation of labor time in both peak and off-peak periods, should read Volume III.

Base Case Assumptions

Crop Yields With and Without Interventions

Without interventions, crop yields are assumed to decline over time from the multiple effects of erosion, nutrients lost and other degradation. Crop yields may decline at slower rates, remain constant, or even increase as different resource management interventions are applied, however. Two issues require particular attention:

Time to first impact: Contour ridges and chemical and organic fertilizers will help increase yields within the first season of application. Live fences, windbreaks, and, in particular, *Acacia albida*, will take several years to have an impact.

Duration of impact: By and large, soil and water conservation measures (contour dikes) will not result in sustained increases in yield, eventually being constrained by the available nutrients in the soil. Soil fertility improvement measures like *Acacia albida*, on the other hand, improve soil quality over the long run.

The balance of differences in timing have a significant impact on the financial returns to farmers (the two effects listed above tend to work in opposite directions), and are explained and presented graphically in the Financial Annex.

Risk

Risk is an important underlying factor affecting both farmer perceptions and the advisability of public support for given measures. Because the level of risk differs from one ecological zone to the next, however, it is not formally included in the modeling framework. Crop yields associated with the interventions are based on assumed average rainfall conditions. Although it would have been ideal to link yields to annual rainfall in the modeling framework, to do so would require rainfall data and crop yield measurements for several years. In Sahelian countries, such data is not available. Average rainfall conditions are

assumed because there is no real evidence to support that next year will be either above or below the average. This assumption is just as valid as a no rainfall or abundant rainfall assumption.

The impacts of low or high rainfall are manifest in crop yield differences. These impacts are expressed in the sensitivity analyses in terms of different, initial (1st year) yields than those assumed in Volume III. Under low rainfall conditions, the annual reduction in crop yields without any intervention is calculated on a lower base and the financial results change accordingly.

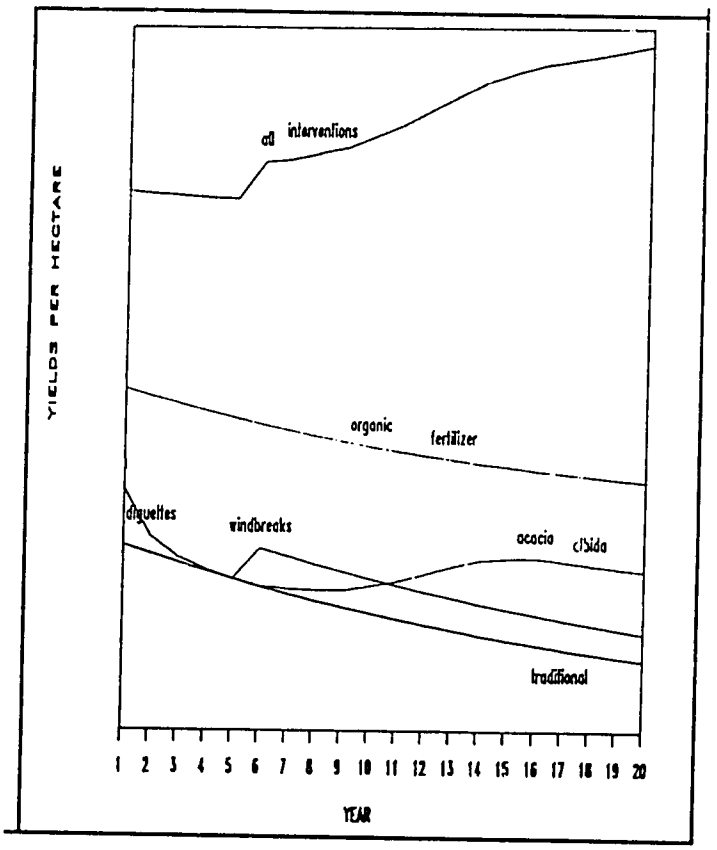
Risk is particularly important with respect to the results for chemical fertilizers. Where cash is not a constraint, chemical fertilizer can have a strong positive effect on crop yields and on financial returns. However, when rainfall is insufficient during the time of application, there is a high risk of crop damage or even total crop failure when chemical fertilizers are used. Because the low rainfall zones are also those where rainfall timing and levels are the most variable, chemical fertilizer carries an unacceptable level of risk in dry zones, despite a high apparent rate of return. In general, the results of the fiancial analysis are valid only in areas where the interventions pass the technical criteria for applicability in that zone.

Analysis and Results

Figure 4.1 shows the timing, level and duration of estimated yield increases for each intervention separately, and for major combinations of interventions. Four separate interventions and a combined case are portrayed: contour ridges, windbreaks, *Acacia albida*, organic fertilizer, and the combined intervention including windbreaks, contour ridges and organic fertilizer.

The separate intervention curves for contour ridges, windbreaks and organic fertilizer follow the same declining patterns as the traditional farming base case curve, but at a higher level. The *Acacia albida* curve exhibits a divergent pattern, as does the combined contour ridges, windbreak, and organic fertilizer intervention. The most significant observation that can be made is that all of the interventions buy the farmer additional time before the land has to return to fallow. Where the base case and intervention curves diverge, however, land productivity is improving over time, which means that the return to fallow can be postponed. This is a very significant environmental benefit since the pressure to clear additional land to replace recently fallowed land, may be lessened. Further, because of this reduced pressure, land land not in cultivation can remain in fallow longer, thereby restoring additional fertility to the soil. This land will be more productive when it is eventually brought back into production.

Figure 4.1
Impact of Interventions



Tables 4.2 and 4.3 summarize the financial results for each of the interventions considered separately and in combination. The results are based on the assumptions listed in Volume III. The results are expressed in terms of: breakeven crop yield increases in Table 4.2 and NPVs in Table 4.3. The breakeven yield increases are an average of the increases required over the assumed 20-year time horizon to pay off time and money investments incurred. The breakeven and NPVs results are mutually exclusive. The former uses cost information only to generate the breakeven results. The NPV results are based on sketchy and site specific information on benefits. It is emphasized that the results must be interpreted with caution. The information used to generate the assumptions is based on the limited observations by the Team and may not be sufficiently representative to draw conclusions for the entire region.

Table 4.2
Breakeven Results: Separate and Combined Interventions

Intervention	Kilos to Breakeven	Risk	Type of Impact	NRM Effect
Separate				
1 Windbreaks	18	L	M	C,P,B
2 Live Fences	7	L	M	C,P,B
3 Organic Fertilizer/Compost	28	M-H	S	C,F
4 Agricultural Chemicals	751	H	S	C,F
5 *A. albida*: Natural Regen.	7	L	L	C,F
6 Contour Ridges: New	114	L-M	S	C,F
7 Contour Ridges: Replace	26	L	S	C
Combined				
8 Windbreaks, Organic Fert. and Contour Ridges (Repl)	69	L-M	M	C,P,B,F
9 Windbreaks, Ag Chemicals and Contour Ridges (Repl)	792	M-H	M	C,P,B,F
10 Organic Fertilizer and Contour Ridges (Replace)	51	L-M	S	C,F
11 Contour Ridges (Replace) and *Acacia albida*	32	L	L	C,F,B
12 Windbreaks and Contour Ridges (Replace)	44	L	M	B,C,P

Note: Risk is defined on the basis of quantitative and judgemental factors. These include variations in rainfall, proper implementation, cost factors, etc., and the likelihood of obtaining negative NPVs. Where there is a possibility that crop yields will fall below traditional yields if the intervention fails, this possibility has been given high weight in determining risk level.
Legend for "Risk" column: L = Low, M = Medium, H = High
Legend for "Type of Impact" column: S = Short Term, M = Medium Term, L = Long Term
Legend for "NRM Effect" column: C = Soil and Water Conservation,
F = Fertility Improvement, P = Protection, B = Byproducts.
Only primary categories are listed (i.e., *A. albida* provide some by-products, but these are not major impacts of the interventions).

Table 4.3
Net Present Value Results
Separate and Combined Interventions

Interventions	Net Present Value
Separate	
1 Windbreaks	882
2 Live Fences	11,938
3 Organic Fertilizer/Compost	208,921
4 Agricultural Chemicals	37,495
5 *A. albida*: Natural Regen.	7,242
6 Contour Ridges: New	-120,481
7 Contour Ridges: Replace	3,821
Combined	
8 Windbreaks, Organic Fert. and Contour Ridges (Repl)	219,599
9 Windbreaks, Ag Chemicals and Contour Ridges (Repl)	48,173
10 Organic Fertilizer and Contour Ridges (Replace)	218,716
11 Contour Ridges (Replace) and *Acacia albida*	17,038
12 Windbreaks and Contour Ridges (Replace)	4,703

Note: Risk, duration of impact and NRM Effect are as in Table 4.2

Separate Interventions

Windbreaks. Positive, but relatively low rate of return compared to other interventions. Windbreaks will require an average increase in crop yields of 18 kilos/ha for the 20-year period to justify the farmer's investments of time and money. In addition to the increases in crop yields shown in Figure 4.1, windbreaks also provide some income potential from the sale of poles, fuelwood and other by-products. The intervention is rated low in risk (windbreaks will not directly cause crop yields to decline as can fertilizers under low rainfall conditions). The intervention has a medium term overall environmental impact.

Live fences. As with windbreaks, live fences bring positive returns and a low breakeven crop yield increase requirement. The intervention is ranked low in risk and has a medium term overall environmental impact. Some by-products (fuelwood and poles) are also probable. Under the assumptions used, fencing is necessary for the protection against livestock or wildlife. The primary benefits of a live fence include the time and resources saved by not having to collect brush and wood to construct and maintain dead fences. A secondary benefit is the increase in crop yields relative to unprotected fields, attributable to the fence. The rate of return on the live fence could be lower, or negative, if the fencing serves no protective purpose, due to the marginal effect on yield improvement and the years it takes before the fence becomes effective.

Organic fertilizer and compost. Given the assumptions, the organic fertilizer and compost intervention is very attractive. The NPV is high and the breakeven yield increase requirement is low. The intervention is ranked medium to high in risk, however, because the application of fertilizer without adequate rainfall during the application period may damage the crop. Further, the replicability of the intervention is limited to areas where land is relatively abundant and farming and livestock herding can co-exist with little land use competition.

Agricultural chemicals. Agricultural chemicals have a very high breakeven yield increase requirement and a low NPV compared to the organic fertilizer intervention. There are two limiting circumstances to this intervention: that farmers have access to cash or credit to purchase inputs (this will eliminate the majority of Sahelian farmers, except within large and well-organized project structures), and that rainfall be high enough to contain the risk of crop burnout after application of the chemical fertilizers. In sum, the intervention is limited in its applicability but attractive where appropriate.

Acacia albida. The *Acacia albida* intervention consists of the protection of naturally regenerated seedlings in the farmers' fields to increase the stocking density from a present average of 15 - 20 trees/ha to the optimal density of 50 - 60 trees/ha. The intervention is rated low in risk and provides long term economic and soil fertility benefits. Although positive, the NPV is low because of the relatively long time period (6 - 10 years) before the benefits (increased crop yields) of the farmer's investments begin to appear.

Contour ridges. The contour ridge intervention is treated as a special case. In view of the severity of the soil erosion problems in the majority of Sahelian countries, it is more of an either-or situation -- a farmer either does it or he loses his land. Also, it is important to note that many farmers, particularly in Mali's 5th Region, are already responding to to urgent needs to practice soil and water conservation by constructing their own versions of water catchments. This system improves crop yields and conserves the soils, but not nearly as much as can be accomplished with ridges constructed along the contour lines. For the farmers who have already invested their time and effort, the additional effort required will be to reconstruct the ridges along the contour lines. In such cases, the rocks will already have been mined, broken and transported to the fields. The only additional time will be to move them to a different location. The NPV for the replacement ridges is positive but low. For the new contour ridges, the NPV is negative because of the heavy time investments required.

The negative NPV, however, should not be interpreted to mean that new contour ridges should be discouraged. Where they are needed there may be extenuating circumstances that justify the investments of the farmers' time. Characteristic of the majority of Sahelian countries is that there are few alternative employment opportunities available. Farmers have no options left but to make the land improvement investments or lose the land to erosion altogether. Protecting this land assumes a much higher importance than can be explained by the financial results.

Interventions in Combination

Breakeven and NPV results for five different combinations of interventions are shown in Tables 4.2 and 4.3. The combinations that show the best financial return are not necessarily optimal technically. In particular, labor availability can be a constraint when more than one intervention is implemented. Selection of initiatives requiring complementary labor inputs (peak and off peak, low and high labor input, etc.), as well as those having complementary benefit streams (immediate yield increases and long term soil enrichment) is necessary to the

development of a viable management package for small farmers. Case 8 which combines windbreaks, organic fertilizer and contour ridges, is cited as particularly well-balanced from both points of view.

Windbreaks, organic fertilizer and contour ridges (Case 8). This combined intervention appears to be the most financially attractive to the farmers. The breakeven increase in crop yields of 69 kilos/ha/year for the 20-year period is relatively low. The farmer will probably enjoy a much higher crop yield increase. If the crop yield increase were known, the NPV/ha is nearly 220,000 F CFA/ha. This figure is higher than the total of the NPVs associated with the individual interventions because of the synergetic effect of combining several interventions.

Windbreaks, agricultural chemicals and contour ridges (Case 9). This combined intervention is the same as the previous one except that the organic fertilizer is replaced by purchased chemical fertilizer. This difference, however, entirely changes the financial attractiveness of the case. Because chemical fertilizer is bought with cash, the breakeven yield increase requirement rises dramatically, to 792 kgs./ha for the twenty year period, vs. the same intervention where organic (non-purchased) fertilizers are used. The intervention is rated medium to high in risk and is limited in its application in Sahelian countries.

Organic fertilizer and contour ridges (Case 10). The combination of organic fertilizer and replacement contour ridges will generate attractive financial returns where necessary conditions are present. The intervention is ranked low to medium in risk.

Contour ridges and Acacia albida (Case 11). This case combines the immediate benefits of soil and water conservation with the longer term potential for fertility improvement from *Acacia albida*. It is low in risk and has a positive -- but comparatively low -- NPV and crop yield increase requirements.

Windbreaks and contour ridges (Case 12). As with Acacia albida, windbreaks generate benefits only after several years. They also require most of the planting and weeding labor up front and some out-of-pocket cash outlay for the seedlings. Contour ridges are also labor intensive and require front-loaded inputs. Nevertheless, NPV is positive and the breakeven crop yield increase requirement is releatively low.

Regional Differences

The results of the financial analyses do not allow anything profound to be said about regional differences, or how the results will likely differ as the interventions are applied in different climate zones. One can hypothesize,

however, that interventions applied in the Sudano-Guinean zone will generally show more attractive results than if applied in the Sahelo-Sudanian zone. The one factor largely responsible for this difference is the higher rainfall level in the Sudano-Guinean zone.

Sensitivity Analysis

Sensitivity analyses were carried for the most financially attractive intervention -- Case 8 -- consisting of windbreaks, organic fertilizer and contour ridges. The following parameters were analyzed: discount rate, market prices, initial yields and the rate of soil depletion over time. The analysis consists of bracketing the base case assumption on either side by a maximum of plus or minus 50 percent (of the base case value) to reflect both pessimistic and optimistic scenarios. Only one parameter at a time was varied, with all others being held constant in a given sensitivity run. The results of the sensitivity analysis of Case 8 are presented in Table 4.4.

Table 4.4
Sensitivity Analysis: Combined Intervention Case 8

NET PRESENT VALUES (000 F CFA Rounded)							
Assumptions For Which Changes Are Made	**-50%**	**-25%**	**-10%**	**Base Case**	**+10%**	**+25%**	**+50%**
Discount Rate	378.8	281.9	241.5	219.6	200.9	177.6	148.2
Market Prices	191.2	205.4	213.9	219.6	225.3	233.8	248.0
Initial Yields	190.5	205.1	213.8	219.6	225.4	234.1	248.7
Yield Decline	261.9	239.5	227.2	219.6	212.3	201.9	186.1

The base case NPV for Case 8 is 219,600 CFA francs per hectare. The most sensitive of the four parameters tested is the discount rate. If the base case assumption of a real discount rate of 20 percent were increased to 30 percent, the NPV would drop to 148,200 CFA francs. The second most sensitive parameter was the rate of decline of crop yields in the absence of offsetting land and resource management investments.

For this "best case", it is encouraging to note that the initial positive result appears to be fairly robust. That is, even with variations of as much as 50 percent in either direction for four key paramaters, all of the resultant NPVs remain positive.

CHAPTER 5
PRINCIPAL FINDINGS OF THE ASSESSMENT

Introduction

The principal findings of this review of successful resource management efforts in Mali, Niger, Senegal and The Gambia are presented in this section. Out of the diversity of the field initiatives we visited, there emerges a picture of common elements in the ways in which successful interventions have managed the interplay of factors affecting the resource degradation cycle. Each finding, and the discussion which follows it, details one part of that picture. Taken together, these form the basis for specific recommendations for an A.I.D. natural resources strategy in the Sahel.

Findings

1. Intensive application of human energy has regenerated degraded land and created productive microenvironments

The Potential

The team saw widespread evidence of human energy applied intensively to regenerate degraded land and permit its productive use. Natural regeneration of *Acacia albida*, planting of windbreaks and use of water catchment dams are among the principal methods being applied to create "microenvironments" which are protected from the degradation of the general environment. Having been driven by necessity to invest in their land, a number of farmers have gone the next step to diversify their activities: vegetable gardens, woodlots, orchards and forage production have provided new fallback mechanisms and created opportunities for some cash income as well.

Angel Togo, a 55-year old middle income farmer near Biandagara in the Fifth Region of Mali, chose to plant eucalyptus as windbreaks to protect his eroding 5 hectare field, and to allow the natural regeneration of *Acacia albida*. After the success of his initial eucalyptus plantings, he has added over 3000 trees in the past five years. With the proceeds from the sale of poles (realized within three years), he dug a well and has planted fruits, vegetables and spices. From

this investment, based almost entirely on labor input, he has year round cash income to supplement his millet and sorghum, a diversified set of revenue sources largely immune to the vagaries of climate, higher grain yields and a standing volume of eucalyptus and other trees with a marketable capital value of between $16,000 and $23,000.

The A.I.D.-supported natural forest management project in Guesselbodi, Niger, provides an example on a larger scale. Through village cooperatives it has helped create, the project has supported soil conservation and management investments which have transformed 5,000 hectares of barren plateaux into income generating zones to supply grasses (for forage) and wood to urban markets. In each village the project has initially used paid village labor to upgrade the land through such measures as ridges to control erosion, planting of grasses and water catchments. It has then organized village cooperatives to manage the newly productive zones. The team visited villages in which this new opportunity provided sufficient revenue to pay full time workers from the village, and to generate a profit for the cooperative of $800 per year.

Issues Requiring Attention

The potential for positive resource management initiatives has been improved by the intensified smallholder, government and donor perceptions of the seriousness of the environmental crisis. In the most threatened zones, farmer receptivity to improved techniques is extremely high because crisis has sharpened the choices they face. Many now feel that traditional rainfed agriculture is no longer viable as currently practiced. Enough of the small scale, long term field efforts have borne fruit to provide a realistic menu of successful models on which to build. At the same time, national governments and the international community have, within the past twelve months, sharply increased their emphasis on natural resources. The renewed A.I.D. focus in this area coincides with a major increase in World Bank lending for environment and natural resources, and similar growth in the programs of France, Holland and the Scandinavian countries.

In each of the four countries, and in every region visited, the absence of land tenure rights stands as a major impediment to farmer initiative. In the changing context that underlies these cases, investment in the land raises the legal, social and economic stakes regarding property rights. The willingness to provide inputs of human energy and financial capital to improve the land is directly undercut if it is impossible, as it currently is, to have legal ownership of that land. The traditionally ambiguous systems of land tenure in the Sahel are a luxury which the rural economy can no longer afford. The successful initiatives we reviewed have either negotiated specific exemptions to existing resource tenure legislation, or have succeeded in spite of that legislation. Flexibility and multiple use remain a high priority, while clarification of rights and duties of local resource managers is required.

At the margin, some farmers are taking individual initiative, but the majority are not. There is a great shortage of specific technical skills among farmers and within the extension agencies which support them. A major effort will be required to improve the training of technical agents, to reorient the service traditions of forestry agents from policing to outreach, and to alleviate resource bottlenecks (lack of transport, seedlings, technical packages) which currently prevent extension agents from responding to farmers who are willing to take action. Outreach programs to sensitize smallholders to the benefits of resource conservation are limited and uneven in their coverage, and can be expanded, including through use of mass communications systems.

2. Successful "farmer-innovators" have provided powerful role models

The Potential

Throughout the region, the team observed a thirst for techniques and knowledge of ways to protect the land. Many useful techniques can be applied even within the technical and financial constraints of poor farmers. Rural innovators have served as role models, allowing others to see techniques at work and to understand how they can be implemented.

The innovators were similar to other smallholders in terms of socioeconomic status, and they were typically not outsiders or the most marginal who had the least to lose in breaking with tradition. Generally they were of the region, and respected members of the village or community. **The characteristic which most set them apart was exposure to new and different cultural influences, often combined with some previous access to cash income:** one had served and travelled in the French Army, one was a traditional mason, one was a part-time seller of handicrafts, one had been trained to read and write by missionaries and of one it was said simply by his fellow farmers, "he has travelled".

Their initial ventures were often treated with skepticism and sometimes ridicule by their neighbors, but their success has subsequently been copied by others. Successful gardeners in the river basins and water flows have been copied by thousands of small farmers. A farmer who planted eucalyptus has so far provided seedlings to 100 others in four surrounding villages who are planting eucalyptus as well. His immediate neighbors were seen to have trees which were already ten meters high.

Issues Requiring Attention

Discussions with donors and public officials revealed few mechanisms for relating to smallholders who succeed on their own initiative. Whether because

of the poverty of Sahelian Africa or the natural tendency of public assistance, **little public attention has been given to ways by which to capitalize on the limited successes which have occurred or to provide encouragement to farmer innovators.**

Many of the more thoughtful development projects in the Sahel have, in fact, replicated key elements of these "innovators'" success. An effective approach has been that of taking ordinary farmers from a project area to visit other farmers who have implemented new techniques. The CARE project in Koro (Mali), for example, took **fourteen** poor farmers, along with a limited number of extension and project personnel, to visit the established windbreaks in the Maggia Valley in Niger. Two years later, **ten** of the original fourteen **have successfully planted windbreaks,** and each has been **copied by several others in his own and other villages.** The Soil and Water Conservation Unit in The Gambia has successfully applied this extension technique as well.

The approach of taking groups of farmers to visit successful models has yielded a number of secondary educational benefits, and compares favorably with the cost of bringing in a team of outside specialists to convince the same farmers to implement techniques they have not observed. We observed several other successful actions aimed at increasing awareness of natural resource issues. A children's magazine published in the inner delta region of Mali, has helped preserve methods and knowledge otherwise being lost by the younger generation. National publicity campaigns, use of mass media and organization of village councils and women's groups have shown returns in several programs. The impact of such efforts may be hard to measure relative to the criteria to which most project designs are subject. However, we saw several cases in which they contributed to achieving widespread participation at relatively low cost.

3. Public policy changes have increased incentives for more rational natural resource management by small farmers

The Potential

The team found several programs in which policy measures have been vital to success. Central to the success of the Guesselbodi project has been the empowerment of village cooperatives to manage local resources (within the limits of government established management plan) and the exemption from taxation as commercial enterprises. Income generation potential through the cooperatives has mobilized village participation. Throughout the Fifth Region of Mali, U.S.A.I.D. has negotiated a suspension of fines by forestry agents in the project areas of the Village Reforestation Project. The policing role of forestry agents, often accompanied by abusive fining for their own profit, has engendered mistrust of both the agents and their messages. Removal of this role has increased villagers' receptivity to the extension services and provided a more constructive vehicle through which to obtain much needed technical support.

In a few cases, political support and commitment have had dramatic results. The attempt to spread the use of more efficient earthen woodstoves in Mali eventually achieved success because of years of field extension and training, mobilization of local organizations, national publicity campaigns, and direct political mobilization through the Party, including passage of a law which requires all households to use improved stoves. The first two mechanisms have been in place for many years. National publicity, political mobilization and passage of the law appeared to have pushed the effort over the top. In every village we visited in Mali, a majority of households were using improved earthen stoves. A similar example of large-scale participated through political mobilization is provided by the Keita project in Niger, where over 50% of farmers in the entire arrondissement have adopted new resource management techniques under the direction of an energetic and committed regional governor.

Issues Requiring Attention

Conflict resolution as a public role will take on increasing importance in coming years, but remains under emphasized and under funded. As the environmental crisis in the Sahel has worsened, so have the potential conflicts between competing interests: between farmers and herders, between agriculture and the wildlife driven from their natural habitats and now threatening dwindling agricultural outputs; among producers for access to fertile lands. The primary output of the IUCN project in the areas around Youvarou (Mali) is to work with fisherman, farmers and herders to determine sustainable and equitable means of **allocating the scarce water resources and land rights** in the complex ecosystems of the inner delta. Legislation currently on the books was written in colonial times and freezes relations on an inadequate understanding of local resource management needs and practices. A development project in Senegal is working with villages established inside a national wildlife park. The project has recognized that villagers are **competing for the same land resources as the wildlife**, and that generalized rules on wildlife protection will be inadequate unless the villagers find **new economic opportunities** which relieve the pressure on the surrounding land.

The single most important public policy issue we saw was that of **resource tenure.** By law, land tenure is ill-defined in all four countries. Farmers enjoy use rights only, within the bounds of traditionally-defined land use practices governed either at the village or district levels. Legal title to the land resides in the public domain, in practice the State, and there is no formal protection to landholding. Environmental crisis has created the **need** to invest in private land to protect it from degradation. Insecurity of tenure **has reduced the incentive** to make such investments. Heightened conflict for resources has further reduced

the security of tenure for smallholders. Finally, as communal organization is overlaid with more impersonal structures, the system of vaguely-defined rights increasingly lends itself to **abuse** by those with access to the levers of authority.

Lack of land tenure was a constraint to replication of successful initiatives in every country visited. In interviews with farmers, field workers and project staff, the issue arose repeatedly. Some projects have obtained exemptions to land tenure and other legislation, but these remain local in their coverage and impact. Successful projects have often taken place despite the negative impacts of current laws, but even here there is clear evidence of land tenure being a constraint to further replication. We saw several cases where successful initiatives have increased the perceived value of the land, making it more difficult for future farmers to gain similar land access rights (see Box)

INFORMAL LAND TENURE RULES INVITE ABUSE
A small garden just outside Djene (Mali) was established 18 months ago on a highly degraded and unused two hectare plot. The farmer who established it received permission to use the land from local authorities. Seeing his success, another farmer had applied for access to the adjacent plot, also unused and degraded. The potential value of the land having been shown, the second farmer has had much more difficulty in getting permission than the first. Three other farmers have similar applications before local authorities. As the perceived stakes get higher, even the first farmer, who has dug three wells, built a fence and a shed and has planted a wide variety of garden crops, trees and some grain, is not assured of the future use of his plot.

As potential conflicts for natural resources become more acute, land tenure is likely to take on increasing importance as a **constraint** to the massive popular participation that will be required to stabilize the Sahelian environment. A number of specific issues will also have particular localized importance, and will require local solutions which even a reform of national legislation will be insufficient to address. Foremost among these are the competing rights of herders and farmers in transhumant zones.

Resource tenure is a complex socioeconomic and legal issue which is an inseparable part of how Sahelian societies are organized. It would be an oversimplification to assume that there is a single, known solution to this problem -- such as through adoption of Western-style individual property rights, for example. Nevertheless, as the rural production context in the Sahel continues to change, clarification of local resource management rights (including tree tenure in Mali and Niger) may be a necessary precursor to increased decentralization and local participation.

The effort at environmental stabilization faces, at best, a very difficult path. Failure to address **legislative obstacles to private initiative can raise the cost and lower the success rate** of all future natural resource management efforts in the region.

4. Successful resource management initiatives have improved the climate for subsequent efforts

The Potential

Successful resource management activities improve the climate for future initiatives, even when they do not directly achieve the ultimate objectives desired. It was observed that when farmers were induced to try one natural resource activity which brought immediate benefits, they often tried other natural resource activities as well. The initial activity may have had limited value for overall management of natural resources, but it nevertheless was sufficiently attractive to bring about farmer participation, and therefore to contribute to long term development. This important lesson has often been ignored in natural resource strategies in the Sahel.

In high water table areas of all four countries, the initial natural resources management activity for many farmers has been the planting of Eucalyptus, which has a long, straight trunk ideal for sale as construction poles. However, beyond some impact on soil retention (especially when planted in windbreaks), eucalyptus has few beneficial effects on erosion control, soil enrichment or general environmental protection, and, as with any tree, the potential competition for groundwater must be weighed whenever they are planted close to crops. From a farmer standpoint, however, Eucalyptus has frequently provided a source of cash (typically between $3 and $5 per three year old tree) and a capital reserve of standing trees which can be harvested and sold when crops fail. Access to this "capital reserve" has allowed many small farmers more freedom to try soil protection measures which they view as intrinsically more risky because they directly affect their agricultural plots. We saw several examples of farmers who have followed successful Eucalyptus plantings with natural regeneration of *Acacia albida*, with neem planted as windbreaks, with contour dikes and with living hedges. Other examples of "leader" technologies include fruit tree orchards.

Issues Requiring Attention

Environmental benefits of different initiatives must be judged in terms of their microeconomic (direct) impacts, *and* in terms of their effect in relieving pressure on the overall environment.

For example, contour dikes involve constructing small ridges (8-12 inches high) along the contour lines which follow a field's slope. Their primary benefit is to reduce the runoff of rainwater and therefore reduce the loss of topsoil and improve water infiltration. The financial (microeconomic) analysis of contour dikes shows that they have a high rate of return for farmers because they are low cost, easy to implement, require labor input primarily during non-peak periods and can directly increase crop yields within the first season of their application. However, more detailed analysis reveals that they do not directly improve soil fertility. By better retention of soil and water, they merely **slow the rate** at which soil quality declines through successive farming seasons. Eventually, soil fertility does decline. Nevertheless, the "macro" impact of contour dikes is to extend the time a given plot can be farmed, thereby **lengthening the fallow** and directly contributing to improved soil quality on fallow lands.

The CMDT (Compagnie Malienne de Developpement des Textiles) Project in Mali provides a striking example of the need to assess activities in a broad and interrelated context. This huge effort, which encompasses a population of 30,000 people on 130,000 hectares, supports the production of cotton in the relatively fertile 3rd Region. The policy decision to maintain high producer prices during the slump in international markets (the CMDT went into debt to do this) contributed greatly to maintaining farmer participation during a critical project establishment period. As prices have recovered, inputs of fertilizer, technical assistance, agricultural tools and improved methods have greatly increased average household income. Ninety-five percent of the households in the CMDT area now own animal-traction ploughs. More interesting, however, is that the improved techniques and "mastery of resources" permitted through the cash incomes generated from cotton production have had a spillover effect on traditional grains. **Average per capita grain production** (primarily of sorghum and millet) **has risen** in step, even as, in terms of percentage of income, farmers have become more dependent on the sometimes fickle international market.

5. Successful natural resources initiatives involved both technical interventions and socioeconomic incentives

The Potential

Success as we have seen it in 75 interventions cannot be attributed to technical methods alone. The right socioeconomic incentives have allowed marginal techniques to succeed, and their absence has caused excellent technical approaches to fail. This point emerges repeatedly from field observation, is written about in evaluation reports, but is **repeatedly lost in the next round of project designs.** Communal woodlots have floundered throughout the Sahel, even though we have seen private farmers on adjacent plots of land with thriving private tree plantings producing marketable poles and fruit. After 15 years of intense effort, mud stoves in Mali, Niger, Senegal and The Gambia had

negligible rates of adoption. When combined with the right mix of sociopolitical mobilization and local economic intermediaries, the same efforts have led, within the last twenty-four months, to adoption by an estimated 60% or more of the population in the regions of Mali we visited.

We saw no "blockbuster" solutions which, if replicated ten thousand fold, would stabilize the Sahelian environment. However, there are actions which could have extremely positive global impacts: reform of the land tenure system, improved cooking efficiency and, in general, better soil and water management techniques have almost universal applicability. **No single approach is likely to be sufficient, and the pattern of adoption of these and other initiatives will follow local incentives rather than global priorities.**

As regards specific technical interventions (e.g. windbreaks, *Acacia albida*, contour dikes, living hedges, etc.), all have a useful role to play and ecological conditions within the Sahel are too diverse to select one as the "best of the best". The diversity of ecosystems in the Sahel argues for a range of options which permit populations to select those which meet their perceived needs.

Issues Requiring Attention

For smallholders closest to the margins of subsistence, risk minimization is one of the important lessons learned for survival. As we have seen in the previous section, **the rational first choice in resource management options for such farmers will not always be the measure which maximizes long term returns. Rather, it may be one which increases the short term margins for risk taking.** Which options best serve this purpose will depend on not just the specific local conditions, but also on the personal choices that household faces (age, number of dependents, personal experience, health, reserves of gain and cash, success or failure of last year's crop, cash support from relatives in urban areas or overseas, etc.). The different options facing women and men are particularly important in this respect, as they have different resource allocation rights and labor burdens. Offering and demonstrating a range of viable options increases the "surface area" through which technology transfer can occur.

Combinations of approaches may be more financially attractive and environmentally sound than focussing on a single approach. For example, *Acacia albida*, which has positive effects on soil fertility and retention, and on long term agricultural yields, is limited in its short term financial appeal. The eight years or more which it takes to realize benefits is often too long to motivate subsistence farmers, and heightens the risk of failure. Contour dikes, as we have seen, have a short term return which trails off after several years. The combination of the two increases immediate yields, allows a near term margin for setting aside a percentage of land area for *Acacia albida* and increases the

financial return above that for either intervention alone. Environmentally, it constitutes both improved management of available resources and enhancement of the resource base itself.

Determination of success or a failure may take ten years or more. **Strategies which have steadfastly pursued a limited set of options which were considered "best", whether or not they are ultimately successful, lose valuable time in discovering the full set of options which might attract participation.** As with central planning, the gain in rationality may be at the expense of the myriad of creative adaptation and compromises with reality which often yield solutions which are cheaper, easier and more attractive, and which may solve problems that the current wave of planners did not even know existed. The A.I.D.-supported project at Guesselbodi began eight years ago with very different objectives from those it has today. **An excellent mid-term evaluation recognized that the original objectives were secondary to the new opportunities the field work had created.** The project focus shifted to local participation through village cooperatives which generate income from land management. The grasses sold as fodder, which now account half the revenues of village cooperatives, were not even part of the original project plans.

The basic cleavage between public and private motivation will continue to require multiple and flexible approaches to resource stabilization in the Sahel. Beyond policy reform and means of fostering private initiative, public attention will also have to be focussed on a series of location-specific measures. For example, maintaining biological diversity is a public contribution to future economic viability. Approaches will vary according to the plant and animal species at risk and the solutions to the specific resource conflicts between Man and Environment which threaten them. In many cases, environmental degradation intensified by resource competition between populations may have to be addressed more by creating new patterns of economic activity than by improving resource management techniques, *per se*.

6. Sustainable initiatives which provide immediate benefits have brought about smallholder participation

The Potential

The public responsibility in the Sahel is to bring about stabilization of the environmental base for rural production systems. However, to achieve any meaningful global impact, actions to be taken by smallholders must offer **sufficient incentive to mobilize widespread participation.** But given the severe constraints on public resources, the **recurrent budgetary costs of providing incentives must be low enough that government can afford to replicate them widely.** Within these two boundaries lies the range of realistic participatory measures for protecting the resource base of the Sahel.

Issues Requiring Attention

Providing immediate benefits

We saw several successful approaches to eliciting smallholder participation. **The diversity of approaches** merits analysis. We discuss four case examples below, in order to detail issues which apply to the full range of approaches observed. In all four cases, **success has come from assuring financial benefits to participants.** In each, there is reason to believe that if the same conditions were replicated, there would be equal incentive for future smallholders to participate.

In the IDA (International Development Agency of the World Bank) project in Damana, Niger, project and extension personnel **work closely and for extended periods with entire village communities** to sensitize them to the benefits of improved resource management. The **trigger mechanism for participation has been the offer of project investments for desired village infrastructure.** In return, specific tree planting, soil conservation, water retention or other actions are to be undertaken by village labor. The project has been successful in bringing about the village effort it seeks, but at relatively high cost. The project, for example, responded to a village's desire to dig a well for drinking water (water table: approximately 60 meters), at a cost of 2 million CFA francs ($8,000). The project judges its own success in terms of village development as a whole, and not just by numbers of trees planted, contours dug, etc. Nevertheless, it would be slow and expensive to replicate this approach on a large scale. The valuable linkage the project creates is between local development and infrastructure and improved resource management.

The UNSO *Acacia* Project in Dosso takes an entirely different approach. It encompasses research, extension and diversification, but focuses on one primary outcome: to encourage the natural regeneration of *Acacia albida*. To do this, **it uses one principal incentive: direct cash payment** for each tree protected. The results have been striking. In five years, 386,000 trees have been protected. In effect, the project "buys" farmer participation in the short run, until such time as farmers begin to benefit from the long run improvements in crop yield.

The Church World Services (CWS) project in Senegal has relied instead on promoting approaches which are in the farmers financial interest, and supporting adoption with sensitization, training and technical information. While it appeals equally to the financial self-interest of smallholders, the project **has not resorted to subsidies or direct payment in cash or in kind.**

Finally, U.S.A.I.D.'s FLUP Project in Guesselbodi, Niger, uses a **more subtle interplay of incentives.** With project resources, village labor is paid to undertake soil improvement, water retention and forest management activities. When an area is brought under management, a village cooperative is formed to harvest grasses and firewood from the managed land. These are sold to meet demand in the Niamey area. **The offer of employment brings initial participation, and proceeds from the sales allow cooperatives to continue to employ village labor as well as to realize an annual profit** for the village. In the initial 5,000 hectare application, this approach has required a great deal of project and extension time, but these are expected to decrease sharply in future applications, now that the approach itself has been refined.

Sustainable budgetary burdens

The issue of budgetary sustainability is more complex. The CWS project provides no subsidies, but the tradeoff is a **greater input of scarce (and relatively expensive) project and extension support.** A second tradeoff involves the **higher failure rate and longer time lags** which can be expected in projects which promote participation vs. those which just buy it. It is possible that, purely in terms of cost per unit, the UNSO approach of "buying" participation is the most affordable.

In the CRS, IDA and UNSO project approaches, there is an important development risk. **"Buying" participation in resource management, however effective the results, fosters, sustains and reinforces the impression that better resource management is in "someone else's" interest, and must therefore be paid for.** The demonstration effect of this message may raise the future cost of resource management initiatives by these as well as other projects in the surrounding areas. The Guesselbodi approach addresses this difficult problem by limiting its subsidy to the startup phase, after which village (cooperative) initiative responds to market incentives.

All of the approaches, except CWS and, to some extent, Guesselbodi, face a substantial hurdle if widely applied. They each involve movements of cash from central to private hands. With every further application, opportunities for abuse will proliferate. Experience has shown that such abuse can rapidly overwhelm expected gains.

Even with these caveats, we do not simply dismiss approaches which buy participation in the short run. First, **the discrepancy between individual and social rates of return for resource protection may, in fact, warrant some initial subsidy.** Second, our findings suggest that poor farmers are very receptive to improved resource management, but often **lack the technical knowledge and "breathing space" -- margins of survival -- to adopt them.** If cash or other incentives provide the necessary margins for technology adoption, they may be consistent with a more general process of development. Certainly, if the Dosso

success were replicated a hundred-fold, the future climate for resource protection measures would be materially altered for the better, despite the other limitations of this approach.

Each of the above approaches can be adapted to reduce disadvantages and capitalize on what is most useful about them. **Their common characteristics are that they have stressed immediate benefits and have succeeded in achieving participation on the scale they sought.** They are, from this standpoint, replicable. Evaluation of their potential positive or negative developmental impacts deserves greater detail than the limits of this report permit. Whether or not they are budgetarily sustainable depends on what resources national governments and the donor community make available. Three of the four approaches appear to hold promise in this regard.

Excluded from discussion in this section are actions which have been privately initiated, usually in response to market incentives or, less frequently, to perceived benefits in terms of labor savings, increased yields or risk reduction. **Such efforts are obviously the best of both worlds: their very existence testifies to the sufficiency of incentives, and they place no budgetary burden on the public sector. But their replication is not automatic.** All poor farmers are not equally willing, nor do they have the same margins, to take risks. Moreover, they do not all have the same physical resources or market incentives to work with.

7 It will take twenty years or more before impacts from successful programs become visible on a large scale

The Potential

We found that in the most striking successes visited, positive changes which ultimately contributed to success were taking place long before the success itself became visible. The Mali stoves program, the Guesselbodi effort and the Maggia Valley Windbreaks might all have been judged failures if evaluated a few years ago. In each of these cases, years of sometimes frustrating field efforts paid off "in a spurt" after a long lead time.

Long-term commitment, the willingness to learn from mistakes and try new approaches, and the flexibility to adapt goals to new opportunities as they arise were important contributors to success

Issues Requiring Attention

Individual technologies, such as contour dikes, eucalyptus planting and others, can and have provided benefits to farmers in a relatively short time. The

obstacle, however, is more the time needed to bring about participation than the time needed to realize benefits once a technology has been implemented. It is this human (rather than technological) dimension which takes time.

Many successful projects devoted several years to building trust relationships with local populations. Adaptation of technologies and of the the incentive systems to spread them has often been a slow process. The economic circumstances of rural populations has changed rapidly, and continues to evolve. Even in the most isolated initiatives we visited, no farmers faced a purely traditional and fixed set of socioeconomic influences. Understanding these changes and moving with them over time has been important to many of the most successful efforts we saw.

Where multisectoral and complex strategies are being pursued (such as in the CMDT in Mali), time requirements have increased because of the need to properly sequence components of a coordinated effort.

All donors, field project representatives and extension and government representatives with whom we spoke expressed the strong view that the minimum time horizon for natural resources management efforts in the Sahel was twenty years.

8 Providing increased economic opportunity to local populations has played an important role in successful efforts to maintain biological diversity

The Potential

Increased pressure on the resource base has forced many smallholders to tradeoff future environmental stability for immediate financial gains. The clash of conflicting interests is implicit in this tradeoff at several levels: between human populations and wildlife; between competing resource uses (agriculture, herding, fishing); between this generation's survival and the next generation's economic potential; between individual and social self-interests. **Relieving local economic pressure and creating new income-generation opportunities, though slow and arduous, has had greater success than the attempt to simply protect resources which local populations have little choice but to exploit.**

Issues Requiring Attention

Biological diversity is threatened by the action of local populations and compounded by periodic climatic crises. Even where rural populations have the desire to maintain biodiversity, they often have little immediate financial incentive to do so. A wide range of cases has established that it is extremely difficult for governments to prevent encroachment on protected areas unless the surrounding populations are given a positive stake in their preservation. Unlike

smallholder productivity improvement measures, the primary impetus for biodiversity is likely to come from the public sector. We found that the level of commitment to biodiversity was greatest for those farthest from localized struggles -- that is, for those at sufficient distance to see the "big picture".

Because local economic and environmental pressures necessarily vary from one location to another, alleviating them may require relatively long lead times and patient work at the "micro" level, as in the IUCN project in the Inner Delta region of Mali. There are a number of zones in which tourist development can provide income generation opportunities which can successfully compete with the short term need to mine resources. Indeed, several wildlife and environmental groups throughout the world are actively promoting such approaches. In particular, successful model approaches can be drawn from the more developed tourism development efforts in East Africa. As the examples from East Africa also establish, however, active protection may also be necessary as part of a combined management approach.

Given the long term nature of the effort, environmental education can contribute to increasing the understanding -- especially among children -- of the importance of environmental protection and of the potential solutions to resource competition conflicts. The success of the children's magazine *Walia* (Mali) suggests that expanded publicity campaigns -- including through radio, television and videotapes -- may be a sound long term investment.

Conclusions

From the major findings of the assessment, and from the themes which recur across the initiatives we observed, we have drawn the following strategy guidelines:

- Provide clear, consistent policy signals on resource tenure, local management rights, national political support and mobilization, prices and access to credit. National policy reform should be supported by coordinated donor positions.

- Focus on incentives for local participation. Assure that options provide adequate short term return until long term benefits come on stream. Offer a range of technical and socioeconomic options and allow for flexibility and adaptation in implementing projects.

- Greatly increase emphasis on local training and mass sensitization. Farmers are receptive to resource management knowledge, but rural extension organizations are hampered by inadequate skills and information. Local trainers and intermediaries are more efficient and cheaper than outside agents.

- Build on the success of local models. Policies for encouraging successful smallholders need to be strengthened. "Model farmers" and resource managers provide strong and positive demonstration effects. The ability of successful farmers and resource managers to create employment for the poorest rural dwellers should not be ignored.

- Assure a stable long term commitment to the natural resources sector. The learning curve may involve long lead times. The rural economy is changing rapidly, and short-cycle projects fail to capitalize on those changes. Abandoned projects have a negative demonstration effect.

CHAPTER 6
PRIORITIES FOR A NATURAL RESOURCE STRATEGY

6 Priorities

Introduction

There is a sufficient range of technically proven and economically attractive natural resource interventions available to halt the decline of rural production systems in the Sahel. Better technological packages can and should be developed, but technology is not now the limiting factor in improving small farmer productivity through natural resources management.

The greater development challenge is to bring about widespread adoption of the appropriate technologies. This is a human issue which has economic, institutional and policy dimensions.

Technical packages which are also financially attractive increase the rate of adoption, provide positive demonstration effects and do not limit replication to the constraints of public sector institutional or budgetary capacity.

Donors and the public sector will have an important role to play in training and outreach to make viable approaches available to smallholders; in providing technical assistance during initial phases; and in cost-sharing where direct benefits are insufficient to bring about participation, but where high environmental benefits warrant priority allocation of limited public budgets.

In this final chapter, we recommend the principal options for a natural resources management strategy in the four countries. Unlike earlier sections of the report, this chapter no longer draws exclusively on what we observed during the field review. Instead, we integrate the lessons from the assessment with a more general understanding of resource management issues and constraints in the Sahel. The concluding portion of this chapter suggests priorities for A.I.D. support.

A Contract With Sahelian Populations

The interventions reviewed in this assessment give hope that natural resource management efforts can succeed, and provide useful insights on what strategies have worked. But arresting the decline of the rural production base in

the Sahel will take concerted action over the next generation, built on a long term contract between Sahelian populations, national governments and the international donor community. Each party to the contract must share the costs of resource management in defined ways. Sahelian populations will bear the major part of these costs, both in terms of successful investment in the land and in terms of human suffering when efforts fail. **For the public sector (both national and donor), it is far cheaper, even in budgetary terms, to share the cost of success than to remedy the effects of failure.**

The concept of a contract underscores the need for stable, long-term and collaborative effort. Based on the initiatives observed during this assessment, we do not believe that environmental degradation *per se* will necessarily be reversed. Indeed, it may be unlikely that it can be arrested even at the present level, although the technology to do so exists. Therefore, before proposing a long term strategy, it is useful to state explicitly what a successful strategy can achieve.

Ultimately, we define success in human, rather than biophysical, terms. We have seen successful examples of a process in which human energy is applied to specific parcels of land in order to protect or enhance the production base, even as (and sometimes *because*) the general environment continues to degrade. Protection of the rural production base directly affects the priority concern of rural populations and therefore offers the greatest opportunity for success. Intensified management of farmland, as we have seen, also decreases pressure on the rest of the environment over time.

Opportunities for a Natural Resources Strategy

Concerted action will be required on four fronts: biophysical, economic, institutional and policy. The main opportunities for action in each area are summarized below.

Biophysical

The Goal

The biophysical goal is to establish management systems through which natural capital is protected and is capable of supporting the needs of the rural economy. Actions will be required in soil fertility improvement, soil and water conservation and protection of vegetation.

The two facets of actions on the biophysical front may be carried out concurrently or in sequence: spread of existing technologies, and long term improvement of technologies and germ plasm which will increase the productive potential of the natural resource base. Of these, the more urgent need is to

spread existing technologies, which are already sufficient for immediate needs. Research and field testing of improved methods will take time, and can usefully begin even while major efforts are underway to disseminate existing methods.

The Opportunities

The principal measures recommended for inclusion in the "menu" of options are shown in the following table. Each measure has been been successful in the field, passes the criteria for defining success set forth in Chapter 2, and can be combined in technical packages which meet the criterion of financial attractiveness (Chapter 4) to small farmers.

Measure	Where Seen
Nutrient cycling by plants - primarily woody perennials	All regions
Nutrient cycling by animals	All regions
Application of mineral fertilizers	Higher rainfall zones
Microbially-mediated nitrogen-fixation	Areas where annual or perennial legumes growing
On-farm contour dikes	Higher rainfall zones
Microcatchment basins	Low rainfall zones
Brush litter	All zones
Check dams	All zones
Windbreaks	All zones
Living Hedges	All zones, but especially higher rainfall zones
Salt intrusion dams	Coastal areas and river basins
Dune stabilization	Low rainfall zones
Maintaining Biodiversity	Designated areas, all zones

Economic

The Goal

The economic goal is to increase opportunities for income generation through sound natural resource management practices, and to capitalize on changes in the socioeconomic context which can create new opportunities for natural resource management.

The Opportunities

Four areas of opportunity are recommended:

Markets and cash income. Deployment of the above technologies will be influenced by available markets for commodities produced. Where rural production is marketed for cash (cotton, ground nuts) there will be increased opportunities for farmers to *purchase* inputs of improved seeds, mineral fertilizers and pesticides. Market for such non-agricultural products as construction poles can generate income, reduce dependence on rainfall variations and pave the way for further resource management activities. Where rural producers depend on subsistence non-cash crops (millet, sorghum, etc.), labor time will be the principal input available to them, and cost-sharing may be the best available public sector option for providing limited purchased inputs such as seedlings.

Cost sharing. The majority of farmers in Mali, Niger, Senegal and The Gambia have little cash income with which to purchase inputs, and only have the financial incentive (realized through increased yields and not necessarily through increased cash) to undertake measures which provide some immediate benefit. While measures like contour dikes and *Acacia albida* can be packaged to combine both short term and long term benefits, we have found that the rate of adoption is directly influenced by the level of short term benefits. For these farmers, it is appropriate for the public sector to *share the costs* of initiatives where the economic rate of return exceeds the financial rate of return.

In the first instance, the gap between the two (economic minus financial rates of return) provides a measure of the level of public cost sharing which would be justified. However, it is important to recognize that the public cost of failing to bring about improved resource management is generally much higher than that gap: food relief, urban underemployment, additional health care needs, balance of payments deficits and "development foregone" - all partially results of the decline of rural production systems - cost much more after the fact than the potential public share of improved on-farm resource management.

Risk sharing. A long-term perspective - necessary to the major effort required - must entail recognition of the risks inherent in undertaking improved resource management at the rural level. Not all initiatives will succeed, either because they are not properly implemented, or are not adapted to local needs or because external institutional, climatic or economic factors otherwise prevent success. Direct cost sharing (such as the UNSO *Acacia albida* project in Dosso) will reduce farmer risks, but will not be appropriate or institutionally feasible in every situation, at least partially because it skews rather than improves rational resource allocation decisions at the farm level and encourages dependence on outside programs. In general, the public and private sectors must share the risks on a long term basis. Like in an insurance program, we can determine with reasonable confidence that the insurer (public sector) will profit from the overall program even though individual efforts will fail. In the same way, the insured farmers can best take risks when they know they are protected against the most catastrophic consequences.

We believe that one of the most important risk-sharing measure which the public sector can provide in the next ten years is the provision of *credit.* Access to small-farmer credit in the Sahel is limited and very uneven. Many farmers do not have the means of repaying credit even if they could use it successfully: that is, improved production may not generate the cash needed for loan repayment. Rural taxation systems (often on a fixed number of francs per person per year basis) draw on the same limited cash resources which might finance investment inputs or loan repayment. National government budgets are limited in their capacity to finance rural credit. With donor assistance, credit programs can be expanded, with loan repayment adjusted to both the size and timing of benefits realized. There are many developing country examples of successful rural credit programs, including revolving funds, combined with training and extension, which can be used as models. Within the four countries addressed in this study, the credit programs of the Compagnie Malienne de Developpement de Textiles and the use of paid village labor as a form of initial credit in Guesselbodi, provide two successful examples.

Institutional

The Goal

To bring about those institutional changes which are necessary to encourage and support *widespread* adoption of available technologies. Institutio-

al capacity has been and will continue to be the most difficult constraint to resolve, and should be recognized as such. There are, however, opportunities to improve the ways in which the institutional challenge is tackled.

The Opportunities

Implementation of improved natural resource practices on the scale required to halt degradation in the Sahel, and within the time frames necessary to avert human disaster, is above all a management problem. To date, the effort has been mismanaged. In particular, two management principles have been neglected:

Commitment of resources. Commitments of financial and human resources by donors and host governments have fluctuated, have been unevenly distributed by priority and have been tied to individual and short term pieces of the effort but not to the success of the long term strategy. Rationalization of this process (honoring the *contract* with Sahelian populations) will increase the chances of success.

Phasing of tasks. The environmental problem in the Sahel cannot simply be managed as though it were a project to be implemented: the social and economic dynamics are complex and cannot be centrally planned. Nevertheless, some pieces must be in place before others can be undertaken. The relationship between timing needs of various efforts, if better articulated, can help in defining short, medium and long term priorities for public action.

These management issues underpin the institutional development needs to be met. Each need is discussed below in the context of its relationship to the others and to the overall effort.

Training and skills transfer will be necessary at the local level. Rural organizations such as village councils, women's groups, cooperatives and field NGOs can provide especially useful intermediation and support to small farmers. Investments in training at this level tends to pay off in other development fields in addition to the area for which training occurs.

In many parts of the region, field extension agents themselves need more training and information about natural resources management in order to provide sound advice to farmers. Forestry agents, in particular, tend to be trained in the narrow aspects of tree growing, and in protection (policing and imposition on fines for illegal cutting) of forested areas, but not in the integration of trees and shrubs into the agricultural system for productivity increases.

Training and skills transfer to field intermediaries takes time: for the training itself and for skills to mature with experience. Absence of such intermediaries at the local level can become an important constraint to spreading farmer participation, and should be begun in advance of major efforts to disseminate technologies.

Upgrading organizational capacity: Government ministries and services involved in natural resource management lack the organizational capacity to manage vastly expanded programs. Management skills are particularly deficient at the mid(program management) levels. Expatriate project technical assistance has tended to fill this gap in the short run, but is not a budgetarily sustainable solution if efforts are to be expanded. To some extent, reliance on local intermediaries will avoid delaying implementation until this long term problem is alleviated, but this does not reduce the urgency of the need to begin the required manpower development.

Institutional reform can also have very high payoffs. Forestry agents have historically earned a sizable increment to their salaries (often several times their base pay) by imposing fines - of which they are allowed to retain a percentage - on villagers for illegal woodcutting practices. The service traditions of forestry services are paramilitary. Both the financial incentive to fine and the service traditions have been impediments to establishing productive trust relationships with rural populations. Reversing them will involve the necessary reforms as well as changes in the curricula of forestry schools to provide agents with the skills base needed to support rural development (see box).

Research is as urgently needed in the social sciences issues of technology adaptation and dissemination as in the natural science aspects of technology improvement. The long lead times for research need not precede the deployment of available techniques. Results will be equally useful when and if existing measures have been widely adopted and the climate for further innovation is enhanced.

Changing the Role of Forestry Agents

Through collaborative effort between the Malian Forestry Service and U.S.A.I.D.'s Village Reforestation Project (VRP), forestry agents in the Fifth Region have successfully made the transition from policing to extension.

Decades of imposing fines on villagers, coupled with sometimes abusive fining by agents for their personal profit, had created so much distrust between villagers and agents that the environment for positive extension did not exist. There were even documented cases of agents *renting cars* at their own expense when official vehicles broke down, so that they could continue to impose fines. Income from fines was sufficient to offset the cost of car rental.

By agreement with U.S.A.I.D., agents in the VRP area can no longer fine villagers. They are paid a premium to offset the income loss, and given additional technical training in resource protection and extension methods. Village authorities and farmers reported significantly increased and more positive interaction with agents throughout the region. Technical support from the forestry service has been important to the success of many of the private farmer initiatives the team visited.

Policy

The Goal

The policy goal is to create a policy environment which either provides or ceases to inhibit rational incentives for smallholder participation and investment in natural resources management. Appropriate policy changes will not always be sufficient to bring about participation, but will have a widespread effect which serves as a necessary complement to other more specifically focussed measures.

The Opportunities

There are three recommended policy reform priorities:

Land tenure. As detailed in Chapter 5, resource management in the degrading Sahelian environment increasingly involves investments of time and

money in specific parcels of land. Increased security of land tenure is essential if farmers are to believe that those investments can pay off. Land tenure is an issue in all four countries reviewed.

Resource management rights. Empowering villagers with management authority over local resources is a process which has already begun in many areas, often in conjunction with a specific project agreement, such as in Guesselbodi. As in that example, and in the movement towards *"amenagement du terroir villageois"* (management of village environments), villagers will be encouraged to seek positive opportunities from environmental management when given the authority and allocation rights to benefit from them. This process can be coupled with clear guidelines on management responsibilities and on allowable practices. Fundamentally, however, it recognizes that *environmental management is a decentralized process which is not, in any case, within the effective control of central authorities:* the absence of authority to positively manage natural resources does not eliminate the ability to degrade them.

Prices for forest products and for agricultural production must, over the medium to long term, reflect their full economic values. A major source of forest depletion is the cutting of firewood for direct use or for sale to commercial (generally urban) markets. Because wood is collected as a free good, prices do not reflect replacement costs, and uncontrolled depletion continues. Firewood collected by villagers for their own use is not subject to taxation. However, wood cut for resale is subject to *permit fees,* which are currently still well below the cost of growing trees. Senegal and Mali have recently increased permit fees substantially, and Niger is considering similar action. Much higher permit fees will eventually be necessary in order to stimulate rural wood production (which would be exempted from taxation) and to encourage improvements in consumption efficiency. Concern that fee (taxation) increases will adversely effect the urban poor must be weighed against the effects on rural productions systems of continued forest depletion. Over the last decade, urban retail wood prices have already risen sharply (where they are not officially controlled) in response to scarcity. The long term issue therefore becomes more one of whether wood prices will rise as part of a sustainable incentive structure which conserves resources, or as the result of accelerating wood scarcity.

A.I.D. Programming Considerations

U.S.A.I.D.'s ability to be a party to a long-term contract with Sahelian populations is itself subject to institutional and budgetary constraints. Issues requiring attention on this subject are raised below, because they affect judgements on what strategy A.I.D. should pursue.

Protecting A.I.D.*'s investment* implies assuring sufficient in-house expertise at each mission to monitor natural resources activities, to interact with host country and donor organizations and to select priority investments. At both the mission and subregional levels, institutional continuity will take on greater importance if A.I.D.'s commitment goes beyond individual project involvement. In missions and in A.I.D./Washington, efforts are already underway to develop objective *monitoring indicators* of progress in natural resources management. Such indicators can be an especially valuable management tool in tracking long-term and multi-donor efforts which extend beyond normal programming cycles. Formal training and interaction sessions for mission natural resources staff will facilitate cross-country sharing of information and expertise.

Limiting new *management burdens* on missions will be better served as an objective where resource management is integrated into existing portfolios. The two main themes in resource management fit well with existing A.I.D. programs: improvement of agricultural productivity, and promotion of rural enterprise and income generation.

Maintaining sufficient expertise to monitor resource management will be easier if A.I.D. focuses its limited resources on one or more areas of continuing interest. A more dispersed approach also increases the chances that individual project goals will dominate the agenda. We believe that it will be more useful to national governments for each donor to commit itself to a shared responsibility to carrying out a long term strategy in one or more defined areas.

Project design and evaluation processes will play an important role in shaping A.I.D.'s role in the sector. The long lead times to success, and the "hidden" changes which occur before success becomes visible create the need for proactive evaluation approaches which recognize that original project goals may become outdated. Successful implementation of a strategy will require identification of and following-up on new opportunities as they occur in additional to execution of previously formulated plans. This is a difficult issue to resolve, given the danger of protecting bad projects under the cover of the need for long term commitment. Mid-term evaluations which stimulate a collaborative process of "mid-course correction", calibrated by the strategy objectives and by such tools as the monitoring indicators, can be especially useful in successfully reorienting a project, as the mid-term evaluation of the FLUP project carried out by Africa Bureau in 1984 demonstrates.

Recommendations for U.S.A.I.D.

Priorities

Priority 1: Spread Existing Technologies

Overall Recommendation: As the highest priority at all funding levels, stress the *deployment* of existing technologies which have been shown to have positive and financially attractive impacts at the farm and/or village levels and which help to meet criteria necessary for a sustainable system.

Deployment of existing technologies and strategies were observed to be having substantial and enduring impacts on the capacity of farms and villages to produce food, forage, wood, and other products. Farmer acceptance appears to be as dependent on risk reduction as on the potential for yield increases. Opportunities to earn cash income which reduces economic risk can be a powerful motivating factor.

Priority 2: Increase the Productive Potential

Recommendation: At the medium and higher funding level, support research that reduces risks and increases efficiencies of higher yielding technologies and germplasm. Plan to introduce results of this research where currently available methods to improve natural resource management have been successfully adopted.

Data show that there is a need to increase the productive potential of farms through higher yielding technologies and germ-plasm (HYTGP), but it was observed that acceptance of HYTGP was extremely low in the millet and sorghum zones where risks from droughts were high and/or where the natural resource base was badly degraded. Field evidence strongly suggests that the efficiency of higher yielding technologies and germplasms will be increased when existing methods of soil and water conservation and fertility improvement have already been applied. Valuable research, most notably at ISRA (Senegal) is already being conducted. Some farmers in cotton zones have economically used mineral fertilizers where a cash crop is a major part of the rotation.

Targets for Sustainable Production

From the Assessment and from research data, the following goals for the areas visited are thought to be achievable and necessary. The targeted levels of production are sustainable for small farmers and can realistically be attained within ten to fifteen years after appropriate interventions are initiated.

A. Sahelo-Sudanian Zone (450-750 mm): Low funding option

Millet and Sorghum Yields.

Through increasing field tree densities, restricting soil and water erosion, and improving manure management, the following would be expected (depending upon the original condition of the natural resource base):

- o average yields could be as much as doubled with no or minimal recurring application of mineral fertilizers;
- o probability of crop failure due to drought would be significantly reduced; and,
- o fallow requirements would be substantially reduced.

Forest and Horticultural Products.

Establishment and implementation of management plans for village forest lands and support of on-farm microenterprises will significantly increase the quantity of wood for poles and fuel, and can increase the quantity of other products such as gums, honey, medicines, etc.

Permanent Livestock Carrying-capacity.

Increased supplies of dry-season forage from additional browse and from improved management of forest reserves can sharply increase the permanent land carrying-capacity (and increase both the quantity and quality of manure for soil enrichment).

B. Sahelo-Sudanian Zone: Medium and high funding options.

While fewer data are available for sustainable on-farm impacts from more intensive investments, funding at higher levels should increase the productive potential of farm enterprises and the rate of deployment of appropriate interventions. The priority for this funding level remains that of restoring the soil's productive capacity.

Grain Yields.

Average yields can be more than doubled. The probable expectations for reduced crop failures and fallow requirements would be the same as the low-funding option. The rate of deployment of technologies would be greater than in the low-funding option.

Forest Management.

The products would be the same as the low-option, but more models could be established and greater numbers of personnel trained in forest land use planning (FLUP) techniques and in project management, with consequently higher rates of extension

Carrying-capacity

Same goal as for low funding option -- that carrying capacity be doubled in affected areas, but but with higher targets for affected populations.

C. Sudano-Guinean Zones (Over 750 mm): Low funding option.

As observed during the Assessment and supported by research data, the important differences between this zone and the Sahelo-Sudanian zone included a much higher frequency of cash crops and of existing vegetative cover and a greater risk for erosion and soil leaching.

Crop Yields.

Data are still being collected for this zone on yield potentials under various management schemes, but proper rotations of cash and subsistence crops, modest use of mineral fertilizers, extension of improved seed, establishment of agroforestry systems, improved management of manure, and improved animal traction practices should achieve the following:

- Significant increases in all crop yields;
- Significant reduction or elimination of fallow requirements; and,
- Significant reduction in crop failure due to drought.

Forest Management

Improved management of existing forests will provide sustained increases in wood, forage and other products.

Carrying-capacity

Animal traction was observed to be used in this zone for plowing at both the beginning and the end of the rainy season. The later plowing appears to have had an impact on the amount of soil moisture carried over. Additionally, improved compost pits were supplying significant quantities of manure to the farm enterprise. It should be expected that use of both animal traction and compost pits can be increased.

D. Sudano-Guinean Zones (Above 750 mm): Medium and low funding option.

Soil Fertility

Addition interventions would include alley-cropping research and extension for soil enrichment and livestock feed.

Forest Land Management

Given the greater growth potential of trees, forest management could include enrichment plantings of higher value trees.

Carrying capacity

Additional investments should be made into research and extension of forage legumes.

Recommendations by Intervention Category

Implicit in each of the recommendations below is the assumption that specific measures will be implemented in keeping with the principles of financial viability and incentives discussed in earlier sections of the report.

Biophysical

Soil Fertility Improvement

Recommendation. At the lowest funding levels, focus resources on supporting regeneration of field trees and on manure management. At higher levels, support research on mineral fertilizer and on improving rhizobium adaptability.

The more productive systems observed during the assessment had at least a minimum capacity to recycle nutrients to the topsoil and to make effective use of nutrients brought into the system.

Soil and Water Conservation.

Recommendation. Extend actions which reduce soil erosion and which increase the soil's capacity to retain available water. At all levels of funding, support extension of the following:

- On-farm contour dikes
- Microcatchment basins
- Brush and crop residue litter management

- o Gulley Plugs
- o Living Hedges

At higher levels support increased use of check dams.

Improved systems which restricted movement of water and soil and which had relatively high storage capacity for plant available water were observed in all four countries.

Maintaining Vegetative Cover.

Recommendation. At all levels of funding, support establishment and maintenance of a permanent cover of woody perennials on a major portion of farm or village land. Higher levels of funding would permit more models and more rapid extension.

It was observed that sustainable systems generally included a cover of woody perennials which cycled nutrients, contributed organic matter, reduced erosion and evaporative losses, and provided year-around supplies of forage, wood, and other products.

Institutional

Training and Human Development

Recommendation. At the lowest funding levels, increase the capacity of personnel in both the public and private sectors to manage soils and vegetation, and encourage linkages across sectors of agriculture, livestock, and forests. At higher levels, support advanced training of personnel who can establish priorities and plans for national, regional and subregional natural resources management. Specific support should be given to the following:

- o Convert agents from police to extension agents
- o Train agents in following techniques:

  -Living hedge management
  -Improve stove construction
  -Windbreak management
  -Natural Stand management
  -Water harvesting and management

- Develop local intermediaries
- Develop project and personnel management skills
- Develop accounting and account monitoring skills including management of credit.
- Support micro enterprise skills development
- Arrange training trips for farmers and local agents to "model" sites within the region (Guesselbodi and Maggia Valley are two potential locations).

Human and institutional changes in both public and private sectors were key reasons for the success of many interventions. Generally, these changes were in the form of more effective management of existing resources at the village and farm level. This trend should be supported, but additional training will be required to develop a capacity to establish national priorities for natural resources management and to develop the technologies and strategies for increased productivity.

Sectoral Collaboration

Recommendation. Where appropriate, use diversified A.I.D. portfolios to encourage collaboration on natural resource management between services of agriculture, livestock and forestry, all of whom A.I.D. missions in the region regularly work with.

The greatest opportunities for sustainable yield increases from improved resources management occur in the agriculture and livestock sectors. The greater emphasis on resource protection as a priority has tended, however, to occur in forestry services. The integration of soil and water conservation and soil fertility improvement with the long term production objectives in agriculture and livestock will be best served by closer collaboration between the services. A.I.D. is particularly well-placed to promote such collaboration.

Focussing Resources on Strategic Goals

Recommendation. Promote host country and multi-donor agreement on strategy objectives over a twenty to thirty year time frame. Support creation of a more structured coordination process for monitoring of progress and allocation of scarce donor and government resources. Build on what has succeeded (including support to farmer entrepreneurs and rural innovators).

6 Priorities

With shrinking budgets and increasing demands, a long term resource management strategy will have the best chance of success if focussed on areas of high priority. At present, most of the major donors interviewed are only marginally aware of what other donors are doing in the field. There is significant duplication of effort, especially in pilot projects, adaptive research and institutional development support, even as other high priority activities remain unfunded. The valuable lessons learned from field experience in one donor's projects are often not readily accessible to other donors. Policy signals provided by various donors have sometimes worked at cross-purposes, reducing the potential for success. Several donors, including the World Bank and A.I.D. representatives, have cited the lack of a formal process of coordination and information sharing. Considerable bodies of information and data (including Geographic Information Systems databases) are currently being shared only through the isolated initiatives of projects or individuals. Even within A.I.D., there are few mechanisms and little regional funding available to share information across countries and between projects.

Policy Modification

Resource Tenure

Recommendation. Give high priority to working with host country governments and other donors to identify and implement tree and land tenure policies which establish clearer and more secure tenure systems.

Land and tree tenure policies were found to be a variable that affected the willingness of farmers to practice on-farm natural resource management (NRM). Except in one case (FLUP/Niger), the favorable policy conditions were not part of the national statutes, but, rather, were local. There is substantial evidence that favorable tenure policies being developed in response to changing local conditions are having a positive impact on productivity and can serve as models across the agroecological zone.

Tax Incentives

Recommendation. Support policies already underway to raise permit fees on woodcutting from the natural forest to reflect the long term economic costs of replacing dwindling wood supplies. Work closely with host governments and other donors (in particular the World Bank) to define appropriate levels and *implementation times* for revised rates. In order to increase the incentive to practice sustained-yield management systems, seek a differential tax structure which exempts wood harvested from managed systems (such as Guesselbodi) while increasing taxes on wood harvested outside of managed zones.

In Senegal and Mali, permit fees have been increased sharply in recent years. In Niger, fees on fuelwood are scheduled to be increased by 900% in order to reduce wood demand in urban centers. But, the Assessment noted that the fuel demand has actually supported more rational forest management in the Forest Land-Use Planning Project in Niger by providing incentive to villages around Niamey to produce wood for sale in urban markets. The speed with which such dramatic tax increases is implemented should be moderated to assure that this incentive is not undercut.

Economic and Financial

Financing Natural Resources Management

Recommendation. Encourage the creation of "Revolving Funds" managed at local and village levels to provide credit to small farmers for improved resource management. Public risk sharing would take the form of seeking repayment from the increased yields which can be expected over a five to ten year period.

"Contingent Incentives"

Recommendation. Provide cash or other incentives, along the lines of one or more of the successful mechanisms observed in the assessment, to implement specific measures which increase soil fertility. Make incentives contingent upon implementation of a package of natural resource management activities. Test and develop such incentives systems in demonstration areas, future more widespread future application.

It was observed that the two major sources of plant nutrients in the topsoil were litter from woody perennials and animals. Given their low recurring costs, they will remain the major sources in the foreseeable future. Maintenance of a woody perennial cover has become more difficult under increasing demographic pressure. Animal manure supplies depend to a large extent upon this cover. While one sees dense stands of mature field trees, there is little natural regeneration and a declining animal carrying capacity.

Several projects had developed incentives strategies for establishment of field trees, especially for *Acacia albida* in the millet and sorghum zones. One used a nominal cash payment for farmers who protected saplings. Economic analyses indicate that this approach is viable. In addition, we have developed an approach that would link field tree stewardship with phosphorus (P) fertilizer support. In this scenario, one or two applications of P fertilizer would be provided to farmers who maintain a minimum density of saplings. Phosphorus fertilizer is relatively immobile and may have residual effects on yields for 8-10 years, if properly applied. This would allow sufficient time for litter from field trees to have a significant (and growing) impact on yields. Further information of the costs and feasibility of this specific measure should be collected.

Research Priorities

Following the general guidelines of this chapter, research priorities would include research on soil fertility through improved agroforestry systems and manure management; research on improved soil and water conservation technologies; and research on improved natural vegetation management.

Research opportunities are defined in function of what is known to be possible in terms of productivity (production/time/input) levels, and of what we believe is necessary to meet strategy objectives. Each research opportunity is discussed in terms of the principal outstanding questions to be addressed.

Soil Fertility Research

Soil fertility research has been underway for over forty years in the Sahelian region, most notably in Senegal. Findings from past research indicate the following:

- The agro-sylvo-pastoral systems of the Sahelian region have sustained yield averages of 950 kg/ha (+/- 200 kg/ha) of millet or sorghum with very little fallow requirement, but they are breaking down under demographic pressure. What are the biophysical, socioeconomic, policy, and institutional constraints to their being restored?

- The above systems were found to sustain a population density of between 50 and 60 people per square km, but the population densities are currently about twice that great. How can mineral fertilizers be economically used to complement agroforestry and manure management in increasing the the productive potential of these systems? Under what conditions should mineral fertilizers be used before the natural resource base is restored? What are the major constraints to achieving these potentials?

- What are the constraints to receiving wider benefits from microbially-mediated nitrogen fixation?

- Acceptable soil fertility levels require annual applications of four tons of compost. How much compost can be expected to be produced on-farm under present circumstances, and how can this potential be increased? How can its management be improved?

- Agroforestry and manure management research are specific to soil types and agroecological zones but not necessarily to crops. Within the same zone, technologies have been successfully extended across crops. What technologies are available to be extended within each agroecological zone?

- In the semi-arid region, ISRA appears to be the most active organization conducting agroforestry and compost research as it applies to increasing soil fertility. ISRA takes a systems approach to agroforestry research, which appears to be effective in addressing socioeconomic constraints. Agroforestry research in Senegal was initiated in the 1960s and semi-arid region alley cropping was initiated near Bambey three years ago. These involved collaboration among a number of disciplines. (A summary of research results will be included in the final report). We understand that ICRISAT will initiate agroforestry research this year in Niamey, and that ILCA has initiated alley cropping trials (with exotics) in the sub-humid zone of Senegal. Farmer cooperators in the USAID/Mali OHV project are using a mineral fertilizers to complement an improved manure management system.

- Mineral fertilizer research and extension has been conducted in the semi-arid region for the last twenty years. To date its extension has been most wide-spread in the cash crop zones (cotton and ground-nuts); its use has been limited on sorghum and millet. Research data from Burkina Faso indicate that using mineral fertilizer in conjunction with tie-ridging (for water harvesting) has significantly reduced its risk and increased its efficiency.

Recommendation. As a priority, support agroforestry and manure management research to answer the questions raised above. Support mineral fertilizer research as it complements agroforestry and manure management, and link it with water conserving research, such as tie-ridging. Conduct this research through an integrated systems approach, much like ISRA is doing. Collaboration between agriculture, forestry and animal husbandry sectors should be encouraged (through fielding multi-disciplinary technical assistance teams, among other strategies). Since research products may have use across large agroecological zones, U.S.A.I.D. missions should apprise each other of research results in each country.

Soil and Water Conservation

As stated above soil and water conservation techniques which have been effective include contour dikes, water catchments, windbreaks, and late season plowing. From the observations made in this assessment, research priorities would include the following:

- o Contour Dikes. First, dikes have not been effective on sandy soils and research on managing living hedges would assist conservation on the lighter soils. Second, there has been a question of whether water harvesting will not rapidly draw down the plant nutrient supply in the topsoil. This question should receive research attention.

- o Late Season Plowing. Plowing under crop residue before the last rain has been adopted by some farmers in the sub-humid part of the 3rd Region of Mali. Farmers believed that more water was held over to the next growing season using this practice. Research by C. Charreau in Senegal supported this observation. This should be quantified. If proven true and economically feasible, it merits development and extension.

- o Windbreaks. Reportedly, research by ISRA in Senegal suggests that tenure policy issues need to be resolved before windbreaks will be more widely adopted. Tree tenure questions in the Maggia Valley Windbreaks are now being resolved at the level of the "Departement". There may be some lessons that would apply across the zones.

Vegetation Management

There is substantial evidence to suggest that improved management of existing vegetation for wood and forage would be more effective, both economically and ecologically, than introduction of new species. Introduction of high-yielding varieties into a poorly managed system has often produced marginal results. Natural stand management for wood and forage production has made substantial progress under the Forest Land Use (FLUP) Project in Niger, particularly in estimating standing volume of wood. In Mali some progress has been made in estimating the forage volume of natural vegetation.

Research findings on the carrying-capacity of natural vegetation would be extremely important in establishing principles for local resource management (such as in the "terroir villageois" approaches planned in Mali).

Conclusions: Sustainable Development in the Sahel

This report is based on field observations of individual solutions which have worked. We have found a rich basis for concluding that in virtually every Sahelian environmental and economic context, there are individual approaches which can lead to greater output and more stable production through improved resource management. The issue, however, is one of improving the economic well-being of Sahelian peoples, not of improving the state of the environment *per*

se. In a word, the issue is development. It would be a mistake to conclude that, just because improved resource management has created opportunities for sustained development, future development will necessarily be best served by vastly increasing the emphasis on natural resources. This is, in some senses, the error which has been made repeatedly in development policy over the last thirty years.

As a team, we approach the formulation of action programs with the view that the degree of emphasis given natural resources must be justified in *economic* terms. Throughout the Assessment, we have found that *financial* returns to smallholders have been an important ingredient in bringing about their participation. The two questions smallholders have asked - "What is in it for me?" and "how does it compare to other opportunities I face?" - are the same questions which must be addressed at the macroeconomic level.

The Search for Viable Economic Solutions

The expected development path in the post-independence period has not materialized for the Sahelian economies. Export cash crops have faced declining and unreliable yields. Declining terms of trade between export crops and major imports have further reduced benefits from the cash crop strategy. Rather than increased exports and a growing cash economy, the net result has tended to foster increased economic dependency and reduced domestic food security, both at the economy-wide and farm levels. The other expected "engine of economic growth" - a stable and productive urban economy based on food processing, light manufacturing and growing commerce - has also sputtered and stalled. Despite low wages and even lower opportunity costs, the real costs of manufacturing in the Sahel have been uncompetitively high: exorbitant rates for expatriate management and technical personnel, relatively low productivity, high maintenance costs and unreliable raw materials supplies have been combined with over optimistic expectations of comparative economic advantages in manufacturing to make this sector as much a drain on growth as a contributor to it. This has occurred despite the fact that a disproportionate share of public investment has historically gone to developing and maintaining urban-based infrastructure.

It is precisely this failure of development expectations which has led to renewed concern about the environment. To be sure, none of the findings in this report are new: published literature from thirty and forty years ago makes the case for long term environmental protection more eloquently than this assessment can. Nevertheless, it is now apparent that smallholder rural production systems will continue to be the cornerstone of Sahelian development, and that such production cannot be sustained if the natural resources base continues to decline. *The economic justification for natural resources protection is that resource degradation is progressively undercutting the only hope for a stable economic future in the Sahel:* rural production systems built around agriculture, livestock and water resource management.

6 Priorities

How much investment is justified to protect the resource base? Many thoughtful observers have correctly expressed the concern that while resource protection should be a high priority, the public budgetary cost (technical assistance, extension, training, cost sharing, etc.) is simply too high to allow more than isolated projects which will have negligible macroeconomic impacts. This concern clearly has some validity. Donors and governments have consistently implemented "demonstration" projects which, even if successful, only demonstrate what we cannot afford to replicate.

Too much has been written in general terms to justify a current wave of thinking, and economic analysis is easily manipulated to make judgemental conclusions seem irrefutable. For example, at one level, we can conclude the following:

> The pace of environmental degradation has been alarming. It is accelerating as human and animal pressure increases. Average rainfall is on a downward trend. Agricultural zones north of what has historically been at the 700 mm isohete are at the margins of viability, even in good years - at least where traditional practices remain in force. With declining yields and increasing populations, local food deficits in drier zones are, to an increasing extent, *structural* rather than the result of abnormally low rainfall. The long term public budgetary cost of responding to structural food deficits are extremely high (emergency food shipments, rapid urbanization and underemployment, etc.). There is little else, if anything, to fill the gap in Sahelian economies if rural production systems continue to decline. Therefore, the returns to natural resources investments are potentially enormous and high investments in the sector are not only justified but necessary.

The problem with this otherwise sound reasoning is that it fails to capture the dynamics of the rural economy. The first chapter of this report is devoted to the "Rapidly Changing Context". Throughout the assessment, we found that the need to innovate in response to new constraints and new opportunities was a more important motivational factor for farmers and resource managers than were abstract decisions to "protect the environment". It is therefore useful to recapitulate the underlying trends we saw:

- there is little or no incentive for local populations to manage or protect resources when they do not benefit from such activity. Where resources such as wood and forest products are available as free goods, it is generally more financially advantageous for the individual to let them degrade through exploitation than to invest in their protection. Even if large sums

are spent on resource protection projects, degradation of common property resources may well continue, stabilizing - if at all - at much lower levels than at present.

- simply to hold the line on agricultural productivity will require intensification of management on specific parcels of land under agriculture.

- the long term relative prices of the "factors of production" -- land, labor and capital -- are changing. Population density has increased and average yields per hectare have gone down. As a consequence, per capita agricultural production has declined steadily since 1968. The returns to intensive land management are therefore potentially greater than ever before.

We found little evidence that public policy was capable of bringing about widespread changes in farmer behavior simply by spending money or resources on the problem, except when public efforts were consistent with these principles of smallholder self interest. We did find, however, that by calibrating incentives, providing training and support and sharing the cost of risk-taking, public initiative can significantly **accelerate** (or hinder) the rate of positive change.

Country Action Programs

The four-country Sahel Assessment aims to establish the factual basis for action. We stress the evidence as contained in the detailed case descriptions of Volume II. The findings and recommendations of this Main Report lay out a menu of options which meet the multiple criteria of developmentally sound field initiatives. The next steps are already underway: to use these findings in the development of specific country action programs in Mali, Niger, Senegal and The Gambia. By definition, such action programs should not be generic prescriptions of what should be done. Their objective is to define what needs to be done by the public sector to capitalize on specific opportunities in each country. Those opportunities will differ, but exist in every subsector, as shown throughout this report.

How Much Will It Cost?

In addressing this inevitable question, we must bring to bear all of the main threads of what we have seen:

- For locally-led initiatives (by farmers, herders and local resource managers), capitalizing on incentives for improved resource management and income generation in ways which the government can afford to sustain and to replicate is the only means to achieve widespread impact. *Initial demonstration investments may be high, but approaches which require high recurrent costs will necessarily not be part of the solution set.*

- For biological diversity and preservation of the common environmental inheritance, we must recognize that it is not now the first priority of rural populations at the margins of subsistence. Large up front public investment may be required. One of the most important contributions to be made is in conflict resolution in buffer zones which will make it possible for local populations to make their livelihood in harmony with and not at the expense of the environment. There are specific case examples which suggest that this approach has worked (see Volume IV on Biodiversity). We saw no examples in which the government has succeeded in protecting the environment at the expense of local populations, even if it wanted to do so.

- There are things worth not doing: woodlots in under 600 mm zones provide an excellent example. In the struggle for survival, rural populations are making implicit choices about what constitutes a waste of time. The government can throw millions of dollars and precious institutional resources at solutions which the intended beneficiaries themselves have rejected, with nothing to show for it.

- Restraint in public policy can usefully take the form of promoting what can work. Only a small subset of what has been tried over the last twenty years meets the criteria of being technically, socioeconomically and financially viable. *Yet there is ample room to increase current levels of funding (from all sources) ten fold without deviating from fairly stringent criteria for success.* The future of successful natural resources management is more likely to coincide with future opportunities for economic development than with battles which may already have been lost.

Success, defined as having a sustained and growing impact on protecting the rural production base, will always be a matter of degree. Dollars spent will be one factor among many which will affect the degree of success. Irrespective of how much is spent or how successfully it is done, millions of people in the Sahel will be dislocated in the coming decades through the combined effects of drought, resource degradation and lack of economic opportunity. The amount of investment which can successfully be absorbed exceeds what any single donor can commit. It probably exceeds what the sum of donors and host governments can reasonably provide. If we had to venture a guess, an appropriate range would peak at over a hundred millions dollars per year in Mali, Niger and Senegal, and somewhat less in The Gambia. The chances for success will therefore be vitally influenced by the degree of donor coordination and of integration of natural resources management with other rural development programs.

PERSPECTIVES

D'UN DEVELOPPEMENT SOUTENU

La Gestion Réussie Des Ressources Naturelles Dans Le Sahel

Asif Shaikh

Eric Arnould
Kjell Christophersen
Roy Hagen
Joseph Tabor
Peter Warshall

VOLUME 1:
RAPPORT PRINCIPAL

Evaluation Financée par
l'United States Agency for International Development

e/di

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VOLUME I: RAPPORT PRINCIPAL

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PREFACE

En Février 1987, Le Bureau Africain a sanctionné le Plan pour l'Appui de la Gestion des Ressources Naturelles dans l'Afrique du Sous-Sahara (PNRM). Le but du PNRM est d'exécuter des augmentations soutenables en agriculture et en revenus ruraux où l'agriculture comprend la production de culture alimentaires et d'exportation, le bétail et le bois. Le PNRM a résulté de l'expérience de l'AID qui indique que la production soutenable est directement liée à la condition au long terme des sols et de la végéation et à la maintenace d'habitats qui hébergent une flore et une faune génetiquement diverse. Sous le PNRM, le développement agriculturel est nécessairement considéré un sous-groupe de la gestion des ressources naturelles (GRN). Le PNRM reflète un souci croissant du public et du Congrès au sujet d'investissements pour impacts soutenables en Afrique. Sous le Fonds de Developement pour l'Afrique (DFA) on s'attend à ce que le Bureau Africain cible 10% du budget de développement vers les activités de gestion des ressources naturelles.

Le Rapport sur l'Evaluation de la Gestion des Ressources Naturelles de la Sous-Région du Sahel (SSRA) comprenenant un résumé exécutif, est une des démarches essentielles dans la mise en oeuvre du PNRM. C'est le résultat de plusieurs mois d'etudes dans le champ parrainés par le Bureau Africain et faits pour addresser un aspect important du problème de la soutenabilité du développement.

Le SSRA a été mené en Gambie, au Mali, au Niger et au Sénégal. La portée du travail pour l'équipe SSRA a demandé que ses membres examinent de première main les initiatives basées sur les fermiers sous lesquelles les impacts se produisaient. Le développement soutenable, par sa nature entrecoupante, exige que nous sachions plus sur l'agriculture, l'économie, l'environnement, les institutions nationales et leurs politiques et le milieu socio-culturel dans lequel les petits producteurs mènent le commerce. Le développement soutenable exige aussi que nous ayons une fiable compréhension analytique des rapports entre les élément d'un sytème de production afin de comprendre la résilience du système et sa capacité de résister le choc et la tension, à la fois externes et internes.

Ce rapport se concentre sur une multitude de pratiques de production agricuturelles qui promettent une croissance agriculturelle soutenable dans les quatre pays Sahéliens étudiés. Il a été préparé par une équipe d'experts rassemblée par Energy/Development International sous la coordination de Michael McGahuey, Agroforestier, Branche des Ressources Naturelles, Division Agriculture et Ressources Naturelles, Bureau de Ressources Techniques, Bureau Pour L'Afrique. Le Premier Volume fournit une vue d'ensemble et les conclusions de l'évaluation et présente les recommandations.

Le Deuxième Volume fournit une description approfondie et une analyse de chacune des soixante-dix initiatives étudiées. L'Annexe

d'Analyse Financière (Volume III) fournit une table d'interventions potentielles et une analyse de coûts et bénéfices. L'Annex sur la Diversité Biologique (Volume IV) donne un rapport sur l'effet des interventions sur la diversité biologique d'une région et le potentiel pour l'intégration des questions de biodiversité dans les programmes futurs.

La compilatation de ce rapport n'aurait pas été possible sans les contributions de beaucoup de personnes. Le personnel des Missions dans chaque pays a contribué des heures san nombre à préparer pour la visite de l'équipe, pour faciliter leur travail dans le pays, et pour réviser leur conclusions. Une gratitude spéciale est due aux fonctionnaires des gouvernements de la Gambie, du Mali, du Niger et du Sénégal qui ont fourni l'équipe avec des informations de base et des conseils. Un grand nombre de professionels, dans L'AID et en dehors, ont aussi révisé les ébauches de rapports et ont fait des contributions substantives.

Notre intention est que ce rapport soit le début d'un processus plutôt qu'un produit final. La richesse des informations présentées dans ce rapport en quatre volumes fournit nombre de leçons pour consolider les programmes d'action pour l'agriculture soutenable des pays. Il devra aussi aider le Bureau Africain dans ses efforts de planification stratégique à long terme et de coordination de donateurs. Le plus important, c'est de constater que les soixante-dix interventions décrites ne rérésentent qu'une portion des stratégies de gestion utilisées par des innovateurs qui peuvent servir de modèles pour les pays hôtes et les investissements de donateurs qui aident les fermiers à s'aider eux-me^mes.

Dr. Abdul H. Wahab
Chef de Branche, AFR/TR/ANR/NR
10/19/88

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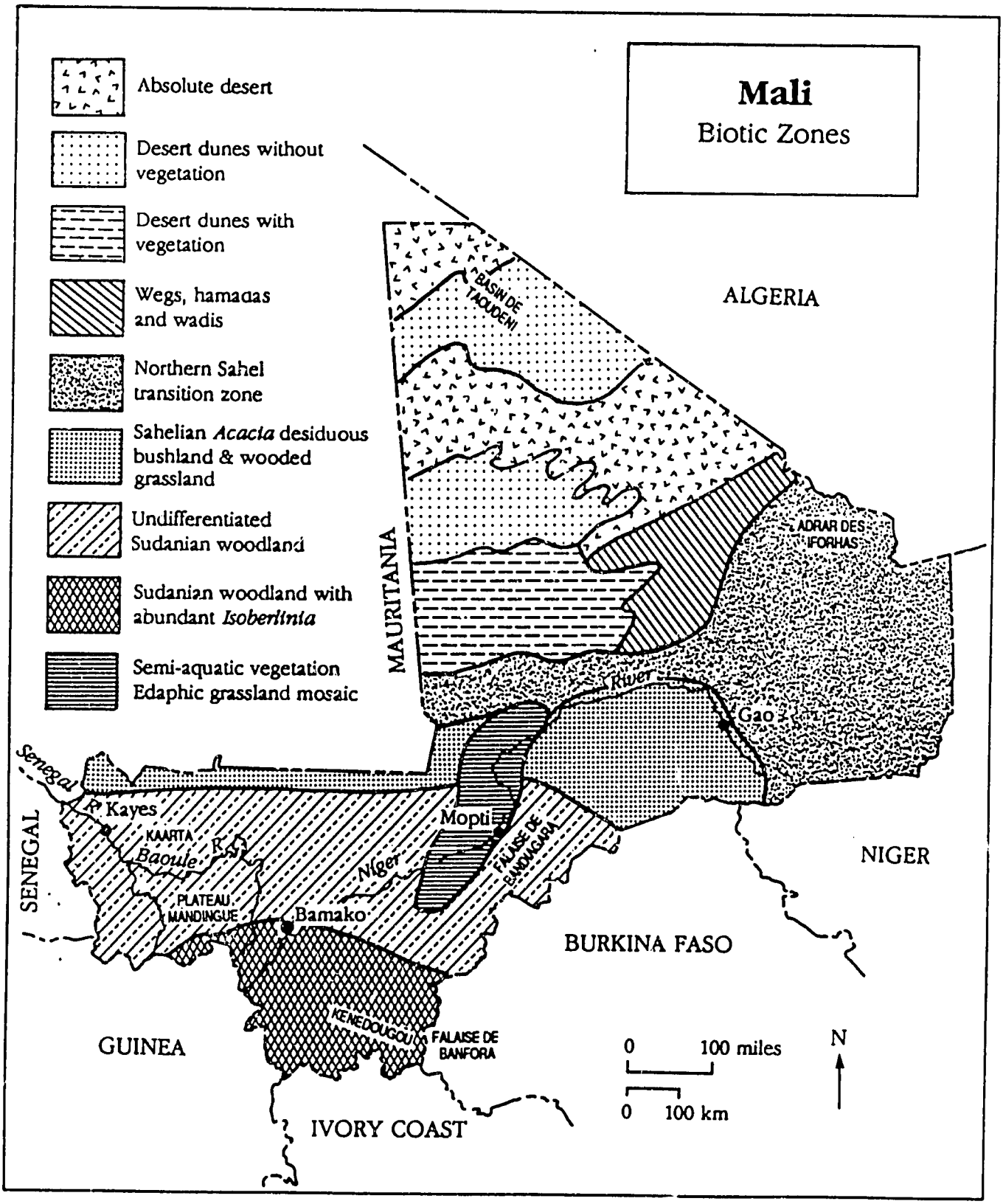
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Biotic Zones
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Desert dunes with vegetation
Wegs, hamadas and wadis
Northern Sahel transition zone
Sahelian Acacia desiduous bushland & wooded grassland
Undifferentiated Sudanian woodland
Sudanian woodland with abundant Isoberlinia
Semi-aquatic vegetation Edaphic grassland mosaic
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MAURITANIA
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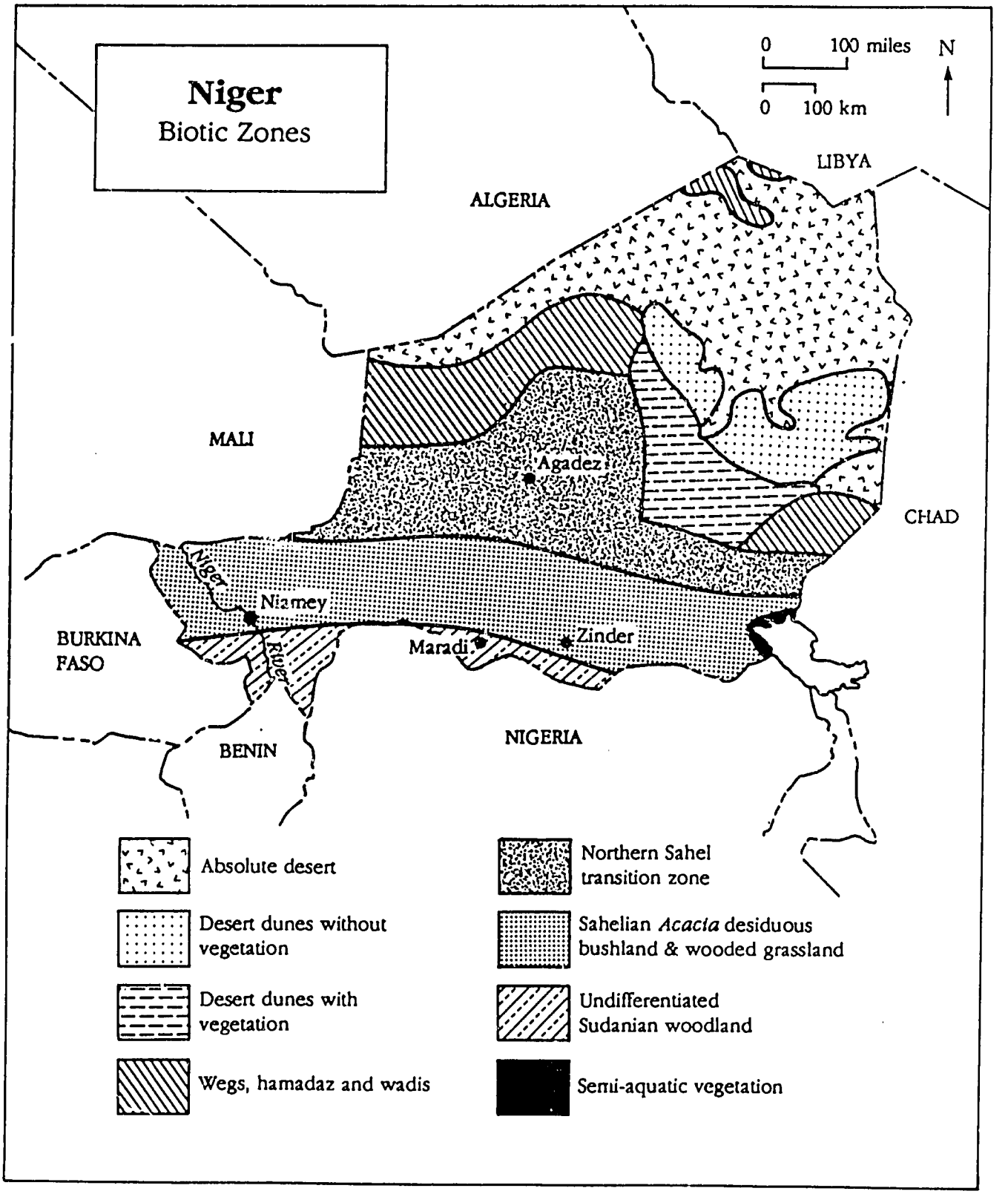
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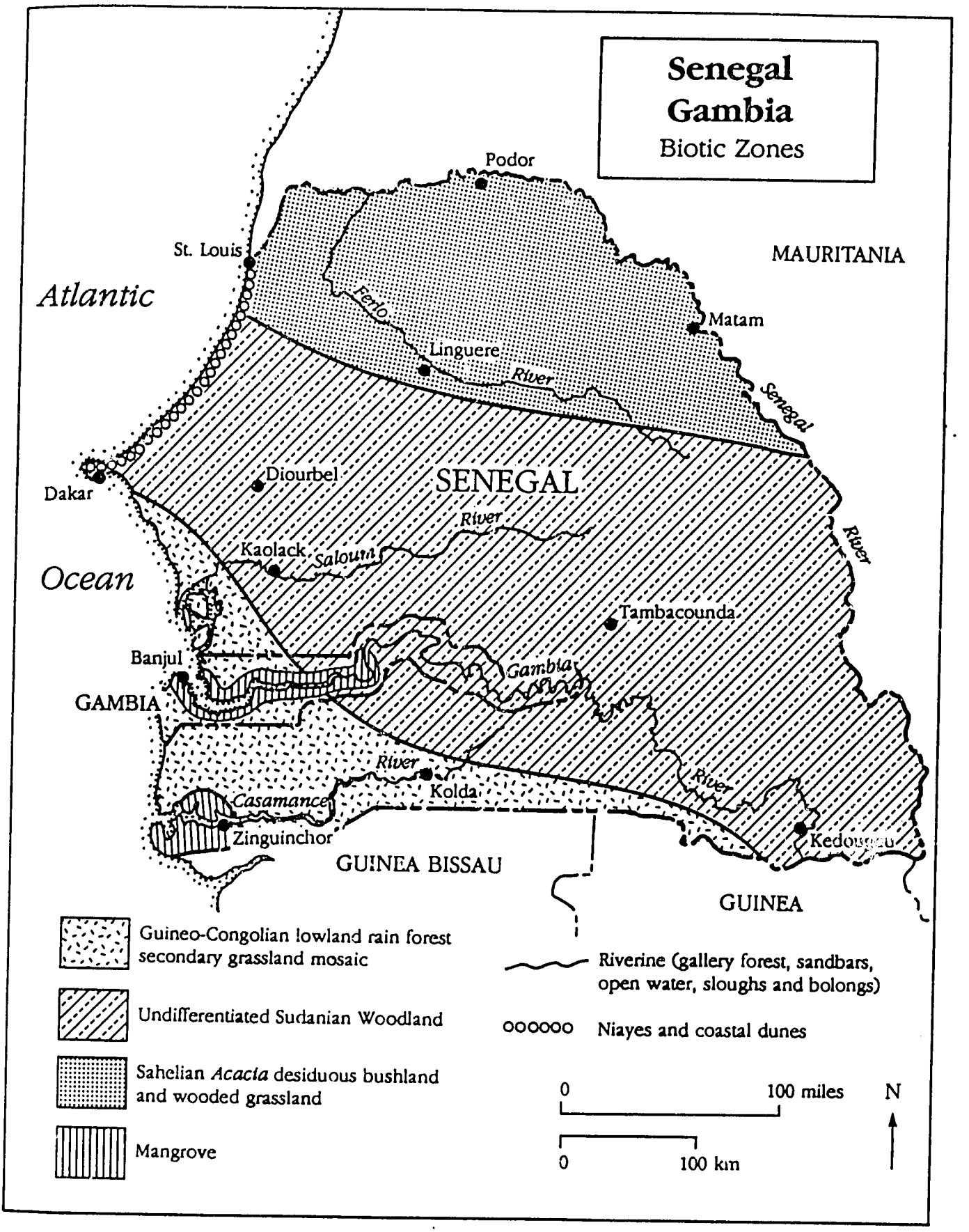
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Dakar
River
Kaolack
Saloum
River
Ocean
Tambacounda
Banjul
Gambia
GAMBIA
River
River
Kolda
Casamance
Zinguinchor
Kedougou
GUINEA BISSAU
GUINEA
Guineo-Congolian lowland rain forest secondary grassland mosaic
Undifferentiated Sudanian Woodland
Sahelian Acacia desiduous bushland and wooded grassland
Mangrove
Riverine (gallery forest, sandbars, open water, sloughs and bolongs)
Niayes and coastal dunes
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CHAPITRE I
UN CONTEXTE EN VOIE D'EVOLUTION RAPIDE

INTRODUCTION

Les ressources naturelles d'un pays constituent le capital à long terme servant de support à son développement et à sa croissance. Chaque nation dispose, à l'origine, d'un ensemble bien déterminé d'eau, de sols, de minéraux, de plantes et de faune; il lui faut bien gérer ces dons de la nature, afin de maintenir en état et d'améliorer les moyens de vie de ces populations humaines, y compris les termes d'échange avec les autres nations. On ne saurait distinguer la gestion de ses ressources naturelles -- comprenant son approvisionnement d'eau et la qualité de cette eau; la qualité de l'air; la fertilité des sols; les minéraux; la couverture végétale; la flore et la faune, bref l'écologie du pays--de l'économie nationale. Lorsque des conditions de sécheresse et une croissance démographique rapide fatiguent l'écologie, la gestion des ressources naturelles devient de plus en plus difficile. Par ailleurs, retirer des bénéfices à court terme risque à long terme de sacrifier la qualité et la quantité du capital naturel du pays. C'est en effet la situation actuelle de l'Afrique de l'Ouest.

L'équipe des Systèmes de Gestion des Ressources Naturelles (SGRN) s'est rendue au Mali, au Niger, au Sénégal et en Gambie. Elle a recherché des réussites dans le domaine de l'utilisation et de la gestion des ressources naturelles, c'est-à-dire, des initiatives ou des interventions qui, dans une certaine mesure, donnaient des résultats. L'équipe a évité de déterrer des échecs et de dresser, une fois de plus, une liste de raisons pour lesquelles la gestion des ressources naturelles a échoué en Afrique. En effet, ceci constitue des informations surannées et, en partie, inexactes. Avant d'approfondir la notion de réussite, il faudrait, au risque de réitérer des faits bien connus, décrire ce qui se passe dans les régions sahélienne et soudanienne de l'Afrique de l'Ouest. Etant donné la sécheresse durant seize ans (voir la case ci-après), il faut que nos critères de succès soient compensés par les énormes empêchements écologiques et économiques subis par les populations d'Afrique de l'Ouest.

LA SECHERESSE ET LES POPULATIONS

Les paramètres fondamentaux du développement économique (par exemple, les termes d'échange, l'emploi, les types d'emploi, l'organisation communautaire du travail, et les règlements régissant l'accès aux ressources naturelles) ne sont plus identiques à ceux qui existaient avant la période de sécheresse. Au cours des dernières douze à seize années, la pluviométrie est

restée à 60% des pluies de la période pré-sécheresse. Les fleuves principaux, soit le Niger, le Sénégal, et le Gambie, ont baissé de beaucoup. Des eaux salées ont pénétré en amont des fleuves vers l'intérieur et se sont infiltrées dans la nappes d'eau souterraines. Le niveau des puits a baissé jusqu'à 75 pieds (23 m), rendant considérablement plus dur le travail des femmes, qui ont à charge de tirer de l'eau. Les forêts et les herbages sont devenus de plus en plus fragmentés. Dans certaines régions, les arbres et les herbes productifs, ainsi que certaines espèces utiles, telles que des plantes médicinales, ont complètement disparu. Il devient plus difficile de contrôler les feux de brousse. Par ailleurs, le nombre réduit d'agents pollinisateurs, ainsi que les distances plus grandes séparant les plantes ont entraîné une décroissance de la production de graines. La dissémination des graines par les moyens usuels (oiseaux, bêtes sauvages, bétail) est devenue moins fréquente. De même, la régénération naturelle des forêts a été rendue plus difficile par la disparition des agents pollinisateurs et de dissémination, ainsi que par les demandes accrues de pâturage. Bien des espèces de plantes et de faune, qui constituaient traditionnellement des sources de nourriture de reserve ou des éléments supplémentaires dans les économies locales, ne se trouvent plus en quantités suffisantes pour en permettre la récolte (par exemple, fonio, bourgu, gibier). Le "compte bancaire" naturel du Sahel est à présent épuisé. Dans certaines régions, la perte d'abrisseaux et d'arbres s'est avérée si marquée, qu'elle a entraîné la perte de la connaissance de l'horticulture, de l'emploi des plantes et des parcours de pâturage, et avec cela, les possibilités se trouvent diminuées pour les mères d'enseigner à leurs filles, et les pères à leurs fils, les connaissances portant sur l'écologie locale.

COMPTE RENDU DE LA SECHERESSE

La baisse dans la pluviométrie en Afrique de l'Ouest date de 13-16 ans. Le problème s'est manifesté de la manière la plus marquée au Sénégal, en La Gambie, au Mali, et au Niger, en passant de l'ouest à l'est. Cette période a duré suffisamment longtemps pour détruire de la végétation naturelle et pour supprimer définitivement certaines pratiques agricoles. Les media y ont prêté beaucoup d'attention. Toutefois, dans l'intervalle entre les années de pluviométrie extrêmement basse, on n'a jamais pu atteindre de nouveau dans les zones sahélienne et soudanienne les normes établies avant cette sécheresse.

Mais il y a pire: la saison des pluies s'est raccourcie: elle commence plus tard (de 16 à 21 jours) et elle se termine plus tôt (de 6 à 8 jours). En moyenne, la saison des pluies est de 22-27

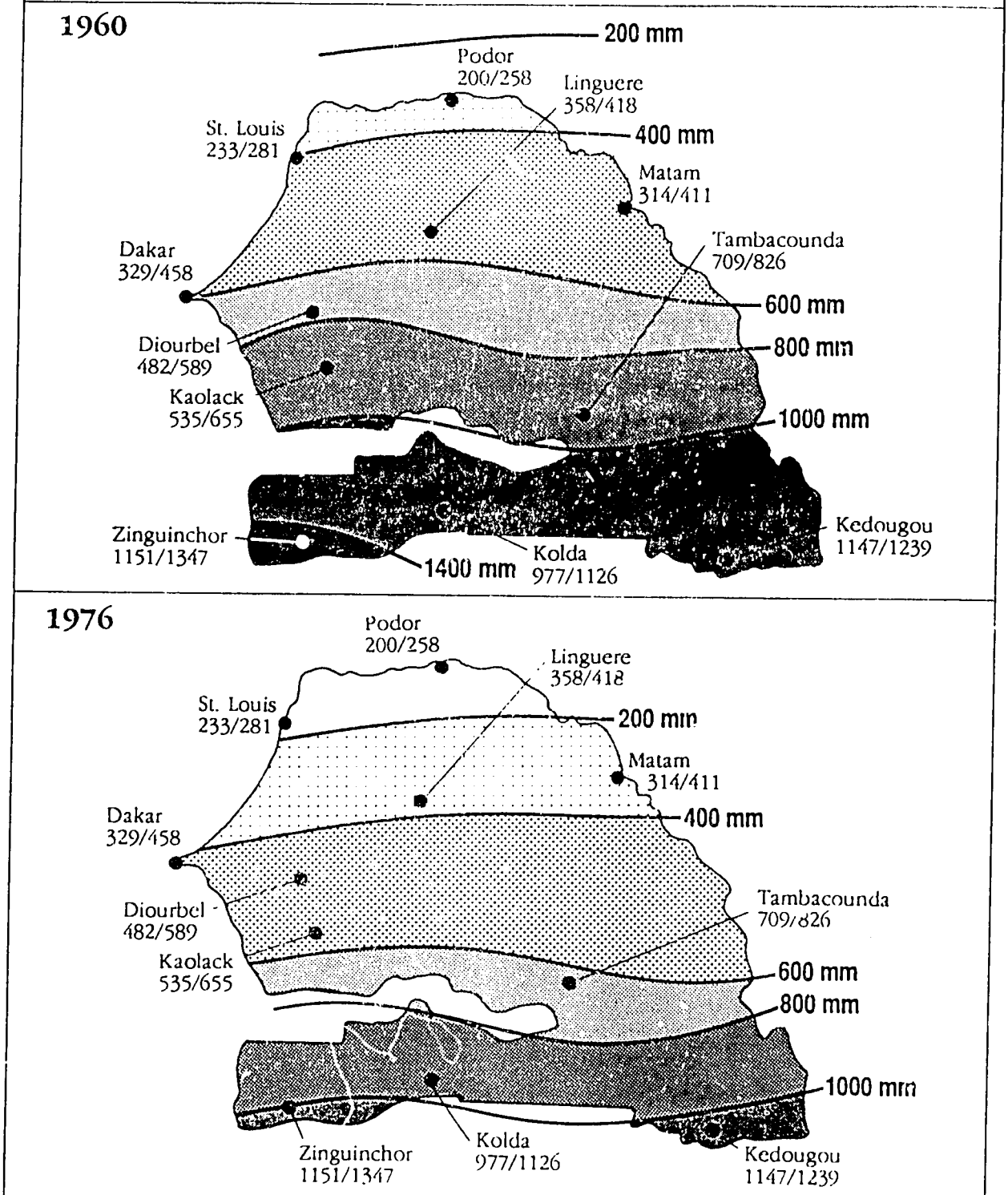
jours plus courte que les valeurs moyennes à long terme, sapant ainsi la capacité des fermiers de cultiver les variétés de cultures existantes jusqu'à maturité.

Les deux cartes en annexe montrent l'ancienne situation des pluies, et celle de nos jours. En effet, le Sahara s'est bien déplacé vers le sud. Il faut noter que le "nouveau" Sahel se trouve à présent à de 61 à 133 kilomètres au sud de l'"ancien" Sahel. Cela signifie que la zone du sorgho/mil et la zone de pâturage intermittent (200 à 500 mm) doivent remplacer une partie de la zone du maïs/sorgho/mil/arachide qui se trouve plus au sud (zone recevant de 500 à 900 mm de pluie). Une partie de cette deuxième zone remplacera, à son tour, des parties de la zone coton/cultures commerciales (par exemple, arbres fruitiers) au Sénégal et au Mali. De même, il a fallu que les rizières soient établies et en amont des fleuves et vers le haut des collines, afin d'éviter les eaux salées envahissantes. Dans d'autres régions, le riz se fait remplacer par le sorgho.

Du point de vue de la planification pour le développement économique, on peut tirer une conclusion évidente: **Ne pas utiliser la pluviométrie normale.** Beaucoup de projets envisagés pour le Sahel ont été voués à l'échec, du fait d'espérer que la sécheresse prendrait fin dès le commencement des travaux. Des interventions visant les écoulements, l'irrigation, des mélanges de cultures et le pâturage ont été planifiés en se basant sur des données pluviométriques surannées. Dans les années à venir, personne ne peut prédire le retour des pluies de la période pré-sécheresse; par conséquent, il faudrait élaborer des projets en utilisant les moyennes pluviomètriques des seize dernières années.

Afin de lutter contre la présente catastrophe, l'énergie humaine compense les forces naturelles. On pourrait citer comme exemple un programme important d'échange de semences, dans lequel on échange, vend ou transporte des espèces plus adaptées à la sécheresse et provenant du nord, vers le sud, c'est-à-dire dans des régions qu'on devra dès à présent considérer comme faisant partie du Sahel. En revanche, d'autres personnes apportent vers le nord des graines d'espèces du sud qui ont été détruites pendant la sécheresse; on les replante, moyennant une irrigation supplémentaire afin de compenser la pluviométrie réduite. Cet échange massif de semences représente la tentative de la part des populatiions de rétablir la biodiversité, et de s'adapter aux nouvelles conditions de sécheresse, lesquelles, en comparaison avec les durées de vie humaines en Afrique de l'Ouest, sont permanentes. Le désir de cultiver des arbres fruitiers et d'autres variétés cultivées paraît universel. La plantation d'arbres, quel que soit le degré d'adapatation et de succès de ces projets, est très

Seize Ans de Transformation Climatique au Sénégal



Pluviométrie annuelle en isohyètes en 1969 et 1976 démontrant une migration vers le sud de la sécheresse de 113 km. Chaque ville montre la pluviométrie moyenne des seize et trente dernières années. On constate une pluviométrie diminuée pour les seize dernières années à toutes les stations.

généralement considérée comme étant bénéfique du point de vue économique, et importante, du point de vue écologique.

Partout dans le Sahel, de grands nombres d'éleveurs ont perdu leurs moyens d'existence. Les bovins sont souvent remplacés par des caprins. L'accès aux sources d'eau, aux herbages, et aux pâturages par les éleveurs transhumants est devenu difficile, à mesure que les propriétaires locaux réservent ces ressources à leur propre subsistance. Ainsi de nombreuses dispositions traditionnelles régissant l'accès sont tombées en désuétude; ou bien, ont été rendues plus complexes par la nationalisation des pâturages en commun. Les pressions exercées par le pâturage sont extrêmement prononcées dans les localités où la sécheresse et/ou les règlements régissant l'accès permettent toujours l'exploitation du bétail. De tous les secteurs de l'économie, l'élevage du bétail s'est avéré le plus réfractaire et le plus difficile à contrôler. Il n'y a eu que de rares succès.

Partout dans le Sahel et même plus au sud, beaucoup de fermiers ont dû abandonner des champs de culture sèche ou côtoyant des rivières, puisque les eaux de ces rivières sont devenues trop salées. Parmi les autres consèquences de la sécheresse, les fermiers tiennent à faire pousser des cultures telles que le riz, le mil et le maïs, dont la courte saison de croissance répond à la saison des pluies raccourcie. Par ailleurs, étant donné une quantité de terres diminuée, les périodes de jachère pour les terres encore arables ont été réduites, allant par endroits de plus d'une décennie jusqu'à une année. En tentant d'augmenter la fertilité des sols, on met le feu à la brousse plus fréquemment et de manière plus intense. Et pourtant, cette technique provisoire n'a pas abouti: la période de jachère raccourcie est caractérisée par une fertilité des sols diminuée et par une érosion du sol augmentée. Dans de nombreuses zones du Sahel, et malgré l'augmentation de la superficie cultivée, la production vivrière totale a baissé. Les avantages à long terme découlant de la diversité et de la productivité des forêts, ainsi que des sols stables améliorés, sont devenus difficiles à atteindre.

De grands nombres de fermiers partout dans la région sont enthousiasmés par de nouvelles techniques telles que les micro-bassins et les captations d'eau, dont l'objectif est d'augmenter l'approvisionnement d'eau. Partout en Afrique de l'Ouest, on trouve des puits alimentant des jardins irrigués. Pour la première fois, des fermiers font usage d'engrais à base de pétrole et de phosphate dans ces jardins irrigués et dans les zones de pluviométrie plus importante, où les risques sont moindres. En revanche, l'achat d'engrais et, parfois, de semences adaptées aux conditions de sécheresse, a entraîné la participation des fermiers à l'économie de marché, augmentant ainsi le besoin de crédit.

De plus, la sécheresse a exacerbé le conflit entre la faune sauvage et l'agriculture; on considère de plus en plus en tant que animaux nuisibles, les élephants, les phacochères, les babouins, les hippopotames, et différentes espèces d'oiseaux. La pénurie d'eau a contraint beaucoup de mammifères de grande taille de quitter les parcs nationaux pour chercher de quoi manger dans les zones agricoles, où on les tue avec des armes à feu. Il existe, donc, un besoin pressant de la gestion des animaux nuisibles, afin d'élargir sa portée au-delà des sauterelles et des oiseaux granivores et pour envisager des moyens afin de maintenir en bon état l'agriculture et la biodiversité en Afrique de l'Ouest. L'état de la plupart des populations de mammifères de grande taille est désespéré.

Il existe également des malentendus entre générations très courants, car les jeunes croient de plus en plus fermement que les méthodes traditionnelles d'exploitation agricole, de pêche et d'élevage ne sont plus aussi valables qu'elles ne l'étaient par le passé. En conséquence de la crise du milieu, les habitants ouest-africains accueillent les innovations plus librement qu'ils ne le faisaient avant ou au début de la sécheresse. Les structures sociales de la vie économique sont devenues plus flexibles, afin d'y incorporer de nouvelles techniques et innovations permettant d'affronter les problèmes posés par les sols épuisés non-fertiles et la disette d'eau. Les personnes innovatrices qui adoptent de nouvelles méthodes pour faire face aux conditions de sécheresse, qui font usage de nouvelles façons d'augmenter leurs revenus monétaires et leur productivité à court terme au moyen de la conservation des sols, ou qui savent épargner l'énergie et la main-d'oeuvre, sont eux-mêmes des ressources naturelles importantes; car il faut dire que les interventions à grande échelle, telles que les projets anti-désertification exigeant de grands investissments de capital et de maintien ou les projets d'exploitation des bassins fluviaux comprenant des barrages et des systèmes d'irrigation à grande échelle, n'ont pas rapporté les rendements attendus.

La main d'oeuvre migratoire saisonnière vers les villes et d'autres pays (même la France) a beaucoup augmenté à mesure que l'ensemble des terres et des eaux diminuent, et que les économies monétissées remplacent progressivement la production locale des nécessités de l'existence. A mesure que les habitants ouest-africains se déplacent vers les villes, tout comme la population urbaine en général, ceux-ci perdent leurs sens des liens très intimes entre le sol, l'eau, les arbres, le bois de feu et la nourriture. La distance qui les sépare de l'écologie nationale a fait obstacle à la plupart des tentatives de préserver les ressources naturelles en en faisant un usage plus efficace (par exemple, foyers qui conservent le bois). L'urbanisation en croissance a entraîné la nécessité d'éducation en matière

d'environnement et de conservation, afin d'enseigner de nouveau ces liens et de souligner l'importance pour les ménages urbains de réduire les pressions exercées sur les ressources du pays. En elle-même, la sécheresse a nourri le désir de plus amples connaissances relatives à l'environnement et aux moyens de vivre dans ces nouvelles conditions. Les jeunes ouest-africains, qui sont nés après la disparition de la plupart des animaux sauvages, doivent se familiariser avec l'Afrique d'avant la sécheresse, ainsi qu'avec les animaux mentionnés dans les contes de leurs parents.

En somme, l'écologie humaine et l'économie de l'Afrique de l'Ouest sont passées par un changement important. La crise de l'environnement a laissé le chemin libre aux innovations et aux interventions susceptibles de faire face à la sécheresse et aux pressions exercées par des populations croissantes. Le défi consiste à rétablir une économie agro-sylvo-pastorale résistante et productive, laquelle conserverait au moins les ressources naturelles, et notamment la fertilité des sols et la qualité des eaux. Le défi plus grand lancé à l'Afrique de l'Ouest en matière de gestion est celui de l'amélioration des ressources naturelles en introduisant des techniques qui et augmentent la productivité à long terme des sols et aident à diversifier le couvert végétal; ces démarches serviront également à empêcher une crise humaine et économique encore plus prononcée pendant les périodes de sécheresse futures.

L'équipe a considéré le Sahel ouest-africain d'un point de vue optimiste. Partout, nous avons vu des gens qui substituaient leur propre imagination, leurs capacités techniques, leur énergie physique et leurs connaissances aux dons de la nature dont ils avaient joui par le passé: pluies, récoltes fiables, pâturages, forêts, fleuves, eaux souterraines, gibier, poissons et plantes médicinales. La sécheresse persistante et la crise économique ont définitivement changé l'Afrique de l'Ouest. Mais on pourrait envisager deux perspectives: soit on peut, en considérant la dégradation du milieu, prévoir un sort malheureux; ou bien, on pourra, en s'inspirant des actions audacieuses et créatrices de petits fermiers, pêcheurs et bouviers individuels, envisager les possibilités d'un avenir difficile, mais non impossible à réaliser.

BIODIVERSITE: LA RESSOURCE NATURELLE A LAQUELLE ON NE PRETE PAS D'ATTENTION

La biodiversité désigne une ressource naturelle qu'on a récemment "découverte." Réduite à l'essentiel, la biodiversité est la ressource naturelle que les hommes scientifiques appellent le plasma germinatif. La plupart des gens connaissent le plasma germinatif sous forme d'organismes constitués de matière génétique, c'est-à-dire les animaux et les plantes, englobant le riz et les élephants, les champignons et les oryctéropes. Et pourtant, la biodiversité signifie plus que les seules espèces; elle comprend également la notion de conservation de ces espèces dans des populations suffisament nombreuses pour assurer leur existence à l'avenir. La conservation de la biodiversité est rendue la plus facile et la plus sûre, en préservant la communauté des espèces qui la supporte et qu'elle aide à préserver. En Afrique de l'Ouest, il y a cinq communautés biotiques: le désert du Sahara; les terres sèches du Sahel où poussent des arbres et des arbrisseaux; la forêt sèche soudanienne; les estuaires littoraux et les îles près de la côte; et les cours d'eau douce. Au sein de chacune des ces communautés, il existe une chaîne alimentaire et des végétaux qui diffèrent de manière importante de celles des autres communautés. De plus, dans chacune de ces communautés, il peut y avoir d'autres distinctions plus fines, qui représentent également des complexes, seuls en leur genre, de plasma germinatif suffisant à leurs propre besoins. Par exemple, dans le Sahel on trouve des dunes, des reg (collines tronquées), des plateaux, des bassins d'eau fermés, et des dépressions, dont chaque accident du terrain est une variante évidente de la communauté biotique du Sahel.

On s'est familiarisé avec la notion de biodiversité à cause d'une des questions importantes sur laquelle elle met l'accent: les espèces et les variétés exposées à des risques et menacées d'extinction. Cette optique aide à illustrer le souci double de la biodiversité. D'un côté, il existe la nécessité de préserver des espèces dont les usages humains directs ne sont pas immédiats ou suffisamment bien compris. En Afrique de l'Ouest, les hommes font usage de presque toutes les espèces connues de plantes et d'animaux; et pourtant, sur cette liste peuvent figurer certains animaux, tels que le chien sauvage, le martin-pêcheur pygméen et le calao des terres, ainsi que certaines plantes qui n'ont pas encore été étudiées pour déceler de possible usages médicinaux ou industriels. Il se peut que ces espèces ou communautés ne continuent d'exister que dans des régions protégées que les gouvernements nationaux auront consacrées à cet usage. Dans ces cas, le but immédiat de la biodiversité est la creation d'un refuge où les citoyens pourront regarder une partie de leur héritage africain, lequel, sans cela, aurait disparu; d'une communauté

biotique de référence, en comparaison avec laquelle on peut apprécier les changements produits par les êtres humains; et d'un milieu éducatif dans lequel les enfants et les adultes peuvent étudier l'écologie, les communautés naturelles et la biologie de l'Afrique tropicale.

De l'autre côté, on tient à préserver différentes espèces dont les hommes font usage. Celles-ci comprennent des especes animales, telles que le lamantin, qui fournit de la nourriture en période de sécheresse et qu'on considère comme étant sacré dans de nombreuses religions locales, et des plantes telles que les variétés de mil en voie de disparition qui seraient résistantes aux maladies, à la sécheresse et aux dégâts causés par les oiseaux, ou des arbres comme le kouf, qui est menacé par la sécheresse et la surexploitation, et dont on fait traditionnellement usage pour des fins médicinales et religieuses depuis très longtemps. Pour les fins de cette évaluation, la biodiversité implique la préservation de la variété dans les milieux tant naturel qu'humain. On peut marquer le contraste entre la biodiversité et les activités qui diminuent la richesse des espèces et l'abondance des populations. Il y a sous cette rubrique, trois questions importantes: les types d'habitat, les espèces et les variétés des cultures (plasma germinatif). En realité, il est impossible de distinguer, l'un de l'autre, les milieux naturel et humain en Afrique de l'Ouest. Dans la plupart des cas, l'écologie humaine relevant de la biodoversité est d'une importance cruciale, et pour la conservation et pour le développement soutenable.

CHAPITRE II
METHODES ET CRITERES DE DEFINITION DE SUCCES

INTRODUCTION

En novembre 1987 et janvier 1988, une équipe polyvalente, composée de personnes ayant longuement travaillé dans le Sahel ouest-africain, a visité quatre pays, à savoir le Mali, le Niger, le Sénégal et la Gambie. Elle était chargée de documenter et d'évaluer dans ces pays des initiatives réussies en matière de gestion des ressources naturelles. Le Bureau africain de l'USAID avait demandé à cette équipe de définir des critères de succès, d'identifier des interventions réussies sur le terrain, de documenter et d'analyser ces réussites, et d'en tirer des leçons qu'on pourrait appliquer pour augmenter le nombre d'options régissant l'élaboration d'une stratégie pour les ressources naturelles dans le Sahel.

METHODOLOGIE D'EVALUATION

Notre équipe a élaboré une méthodologie bien définie. Préalablement à chaque visite dans un pays particulier, les membres de l'équipe s'informaient, auprès de professionnels qualifiés, sur les interventions réussies en cours en matière de ressources naturelles. Simultanément, et en faisant appel au personnel des missions de l'AID, nous cherchions à identifier des sites d'importance particulière. D'après les listes maîtresses, notre équipe a choisi des endroits qui étaient typiques des ressources naturelles, des organismes donateurs, des régions et des écologies.

Les membres ont également consacré beaucoup de temps à la définition des types de données à recueillir dans chaque endroit, ainsi que les critères de succès. Après plusieurs itérations notre équipe a élaboré une approche uniforme de collecte de données à chaque endroit. On considérait la normalisation comme étant importante pour s'assurer de l'efficacité et de l'uniformité des visites sur le terrain; et pourtant, à notre avis il était tout aussi important de se servir d'un format permettant des discussions non-structurées des facteurs qui auraient contribué au succès du projet dans un endroit donné. Le format des rapports reflète ce besoin de flexibilité (Table 2.1).

TABLE 2.1.
FICHE D'ENREGISTREMENT DES DONNEES
SYSTEMES DE GESTION DES RESSOURCES NATURELLES

I. DONNEES DE BASE

A. Lieu
B. Participants à la visite
C. Caractéristiques principales du lieu (sols, végétation, eau)
D. Nombre d'hectares concernés
E. Facteurs spéciaux du cas particulier
F. Pratiques traditionnelles relevant de l'exploitation des terres
G. Nature de l'intervention

II. DESCRIPTION DE L'INTERVENTION

A. Mesures techniques mises en oeuvre
B. Organisation sociale de l'intervention
C. Système de primes d'encouragement économique
D. Données socio-économiques

III. DISCUSSION GENERALE SUR L'INTERVENTION

Dès son arrivée dans chaque pays, l'équipe passait plusieurs jours dans des réunions avec des dirigeants gouvernementaux, du personnel de l'AID et d'autres contacts clés dans les capitales. Ces réunions permettaient à l'èquipe de faire un choix définitif des sites à visiter, de consulter des documents clés, de prendre des rendez-vous pour des visites avec le personnel de terrain et, lorsque cela s'avérait convenable, d'incorporer des cadres de l'AID et/ou des ministères concernés dans les équipes s'exerçant sur le terrain.

Le choix final des sites à visiter était basé sur plusieurs critères. Premièrement, nous envisagions d'établir un équilibre entre les interventions du secteur privé qu'appuyaient l'AID, d'autres organismes donateurs bilatéraux et multilatéraux et des organismes non-gouvernementaux. Deuxièmement, l'équipe décidait de ne rendre visite qu'aux interventions qui auraient été réellement mises sur pied depuis au moins trois ans, et, de préférence, plus longtemps. Nous nous sommes efforcés d'évaluer des interventions visant chaque ressource naturelle principale, savoir l'eau, les sols, la diversité de la flore et de la faune et l'énergie humaine. Finalement, il fallait prendre en considération

des questions logistiques. Notre équipe ne pouvait pas, par exemple, visiter la Deuxième Région du Mali, le Ferlo et la Vallé du Sénégal au Sénégal, ni les départements du nord et de l'est du Niger, en raison des limitations du temps, des conditions difficiles de déplacement et des grandes distances à parcourir. Cependant, nous tenions à nous assurer que les régions visitées embrasseraient, en gros, toutes les variations écologiques et économiques à l'intérieur de chaque pays.

Pour chaque pays, notre équipe originale s'est répartie en deux ou trois petites équipes, afin de pouvoir affecter le nombre de personnel disponible dans le pays au nombre de visites prévu. L'incorporation de spécialistes des sciences naturelles et sociales dans chaque équipe encourageait une collecte de données plus rapide et plus approfondie. Au total, nous avons visité plus de 70 différentes interventions visant la gestion des ressources naturelles dans quatre pays. Il faudrait bien noter que nous mettions l'accent sur des interventions et non pas des projets; nous tenions non seulement à surmonter une tendance vers l'évaluation de projets, mais aussi à faire des appréciations d'interventions dont le financement provenait et du secteur privé et du secteur public. Il arrivait souvent que les interventions visitées faisaient partie intégrante de projets d'une portée plus vaste. Par ailleurs, nous observions très souvent des efforts qu'on déployait avec succès au sein de projets, lesquels, lorsqu'on les appréciait dans l'ensemble, n'étaient pas réussis. En beaucoup de cas, les interventions en étaient à leurs stades de développement initiaux; ainsi ne pouvait-on les caractériser, à ce stade-là, comme étant de véritables réussites. Enfin, en mettant l'accent sur des interventions plutôt que sur les projets, les membres pouvaient documenter les efforts innovateurs qui retenaient leur attention.

Notre équipe reste convaincue que, malgré les limitations du temps et des distances, l'enquête englobait bien toute une gamme d'interventions portant sur les ressources naturelles dans le Sahel. Les bandes d'échantillonnage ont couvert les parties tant nord que sud du Sahel, dans les régions historiques soudano-sahélienne, soudanienne et soudano-guinéennes. Dans chaque zone, les endroits représentatifs contenaient un haut degré de diversité écologique, économique et sociale. Par exemple, nous avons étudié des plateaux, des plaines et des vallées fluviales; les interventions appréciées touchaient des zones agricoles, des réserves forestières et des régions sauvages. L'expérience préalable des membres de l'équipe dans d'autres circonstances au Sahel a fourni des exemples utiles, complémentaires à ceux observés en tant qu'équipe.

Notre équipe a passé de quelques heures à une demi-journée à visiter chaque site. Au début de la visite, on révisait des

informations générales avec le personnel du projet ou avec des services de vulgarisation. Ensuite, accompagnés de ce personnel, nous rendions visite à un ou à plusieurs sites où se déroulaient les activités sur le terrain, afin de mener des entrevues avec le personnel. Souvent, celles-ci commençaient dans une maison particulière ou au centre d'activités villageois, et se poursuivaient sur le terrain. On interviewait personnel et villageois. Il arrivait fréquemment que l'équipe se divisait, en séparant les participants villageois du personnel d'assistance, afin d'encourager l'expression plus libre de leurs opinions. Lorsqu'on appréciait une intervention privée, ces différentes démarches étaient souvent incorporées dans une longue discussion avec les entrepreneurs concernés.

Le plan des rapports de terrain, représenté dans la Table 2.1 ci-dessus, a aidé l'équipe à structurer ses enquêtes et les rapports soumis aux missions de l'AID dans chaque pays. De plus, les membres employaient des listes de thèmes ou de questions clés, afin de mieux structurer les discussions qu'ils entretenaient sur le terrain. On recueillait des données à la main, en les transcrivant dans les notes de chacun. Chaque membre d'équipe tâchait de représenter les phénomènes observés, en fournissant des détails aussi exacts et fins que possible. Quoique chaque membre de l'équipe de recherche eût son style à lui légèrement différent de celui des autres, chacun d'entre eux tenait à respecter les objectifs de fidelité et de provision d'informations complètes. A mesure nous poursuivions nos travaux, l'assimilation progressive des mêmes valeurs et des procédés intellectuels par tous les membres de l'équipes nous aidait à concentrer notre attention sur ces objectifs et à èlaborer un portrait détaillé de chaque intervention. A la fin de chaque journée, les membres échangaient leurs notes entre eux. De plus, ils travaillaient en commun à dresser le portrait synthétique de chaque intervention, au cours de la séance que nous consacrions la fin de chaque semaine passée sur le terrain à la rédaction des rapports.

VERS UNE DEFINITION DE LA REUSSITE

Tout au début, notre équipe avait pour mission d'identifier les interventions techniques qui (par exemple, l'Acacia albida, les brise-vent, les diguettes en courbe de niveau, les haies vives, etc.) concouraient à la réussite de la gestion des ressources naturelles de la part des petits cultivateurs; et de classer ces interventions selon leur degré d'efficacité. Cependant, nous avons trouvé, au stade initial de notre évaluation, que les interventions qui répondaient à nos critères, c'est-à-dire qu'elles étaient soutenables et qu'elles pouvaient se reproduire d'endroit en endroit, résultaient d'un agencement de facteurs sociaux, financiers et techniques. Par conséquent, nous avons mis un accent plus marqué sur les observations faisant partie des rapports de

visites sur le terrain, car nous n'avions pas l'intention de ne trouver que ce que nous cherchions; plutôt nous tenions à comprendre les facteurs fondamentaux mis en jeu aussi pleinement que possible.

En recherchant des cas de réussite, notre équipe ne prenait pas nécessairement en considération le but du projet ou intervention en question. Parfois, les réussites étaient inattendues et différaient du dessein original de l'activité en question. En d'autres termes, notre attention était portée sur les enchaînements des faits; nous désirions éviter d'évaluer un projet en nous basant sur ses termes de référence. Les interventions étudiées pouvaient donc être de nature technique (les foyers à faible consommation d'énergie, la protection de cours d'eau, les micro-bassins d'eau), sociale (la résolution de conflits portant sur l'accès aux ressources communales, la création de coopératives villageoises) ou économique (les travaux compensés par la nourriture, le capital d'apport, les espèces, le crédit).

Pour les fins de notre enquête, on considérait une intervention comme étant réussie si elle parvenait à satisfaire au moins un des critères suivants:

- améliorer la fertilité des sols ou arrêter la dégradation additionnelle;

- améliorer l'utilisation des eaux ou la gestion de la qualité de l'eau;

- augmenter la couverture végétative, notamment les plantes qui aident à affermir le sol, à améliorer la fertilité des sols ou à gérer l'approvisionnement d'eau;

- maintenir en état ou améliorer les conditions stimulant la biodiversité, y compris des variétés agricoles et horticoles, ainsi que les espèces et les habitats naturels;

- épargner ou structurer de nouveau les énergies humaines (augmentation de la productivité), afin que des individus ou des communautés disposent des revenus et/ou du temps nécessaires pour prendre en considération la gestion des ressources naturelles.

Les pauvres en pays rural ne s'opposent pas à la protection de leurs ressources naturelles; bien au contraire, lorsqu'ils en sont informés, ils semblent désirer améliorer la gestion des ressources. Pourtant, les économies appauvries et dépourvues de ressources ont très souvent fait de sorte, que les fermiers ne se soucient guère que de se procurer les moyens de subsistance à court terme. Autant "la conjoncture" (la crise économique prolongée) que la vitesse de la détérioration écologique empêchent les fermiers,

les éleveurs et les citadins de tenir compte des coûts et des bénéfices à long terme, lesquels,liés aux ressources naturelles, résultent de leurs conduites. En effet, il y avait souvent une relation étroite entre la gestion réussie des ressources naturelles et des améliorations générales apportées aux économies nationales et locales, ainsi que des programmes de planification familiale.

Les critères de succès ont été mis au point à mesure que notre équipe devenait plus expérimentée. Le choix du moment auquel on mène l'évaluation d'une intervention prête à des conclusions différentes. Par exemple, au Mali, il a fallu consacrer beaucoup d'années au démarrage des foyers à faible consommation d'énergie, en tant qu'entreprise autonome. Au bout de cinq, ou même sept, ans, on considérait que les projets de foyers maliens avaient échoué. Et pourtant, au bout de dix ans, la plupart des domiciles ruraux maliens contiennent des foyers améliorés; en effet, beaucoup de villageois en fabriquent. En général, il n'existait pas de périodes bien délimitées d'incubation, de développement et d'acceptation totale d'idées et techniques différentes; aussi avons-nous conclu que la qualification d'"échec," qu'on y appliquerait prématurément, ne servirait qu'à faire obstacle à la réalisation d'objectifs de gestion des ressources à long terme. Parfois, des interventions devenaient des réussites lorsque, par suite de la prolongation du financement sur plusieurs années, l'acceptation se développait dans un village ou une région. Parmi les exemples de ce phénomène, on pourrait citer la régénération de l'Acacia albida et l'implantation de brise-vent dans le bassin d'arachides au Sénégal. Il était difficile dans d'autres cas de prédire le moment propice où il convenait de juger du succès ou de l'échec. En général, si une intervention répondait à d'autres critères (primes d'encouragement, risques faibles, respect des valeurs communales, technologie appropriée, réalisable du point de vue technique), il semblait qu'une période de dix ans au minimum était nécessaire à la réussite.

La réussite varie aussi en fonction du contexte. Par exemple, la plantation d'arbres au Sénégal s'avère très réussie par comparaison à la situation d'il y a quelques années. Les risques évidents sont moindres; il existe des primes d'encouragement; on met les techniques nécessaires à la disposition des intéressés; il y a eu résolution de certains conflits avec des valeurs et la structure sociale locale; et enfin, les droits relatifs aux arbres semblent assurés. Cependant, du point de vue de la diversité des espèces et du reboisement, la plantation d'arbres n'a pas pleinement atteint son but. Premièrement, certaines espèces, dont l'Eucalyptus et le Gmélina, ne visent que des usages uniques à court terme (poteaux de construction). Par exemple, l'Eucalyptus n'a pas les mêmes effets bénéfiques sur la fertilité au sol, comme l'Acacia albida et le Cordyla pinnata. De plus, le bois de feu de Gmélina est de mauvaise qualité. Et pourtant, quoique, à notre

avis, ce premier stade (la plantation d'arbres) doive dès à présent être modifié, afin de mettre en jeu la diversité des espèces et les arbres à usages multiples et dont la capacité de redonner de la fertilité au sol est améliorée, il serait erroné de considérer ce premier stade comme étant un échec. En fait, la plantation d'arbres pour en obtenir des perches de construction peut représenter la meilleure (plus rentable) utilisation de la terre. L'enthousiasme lié aux bienfaits à court terme découlant de la plantation d'arbres constitue, en toute probabilité, une étape intermédiaire nécessaire précedant un deuxième stade visant l'enrichissement et la consolidation de la diversité biologique et économique.

Le succès varie également en fonction de la perspective de l'observateur. L'analyse des coûts et des bénéfices usuelle ne représentait pas toujours un instrument suffisant pour mesurer la réussite. Par exemple, en ce qui concerne les interventions visant la biodiversité, il était impossible d'attribuer une valeur économique à la préservation d'espèces d'oiseaux ou d'habitats uniques. Or, il n'y avait que certaines interventions qui produisaient des résultats immédiats (par exemple, des barrages de retenue de réservoirs augmentaient des récoltes). Il y en a d'autres, et notamment les parcs nationaux, les haies vives et la gestion des bassins hydrographiques, dont les bienfaits ne se réaliseront que sur une période de temps trop longue pour permettre à l'équipe de la mesurer, la prédire ou l'observer au cours une brève visite. Pour les écologistes culturels, il est évident que la sécurité accrue des droits de jouissance, en encourageant la gestion améliorée des ressources naturelles, constitue un facteur évident de réussite, quoique l'analyse économique de ce phénomène reste difficile à faire. De même, et malgé l'échec d'interventions techniques particulières, certains aspects du processus, dont la participation des villageois à l'élaboration de projets et le choix des sites, sont d'une importance cruciale pour la réussite à long terme; la participation favorise le respect de soi, la confiance en soi et l'indépendance, facteurs qui contribuent tous à la gestion soutenable des ressources naturelles et au développement. Une seule ressource, ou bien la perspective bornée d'un secteur particulier, risquent d'aveugler l'observateur sur la dynamique en cours de l'utilisation des ressources. Parfois, par exemple, en augmentant l'intensité avec laquelle ils exploitaient dans un seul but les terres dans un endroit, des villageois allégaient la pression qu'ils y exerçaient à un autre.

LES LIMITES DE NOTRE ETUDE

L'équipe a limité la portée de notre étude en raison du temps disponible, des désirs de l'USAID et de ses propres connaissances

spéciales. Par conséquent, nous avons omis d'étudier certaines questions fondamentales. Par exemple, nous n'avons pas examiné le problème de la planification familiale, ce qui constituait un lacune importante dans notre enquête sur les ressources naturelles, étant donné que les pressions exercées par la population fatiguent souvent les ressources naturelles. De plus, nous n'avons pas cherché à savoir si les femmes essayient de réduire les dimensions de leurs familles, afin de mieux faire face aux conditions de sécheresse et aux limites imposées à la production vivrière. Parmi les membres de notre équipe, il n'y avait pas de consultant spécialisé dans le domaine "femmes et développement" qui pût susciter des échanges de vues sur les questions de planification familiale qui touchent les femmes en particulier. De plus, nous n'avons pas étudié l'impact éventuel du SIDA (Syndrome immuno-dépressant acquis) sur la qualité de vie et sur les réserves d'énergie humaine dans le Sahel.

Par ailleurs, nous n'avons eu qu'un contact superficiel avec les interventions visant la pêche marine ou d'eau douce. Nous n'avons visité qu'un seul projet d'aquaculture, et à un autre de l'élevage de crevettes. Et pourtant, la sécheresse a provoqué d'énormes réductions dans les quantités de poissons d'eau douce et des espèces qui dépendent des estuaires. Depuis 1960, les prises ont baissé de 80% dans le fleuve Niger (au Niger); de plus, beaucoup de pêcheurs ont abandonné leur travail traditionnel le long des fleuves Sénégal et Niger, et ceux qui restent ont été forcés à prendre de jeunes petits poissons dans bien des endroits. Pour compenser ces pertes, on commence à s'intéresser à la pisciculture; mais les premiers projets de ce genre n'existent plus, et ceux qui ont été mis sur pied par la suite sont trop récents pour susciter des commentaires. Puisque les pêcheries n'ont pas, jusqu'à ce jour, fait l'objet des efforts de l'USAID, elles ne faisaient pas partie intégrante de nos termes de référence. D'autres pays et organismes, dont le Canada et la FAO, s'intéressent beaucoup plus à cette ressource.

De même, notre équipe n'a pas étudié les interventions visant le fourrage et le bétail, quoique cette question importante ait fait l'objet des efforts de l'AID par le passé. L'expérience au Sahel a été particulièrement morne en ce qui concerne le suivi, l'amélioration ou l'élaboration de programmes efficaces de gestion des animaux qui broutent.

Enfin, notre équipe n'a pas étudié les minéraux, bien que les phosphates soient un produit important au Sénégal, au Mali et au Niger, de par leur entrée dans le marché des engrais à l'usage de petits fermiers. Même si ces quatre pays produisent des phosphates minéraux, l'absence d'une stratégie régionale production et de commercialisation les a contraints à importer des engrais à base de pétrole. Le bétail, les pêcheries et les minéraux constituent

des questions complexes en matière de gestion des ressources naturelles, questions exigeant des analyses micro- et macro-économiques approfondies. Elles méritent d'être étudiées en détail dans le cadre de l'élaboration d'une stratégie d'ensemble visant les ressources naturelles du Sahel.

CHAPITRE 3
INTERVENTIONS REUSSIES EN MATIERE DE GESTION DES RESSOURCES NATURELLES DANS LE SAHEL

INTRODUCTION

Vue d'ensemble

Ce chapitre présente une synthèse des observations faites par notre équipe dans soixante-dix interventions réussies visant la gestion des ressources naturelles auxquelles nous avons rendu visite dans les quatre pays. Nous nous sommes efforcés de communiquer non seulement les faits tels que nous les constations lors de chaque visite, mais aussi un sens des facteurs sous-jacents qui ont contribué au succès de chacune de ces actions. Les rapports des visites sur le terrain comportent beaucoup plus d'informations (présentées au Volume II) que ne pourrait raisonnablement assimiler le lecteur d'après une seule lecture; par conséquent, les observations seront classées en trois catégories principales, à savoir les interventions techniques, les interventions socio-économiques et les mesures politiques. Chaque catégorie est définie brièvement dans la section appropriée. Les conclusions présentent en résumé certaines caractéristiques et facteurs décisifs concourant au succès.

Afin de conserver la richesse et la diversité des interventions sur le terrain, les discussions dans chaque catégorie sont suivies d'exemples spécifiques cités en référence (références dans les cases horizontales à la fin de la discussion pertinente). Par ailleurs, pour plus de commodité, nous présentons au lecteur quatorze exemples de cas abrégés, d'une page chacun, reproduits dans ce chapitre. Quand c'est praticable, les textes et les références renfermées dans les cases se reportent à ces quatorze cas. Or, une familiarité avec cet ensemble limité d'observations sur le terrain fournira au lecteur des points de répère concrets et accessibles pour les discussions et les exemples que nous présentons ci-après. Nous avons choisi ces quatorze cas abrégés à cause de leur nature réprésentative. Pourtant, nous ne saurions prétendre qu'ils peuvent remplacer les comptes rendus beaucoup plus amples de chaque intervention que comporte le Volume II.

Y a-t-il eu des succès?

Y a-t-il eu des succès? La réponse simple est oui. Nous avons observé des succès frappants qui ont produit des impacts évidents, parfois sur de grandes populations. Cette catégorie comprend plusieurs aspects du projet Guesselbodi de gestion des forêts naturelles (Niger), le projet de Brise-vent dans la Vallée

de la Maggia (Niger), et les programmes visant l'adoption de foyers de terre améliorés (Mali). Le succès de ces programmes résidait typiquement dans la conjonction des actions qui se déroulaient simultanément. Aucun facteur unique ne conduit à lui seul au succès d'une intervention donnée; de même, aucun type d'intervention n'est forcément voué au succès. Le projet de Guesselbodi, par exemple, tient plus d'une série d'actions que d'une intervention simple: l'affectation de main-d'oeuvre salariée à la restauration des terres, l'aménagement des forêts, la plantation et la récolte d'herbes, et la création de coopératives de bûcherons villageois. De même, le programme malien des foyers se fondait sur la formation, la publicité en masse, le développement technologique et la mobilisation sur les plans social et politique. Dans les trois exemples cités ci-dessus, non seulement les actions entreprises ont réussi d'après leur propre mandat, mais aussi elles sont susceptibles d'être reproduites dans d'autres contextes.

TABLE 3.1

Quatorze Cas de Gestion des Ressources Naturelles

Barrages d'arrêt de l'Opération Haute Vallée (Mali)
Barrages d'arrêt et Microbassins (Niger)
Barrages de retenue d'eau et Conservation des sols (La Gambie)
Pépinières privées (Sénégal)
Techniques de solution des conflits (UICN) (Mali)
Education relative à l'environnement (Mali)
Projets de jardinage privés (Sénégal)
Introduction du riz à cycle court (La Gambie)
Associations intégrées de développement rural (Sénégal)
Aménagement des forêts naturelles (Niger)
Coopérative de Guesselbodi des bûcherons (Niger)
Gestion des pêcheries fluviales (Niger)
Comité féminin de Bignona pour le contrôle des incendies (Sénégal)
Formation des fermiers en matière de ressources naturelles (Mali)

ACTIONS TECHNIQUES VISANT LA GESTION DES RESSOURCES NATURELLES

Conservation des eaux

On met en application des techniques de conservation des eaux partout en Afrique. Dans la région d'Adar Doutchi au Niger et dans le Plateau de Bandiagara au Mali, par exemple, les fermiers Haoussa

et Dogon, respectivement, construisent habituellement des caniveaux consistant en des rangées de pierres, afin de retenir des écoulements provenant des sols latéritiques croûteux. Dans le bassin du fleuve Sénégal en Mauritanie, les fermiers Haalpulaar construisent des clôtures faites de broussailles à travers de petits tuyaux de drainage, de façon à ce que le sable transporté par le vent (qui s'entasse le long des clôtures pendant la saison sèche) forme un barrage de retenue d'eau. Les producteurs de riz Jola au Sénégal et en La Gambie ont, depuis longtemps, capté des eaux de pluie et de l'eau de rivière afin de cultiver leurs rizières au moyen d'irrigation. Au Plateau de Jos (Nigéria) et dans les montagnes de Mandara (Le Cameroun), l'emploi de terrasses était mis en valeur dans la période pré-coloniale. Toutes ces techniques de captage d'écoulements fournissent des eaux supplémentaires aux récoltes.

Nous avons observé, dans le cadre de notre évaluation, beaucoup de techniques de conservation des eaux qui **venaient d'être introduites** (voir la Table 3.2), y compris:

- des barrages de retenue pour pourvoir aux besoins des hommes et des animaux (Etudes de cas 1 et 2, Volume II);

- des barrages de retenue servant à augmenter la production agricole (Etudes de cas 3, 4 et 5, Volume II);

- des captages d'eaux pour augmenter la production d'arbres et de récoltes (Etudes de cas 6 - 9, Volume II);

- des barrages pour la protection des canaux d'écoulement (Etude de cas 10, Volume II);

- le labourage en courbes de niveau, les bandes de végétation et les banquettes rejointes (Etude de cas 3, Volume II);

- des brise-vent (Etude de cas 13, Volume II).

Table 3.2
Mesures réussies de conservation des sols et des eaux

Actions entreprises par des fermiers privés	Actions inspirées par des organismes donateurs
Peits barrages d'arrêt	Protection des canaux
Haies vives	Barrages d'arrêt traversant des ravines
Barrages de retenue	Stabilisation des dunes
Diguettes en courbe de niveau rejointes	Diguettes en courbe de niveau et banquettes
	Microbassins
	Rétablissement des terres érodées par couches, aux fins de l'agriculture

Certaines mesures de conservation des eaux, telles que les barrages d'arrêt de l'Opération Haute Vallée (Mali) et les barrages d'arrêt et microbassins Swissaid, ont réduit les risques résultant de la pénurie des pluies; ces mesures permettent la gestion plus intensive des terres, et elles économisent du temps et de l'énergie humaine. Les fermiers se montraient désireux d'expérimenter ces techniques, car il leur fallait très peu de capital, et que des quantités accrues d'eau, en combinaison avec des engrais, tendent à augmenter les rendements potentiels. En outre, l'intensification de la production réduit le nombre d'hectares que chaque ménage doit affecter aux cultures, allégeant ainsi les pressions exercées sur les terres marginales agricoles, pastorales et forestières.

Etude de cas: Barrages d'arrêt de l'Opération Haute Vallée

Les captages d'eau ont transformé des terrains vagues en des champs productifs, donnant plus de 600 kg de céréales par hectare avec une pluviométrie qui ne s'élève qu'à 250-300 mm (Etude de cas 7, Volume II). La construction de microcaptages sur des terrains dégradés abandonnés a donné des récoltes de céréales de 0,5 kg/m2 (500 kg/ha) avec une pluviométrie de 320 mm (Etude de cas 6, Volume II). Or, la construction de micro-
captages exige l'affectation considérable de main-d'oeuvre, laquelle constitue une ressource dont les ménages fermiers ressentent la pénurie. Quoiqu'il en soit, la transformation de terres incultes en cultures au moyen de méthodes de gestion plus intensives, procure des terres à ceux qui n'en ont pas la jouissance; de plus, elle apaise des conflits naissant des droits de jouissance et elle réduit les pressions sur une ressource fragile.

Etude de cas: Les Microcaptages d'Enadoujoum et les Barrages d'arrêt d'Ourihamija

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Selon les conclusions tirées des entrevues avec des fermiers habitant la Haute Vallée du Mali, à Tahoua, au Niger et La Gambie, les efforts de conservation des eaux à grande échelle font appel à des capacités techniques, financières et d'organisation qui dépassent celles des localités. Et pourtant, des projets de démonstration spectaculaires encouragent parfois des organismes locaux à entreprendre eux-mêmes des travaux supplémentaires, moyennant de l'assistance technique et financière extérieure. L'Unité d'éxploitation des Sols et des Eaux de La Gambie et le Projet Intégré Keita de Développement Rural en sont des exemples.

La mise en disponibilité opportune d'intrants, de crédit et d'assistance technique compétente et flexible était d'une importance cruciale pour la réussite des projets de conservation des eaux que nous avons visités. Peut-être que le facteur le plus important de plus était le transfert des techniques qu'on pouvait mettre en oeuvre en y affectant des ressources locales. Parmi les exemples édifiants, on pourrait citer la technique de captage de Swissaid (Etude de cas 7, Volume II), qui met l'accent sur des méthodes dont les fermiers peuvent faire usage moyennant un minimum d'assistance extérieure, ainsi que l'extension de sa portée opérée par le Service forestier du Département de Tahoua, Niger.

La Conservation du sol et la fertilité améliorée

La conservation du sol est tout aussi difficile à réaliser dans le Sahel que partout ailleurs dans le monde. Les bénéfices résultant de la conservation des sols sont moins évidents et d'un impact moins immédiat que ceux découlant de la conservation des eaux. Par ailleurs, la conservation du sol exige qu'on y consacre des quantités considérables de temps et de main-d'oeuvre, et elle peut conduire à des sacrifices de la production à court terme. A défaut de mécanismes de relais ou d'autres encouragements, ces deux coûts limiteront son extension.

La croissance démographique explosive, l'accroissement de la production agricole commerciale et la baisse des pluies constituent une charge démesurée par rapport à la capacité des sols fragiles du Sahel de produire de la nourriture, du fourrage et des fibres selon les pratiques de gestion actuellement en vigueur. Partout dans le Sahel, en raison du défrichement de terres et des jachères en baisse, les sols subissent l'érosion éolienne et hydraulique, ainsi que les conséquences de l'augmentation de l'évaporation et du lessivage. La baisse des pluies a également occasionné la baisse des niveaux fluviaux et une pénétration accrue des eaux salées le long des voies navigables côtières. Tous ces processus réduisent la fertilité. L'érosion augmente la charge sédimentaire dans l'air et dans les eaux. Les réservoirs s'emplissent rapidement de sédiments flottants. Des sables stériles sont déposés sur des champs qui, par le passé, étaient productifs. Des ravines coupent des vallées anciennement fertiles, en y limitant l'accès et en rendant l'agriculture impraticable. Des ravines creusées dans cours d'eau emportent les écoulements des orages, réduisant la fréquence et la durée de l'inondation des plaines inondables. Ces ravines diminuent les niveaux phréatiques et, par endroits, détruisent les forêts dont la survie dépend des niveaux hydrographiques élevés et d'inondations saisonnières.

Dans les zones de pluviométrie accrue, telles que la région

de Sikasso, Mali (pluviométrie de 1200 mm), l'excédent des eaux est souvent un problème: les risques posés par la formation de ravines et par l'érosion de couches s'avèrent encore plus graves lorsqu'il s'agit de sols croûteux d'où le couvert arboré a été enlevé. La conservation des sols est une action prioritaire dans ces zones.

Les fermiers se rendent bien compte des bénéfices de la conservation des sols, et notamment le maintien des substances nutritives et organiques. Les pratiques traditionnelles d'amélioration de la fertilité des limons sablonneux sont liées à la conservation des eaux et/ou aux actions relevant de l'agro-foresterie (voir ci-dessous). L'usage de cultures intercalaires telles que des légumes ou la plantation d'arbres qui fixent l'azote, en sont des exemples. Les inondations saisonnières le long des lacs, des étangs et des rivières permettent également aux fermiers de se lancer dans les cultures permanentes sans toutefois réduire la fertilité du sol.

Là où l'érosion menace directement les cultures, les fermiers ont mis en oeuvre des mesures de conservation du sol, souvent avec le soutien des projets en matière de vulgarisation. Parmi les exemples figurent les diguettes en courbe de niveau appuyées par l'OXFAM au Burkina Faso, par le projet de recherche DRSPR en matière de systèmes de gestion agricole financé par les Pays-Bas et par l'organisation semi-publique CMDT dans la région de production cotonnière de Sikasso, Mali; les techniques de gestion d'ensemble des bassins hydrographiques, dont la portée a été élargie par le Projet Keita au Niger; et les digues, les barrages de protection et les bermes en courbe de niveau, par l'Unité de Gestion des Sols et des Eaux (SWMU) en La Gambie. Tous ces projets ont réalisé l'adoption répandue de mesures de conservation simples et peu onéreuses.

Parmi les autres interventions réussies visant la conservation des sols, qui sont en voie d'extension dans le Sahel, figurent les brise-vent (Etudes de cas 13 à 15, Volume II); les barrages d'arrêt (Etude de cas 11, Volume II); les digues de détournement (Etude de cas 12, Volume II); les barrages de protection de canaux (Etude de cas 10, Volume II); et la récolte des eaux (Etudes de cas 1 à 9) (voir la Table 2.2). Ces interventions exigent parfois des investissements considérables de capital et l'affectation de main-d'oeuvre importante; dans certains cas, il faut une assistance technique compétente et le sacrifice des bienfaits à court terme. Le soutien fourni par des projets et des organismes donateurs a servi de façon réussie à réduire les obstacles entravant l'amélioration de la conservation des sols.

Etude de cas: Barrages de retenue et mesures de conservation des sols dans la région du village de Sintet

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Les brise-vent constituent des interventions réussies répondant à des objectifs multiples et visant la conservation du sol, que font des fermiers privés dans les quatre pays visités. Les meilleures données dont on dispose concernant les avantages des brise-vent proviennent de la Vallée de la Maggia au Niger, où un projet CARE, mis sur pied depuis plus d'une décénnie, a suscité beaucoup d'attention de caractère analytique. Dans cette vallée, les brise-vent augmentent les récoltes nettes jusqu'à 20%; de plus, ils fournissent du bois et d'autres produits forestiers. Les brise-vent stimulent de plusieurs façons la productivité agricole: ils réduisent la destruction de jeunes plantes due aux jets de sable, ils aident à l'établissement des puplements d'arbres, et ils réduisent les quantités de temps et d'énergie qu'il faut consacrer aux nouvelles plantations. Les brise-vent augmentent l'humidité ambiante et réduisent la vitesse des vents et la température, permettant ainsi une transpiration et une assimilation d'eau par les plantes plus efficaces. Ces phénomènes, à leur tour, réduisent la sollicitation des réserves en eau par les cultures, et leur permettent de mieux résister aux périodes de sécheresse prolongées sans se fatiguer. Les brise-vent mettent également les cultures à l'abri des vents d'orage et réduisent la verse au minimum.

Des bienfaits similaires, quoique non quantifiés, ont été observés dans des plantations de brise-vent par des fermiers habitant ailleurs dans la région. L'action déployée dans la Vallée de la Maggia a eu une influence marquée, de par son caractére de démonstration: le projet CARE à Koro, dans la Cinquième Région du Mali, a fait observer à première main à quatorze fermiers l'intervention réussie de la Maggia. Le taux d'adoption qui en a résulté a dépassé 70%. D'autres petits fermiers ont planté des eucalyptus sous forme de brise-vent (Etude de cas: Angel Togo, Volume II); ils en ont tiré des bénéfices consistant en la protection des sols et en la commercialisation de poteaux. Les fermiers ayant participé à nos entrevues ont insisté sur les usages multiples des brise-vent.

Et pourtant, il y a des inconvénients associés aux brise-vent. Premièrement, ils exigent qu'on y affecte beaucoup de main-d'oeuvre lors de leur plantation, et qu'on veille à leur protection continue pendant les premières années. Ils risquent de chasser le bétail, appartenant aux femmes, qui pâture dans les chaumes. Les arbres et les arbrisseaux fournissent de l'abri pour les oiseaux granivores et les encouragent à y faire leurs nids. Par ailleurs, un mauvais choix d'espèces d'arbres et d'arbrisseaux pour

constituer les brise-vent peut causer une augmentation des prises d'eau souterraine qui soit plus grande que le remplissage des réserves, ce qui peut altérer la quantité et la qualité des eaux. Mais l'inconvénient le plus gênant des brise-vent relève, en toute probabilité, des questions des droits de jouissance des terres et des arbres, et notamment des droits d'abattage des arbres. Il reste aux projets principaux, dont le Projet des brise-vent dans la Vallée de la Maggia au Niger et le Projet pour la stabilisation des dunes côtières au Sénégal, à étudier ces effets. Heureusement que des rangées d'herbes, de pois d'Angole et de brousailles mortes constituent des mesures modérément réussies, répondant à des objectifs multiples; ces rangées peuvent servir de brise-vent dans les endroits où les arbres et les arbrisseaux ne s'avèrent pas convenables.

Etude de cas: Les Brise-vent de la Vallée de la Maggia

Les barrages de protection de canaux, tels que ceux construits par Swissaid au Niger et SWMU en La Gambie, figurent parmi les actions réussies visant la conservation des sols. Ces barrages retiennent les écoulements provoqués par les orages et permettent aux eaux de se répandre dans les plaines inondables, déposant ainsi du limon et augmentant l'infiltration et la mise en reserve des eaux. Les écoulements ralentis des rivières augmentent la sédimentation. L'infiltration accrue le long des cours d'eau et sur les plaines inondables aide à remplir la nappe aquifère. Enfin, il y a stabilisation des ravines secondaires qui se forment sur les canaux principaux et qui menacent de couper les plaines inondables.

Ce type d'action convient tout aussi bien à la zone de 1200 mm de pluie au Mali et à la zone de 250 mm de pluie au Niger. Cependant, il faut, dans bien des cas, qu'une série de barrages de garde de lits soit construite. Une telle action risque de nécessiter des compétences qui dépassent celles que peut y apporter un seul village. L'assistance technique apportée de l'extérieur aide à surmonter les obstacles organisationnels, en aidant les villages à concevoir, bâtir et maintenir ces barrages en état (comme c'est la cas dans les projets OHV, Swissaid et SWMU).

L'emploi d'engrais, qui améliore la fertilité des sols agricoles, est étroitement lié à la disponibilité d'eau, au risque de sécheresse et à la valeur des cultures en question. Dans les zones plus sèches, où les variations pluviométriques sont également marquées, les fermiers limitent les applications d'engrais chimiques aux cultures irriguées. Dans les zones de plus haute pluviométrie, telles que celle de Sikasso, les fermiers font alterner le coton et des céréales, de façon que celles-ci tirent

profit des effets résiduels des engrais appliqués au coton. Le paillage contribue à la fertilité du sol dans la forêt naturelle de Guesselbodi. Le projet d'extension OHV à Ouelessebougou, Mali est l'une des actions peu nombreuses dans la cadre de laquelle les fermiers commencent à expérimenter des fosses et des terrains à compost. De telles techniques semblent constituer une alternative généralement applicable aux engrais chers dans les zones où la pluviométrie est plus importante.

Etude de cas: Extension de l'Opération Haute Vallée

Même là où les petits cultivateurs ont adopté avec succès des techniques de conservation du sol et d'amélioration de la fertilité, notre équipe a constaté la potentialité d'amélioration additionnelle. Dans bien des cas, y compris la stabilisation des dunes côtières au Sénégal et des dunes à l'intérieur du Niger, (Dakoro, Maïne-Soroa), ainsi que la gestion des bassins hydrographiques à Keita, Niger, c'est le personnel des projets qui possède les connaissances techniques nécessaires et qui est responsable de la gestion. Mais, à l'avis des membres de notre équipe, le seul fait de faire passer aux fermiers eux-mêmes un plus haut degré de compétences et d'autorité conduirait en lui-même à l'intensification de leurs efforts personnels pour améliorer les choses. Effectivement, nous avons pu observer des petits cultivateurs et des intermédiares locaux qui ont créé des techniques d'une éventuelle valeur. A Kayes (Sénégal), les forêts côtières sont d'une importance cruciale pour la stabilisation des dunes et pour l'augmentation de la productivité des sols. Un pépiniériste à Kayes avait d'excellentes idées pour rendre les forêts économiquement auto-suffisantes, au moyen de l'abattage contrôlé et de la gestion des peuplements. Malheureusement, il lui manquait et les ressources nécessaires et l'autorité pour les mettre en oeuvre.

Les Interventions forestières et agro-forestières

Les interventions forestières en cours dans le Sahel sont d'une variété marquée. Des cas de méthodes traditionnelles d'agro-sylviculture coexistent avec des méthodes modernes. Cette réunion de techniques comprend les actions suivantes: la protection des espéces qui fixent de l'azote et qui retiennent de l'humidité (**Acacia albida**); les plantations d'**Acacia albida** et d'autres espèces locales dans les champs; la gestion des forêts naturelles;

les bois appartenant aux coopératives, aux villages et aux particuliers (et les plans concernant ces bois); les pépinières villageoises et privées; les vergers privés; et les mesures volontaires visant le contrôle des incendies. Notre équipe s'intéressait tout particulièrement aux cas nombreux de l'aménagement intégré des arbres et des arbrisseaux faisant partie intégrante du système agricole.

Table 3.3
Intervention réussies en matière d'agro-forestière

Actions entreprises par les fermiers privés

Plantations de perches
Pépinières privées
Bois privés
Bois sacrés
Protection sur les terrains
Haies vives
La plantation d'arbres fruitiers parmi les autres cultures

Actions inspirées par les organismes donateurs

Chantiers de bois villageois
Pépinières
Captages d'eau pour les arbres
Brise-vent
Aménagement des forêts pour la production de bois de feu
Plantation d'arbres sur les terrains destinés à d'autres cultures
Aménagement des réserves forestières

On a pu constater les vestiges de beaucoup de systèmes agro-forestiers traditionnels dans les quatre pays visités. De tels systèmes se caractérisent par l'agriculture permanente en combinaison avec la protection de bouquets denses de l'**Acacia albida**, arbre qui fixe l'azote et qui du fourrage, ainsi que par l'emploi de fumier obtenu du bétail. Ces vestiges subsistent, par exemple, toujours dans la région de Thiès dans le pays de Serer au Sénégal, dans certaines régions du Dallol Boboye à Dosso, Niger et dans l'arrondissement de Mirria, au Niger. Des bouquets, denses

par endroits, de cet arbre se prêtant à des usages multiples poussent également dans d'autres zones sahéliennes. La conservation des bouquets établis est plus facile à assurer et moins coûteuse que ne l'est la régénération artificielle. La régénération naturelle de l'**Acacia albida** se produit assez facilement, comme pouvait en témoigner notre équipe lors des visites aux projets à Koro, Mali (CARE), à Dosso, Niger (UNSO), et à Thiès, Sénégal (USAID), par exemple; cependant, la nécessité de mettre les pousses à l'abri du bétail et du labourage pose, dans ce cas, de graves difficultés, d'autant plus que les pressions démographiques sont en voie d'accroissement. Quoiqu'il en soit, les fermiers se rendent bien compte de leur importance.

Des haies vives, plantées par les populations, constituées de sisaux et d'euphorbes, poussent partout dans la Troisième et la Cinquième Régions du Mali, dans le bassin arachidier sénégalais et dans la Casamance. Bien que les pluies en état de baisse aient rétréci la région du nord des sisaux et que les haies traditionnelles ne soient pas toujours bien entretenues, des fermiers ont planté de grands nombres de haies nouvelles autour des jardins et des vergers dans ces régions. Cependant, la mise en culture en allées en rapport avec les haies vives n'est qu'à son début. Des Prosopis, des Neems, des Anacardiers et même des Eucalyptus s'unissent avec des Euphorbes, des sisaux et, parfois, des pois d'Angole dans ces haies. Les systèmes d'irrigation, tant publics que privés, sont mis de plus en plus à l'abri de brise-vent et de haies vives. Or, il arrive que le choix d'espèces pour ces haies n'est pas toujours optimal. Curieusement, notre équipe n'a vu que très peu de haies en La Gambie qui s'étaient incorporé des innovations. Dans l'arrondissement de Filingué, une zone sahélienne assez sèche au Niger, notre équipe a remarqué de nombreux petits jardins dont la protection était fournie par des haies vives constituées de prosopis. On expérimente actuellement dans plusieurs sites au Niger (Dakoro) l'emploi d'euphorbes pour stabiliser les dunes.

Mais les interventions forestières à petite échelle les plus réussies consistent sans doute en la multiplication et en la diversification des peuplements villageois et individuels de perches dans le bassin arachidier au Sénégal et, à un degré moindre, dans le département de Tahoua au Niger. Les fermiers habitant ces régions ont assimilé les technologies mises à leur disposition par des projets à grande échelle (PRECOBA, PAFOCSE, PARCE, CARE-NIGER); par ailleurs, ceux-là ont adapté les techniques de dissémination et de transplantation à leurs propres besoins organisationnels et économiques. Les bois privés aident à alléger les pressions de la demande sur les les forêts naturelles peu abondantes. Dans les zones de haute pluviométrie et dans les bassins à basse altitude, il y a accroissement du nombre de vergers fruitiers privés. Dans les régions plus humides du sud, il y a peu

de projets mettant des informations avancées en matière de vergers fruitiers à la disposition des fermiers, quoiqu'il y existe des possibilités prometteuses.

Etude de cas: M. Ka, pépiniériste

Les brise-vents mis sur pied dans la Vallée de la Maggia au Niger ont démontré avec succès aux fermiers la valeur des brise-vent en ce qui concerne l'accroissement de la productivité (établissement des bouquets, rétention de l'humidité), et de la culture des arbres en général. L'intervention dans la Maggia sert actuellement de site de démonstration pour les fermiers y rendant visite de Maradi, Niger, et même pour des fermiers Dogon de la Cinquième Région du Mali. Ceux-ci ont commencé à planter des brise-vent sur leur propre plateau, balayé par les vents, suite à leur visite dans la Maggia prise en charge par un projet de CARE. Et pourtant, il faut apporter une solution à plusieurs problèmes qui se posent, non seulement à Maggia mais aussi dans d'autres contextes (par exemple, la PAFCOCSE à Thiès, Sénégal): les délais nécessaires pour réaliser les bénéfices des brise-vent, surtout lorsqu'on plante des arbres se prêtant à un usage unique; le manque de terrains; les impacts exercés sur la nappe phréatique; et l'incertitude où l'on en est à l'égard des droits de jouissance et d'abattage. La possibilité de reproduire ailleurs cette intervention dépend des solutions que l'on apportera à ces problèmes.

Les fermiers avec lesquels nous avons eu des entrevues dans les régions boisées de Sikasso (Mali) et de Kolda (Sénégal) ne sont pas motivés par les objectifs du reboisement en eux-mêmes, malgré les campagnes menées par l'Administration forestière visant à leur inculquer les notions élémentaires de la dissémination et de la culture des arbres. Ils étaient par contre désireux de s'informer de la dissémination des anacardiers, des fruitiers (Sénégal), du teck (**le Tectona**), du karité et du néré (Mali). Ces préférences semblaient résulter, du moins en partie, de leur expérience passée négative, premièrement, avec l'Administration forestière (amendes pour l'abattage et des incendies) et deuxièmement, avec les règlements régissant la jouissance des arbres, lesquels reconnaissent la propriété des espèces propres aux vergers, mais non pas des autres arbres; et, par ailleurs, de l'expérience positive des migrants avec les produits des vergers. Il serait

souhaitable de faire de plus grands efforts pour unir les priorités locales relevant de l'agro-foresterie avec les programmes de l'Administration forestière: par exemple, des anacardiers pourraient servir de pare-feu et de brise-vent vifs dans les zones de pluie abondante du Mali, comme ils le font dans certaines régions du Sénégal. L'expérience de terrain dans ces régions fournit d'excellents exemples non seulement de la divergence des motifs publics et privés tels qu'ils se rapportent à la gestion des ressources, mais aussi des moyens qu'on pourrait mettre en oeuvre pour que ces motifs se complétent les uns les autres.

Là où des jardins bien irrigués ont été mis sur pied afin de faire face aux cultures sèches en voie de décroissance, les fermiers achètent des fruitiers et des haies, et ils sont désireux de s'informer davantage de leur entretien. Des fermiers sénégalais voulaient apprendre de nouvelles techniques ne faisant pas partie des programmes d'enseignement de l'Administration forestière ou des personnels de projets et se rapportant à la dissémination des espèces naturelles (Programme de sylviculture des Catholic Relief Services (CRS)/Corps de la Paix, Thially, Région de Diourbel) et aux méthodes pour éclaircir et élaguer les arbres (Entente de Koumpentoum).

Parmi les interventions réussies à grande échelle visant la la gestion des forêts, notre équipe fait figurer celles de Guesselbodi, Niger (400-600 mm), de Sikasso, Mali (1000-1200 mm) et Dinderesso, Burkina Faso (800-1000 mm). A Guesselbodi, on a perfectionné des techniques de restauration et de régénération visant l'accroissement de la couverture arborée et herbacée. L'union des fermiers voisins avec l'Administration forestière a traditionnellement constitué le point faible de la mise en valeur des forêts. Comme nous en discutons ci-après et dans les études de cas, les efforts déployés par le projet PUSF, subventionné par l'USAID, a remporté des succès à cet égard. Dans les forêts de Sikasso, on réunit des informations détaillées portant sur la régénération naturelle des espèces, et on expérimente des techniques qui encouragent la participation des villageois dans le contrôle des incendies. Par exemple, ce projet, qui bénéficie de subventions suisses, propose aux unités villageoises de défense contre l'incendie, qu'on crée dans les villages situés sur les périmètres des forêts naturelles, des primes en espèces qui varient selon le pourcentage des forêts qui, à la fin de la saison sèche, n'a pas brûlé. Le projet fait pression auprès des autorités pour obtenir l'autorisation de faire des feux précoces de protection, bien que le président du Mali ait, en principe, interdit tous les feux, quelle que soit leur origine. Dans la forêt de Dinderesso, un projet a expérimenté les techniques réussies de contrôle des incendies qui comportent le pâturage sous contrat et les feux précoces.

En règle générale, en comparant les unes avec les autres les expériences de ces projets de reboisement à grande échelle, on peut en conclure que le bois d'oeuvre et le bois de feu peuvent être produits économiquement sous un régime décentralisé, si l'on fait usage d'espèces locales et d'espèces exotiques choisies. Certains projets au Sénégal (PARCE, PRECOBA) et en La Gambie (GTZ), malgré leur opinions moins avancées sur cette question, suivent des chemins similaires. Toutes ces interventions à usages multiples en matière de sylviculture et de gestion des terres sont les successeurs pleins de promesses des plantations industrielles, comportant des monomcultures d'espèces exotiques, et qui ont échoué partout dans le Sahel.

Interventions portant sur la biodiversité

Aux fins de cette évaluation, la biodiversité signifie l'entretien de la variété dans le milieu tant naturel qu'humain. On peut marquer le contraste entre la biodiversité et les actions qui réduisent la richesse des espèces et l'abondance des populations. Dans le cadre de la biodiversité, on s'intéresse à trois thèmes définis de façon générale: les types d'habitats, les espèces et le plasma germinatif.

Les réussites nettes en matière de biodiversité comprennent les techniques innovatrices du contrôle des animaux nuisibles (contrôle des hippopotames en La Gambie); la conservation et la régénération des semences (projet Lamin du riz); les tentatives courageuses de protection des parcs nationaux (parc Niokola Koba au Sénégal); les solutions de conflits qui incorporent des refuges pour des espèces non-humaines (delta intérieur du Mali); les publications et l'éducation visant à rétablir le sens holistique de l'écologie que partagent les villageois et les étudiants (Walia, Mopti, Mali); les projets hydrologiques qui, sans qu'on le fasse exprès, se transforment en mares (Sintent, La Gambie); certains bois qui fournissent de l'abri (mais rarement de la nourriture) à d'autres espèces (stabilisation des dunes côtières, Sénégal); la consolidation des traditions sanctionnant des bosquets sacrés servant de refuge à toutes les espèces (Parc de la Basse Casamance, Sénégal); et la réintroduction d'espèces disparues localement. L'équipe a constaté des preuves prépondérantes de la conscience, très répandue parmi les fermiers du Sahel, de la dégradation écologique. Des fermiers habitant de différentes localités sont souvent à même de distinguer des ensembles différents d'au moins une douzaine espèces d'arbres qui ont disparu ou qui sont devenus moins fréquents depuis le commencement des périodes de sécheresse à la fin des années 1960. De même, les bouviers peuvent relater la dégradation des espèces de pâturage. La plupart des adultes se rendent bien compte de la disparition des grands animaux sauvages.

Notre équipe a constaté que, à mesure que la sécheresse et

les cultures de rente permanentes dégradent les terres, les fermiers empiètent de plus en plus sur des habitats naturels, intensifiant ainsi les pressions sur le gibier, les pêcheries et d'autres sources de nourriture qu'on recueille librement en tant que suppléments alimentaires. Les frontières de plus en plus définies séparant les terrains cultivés et les habitats naturels, et le rétrécissement des zones sauvages, ont fait considérer les animaux sauvages comme étant des animaux nuisibles. On ne considère à présent que rarement les babouins, les phacocères et les éléphants au Mali, ainsi que les hippopotames en La Gambie, comme faisant partie intégrante de l'écologie locale.

La conservation de la biodiversité, notre équipe a-t-elle constaté, qu'elle concerne l'agriculture, la flore ou la faune, ne figure pas parmi les priorités des gouvernements sahéliens. On se représente la biodiversité en tant qu'alternative, et non en tant que complément au développement économique. Seuls des groupes très peu nombreux dans n'importe quel pays comprennent la nécessite et les avantages des réserves naturelles en tant que points de référence biotiques, outils éducatifs, "musées" des héritages nationaux, ou "celliers" pour le plasma germinatif.
Il y avait cependant des cadres supérieurs du service des parcs au Sénégal qui avaient des connaissances approfondies sur ces questions.

Quoique les fermiers dans les localités apprécient à la biodiversité, et notamment à la variété des espèces agricoles ou horticoles, notre équipe a constaté que trés peu d'entre eux travaillent activement à la conservation de la diversité des espèces sauvages, et ce, malgré le fait que les espèces ligneuses fournissent des ressources alimentaires en périodes de de soudure et de disette. Effectivement, les plantes qu'on cueille quotidiennement fournissent une proportion élevée des vitamines, minéraux et même protéines dans la nourriture des habitants ruraux. Dans une zone donnée, les différents groupes ethniques font également usage des différentes parties de la flore disponible; les Peuls prisent les fruits, par exemple, tandis que les Mandingues préfèrent les feuilles (Bergeret, 1986). Malgré cela, notre équipe a constaté que la notion que les fermiers peuvent mener avec succès des actions afin de conserver ou de réintroduire la diversité biologique, paraît toujours singulière à la plupart des villageois.

Certains individus et groupes rencontrés par notre équipe et d'autres chercheurs, comprennent la possibilité, voire la nécessité, de conserver la diversité de la flore (Montagne, 1986). Les jardiniers de Gandiolas, les pépiniéristes de Koumpentoum et les femmes membres du comité pour le contrôle des incendies de Bignona figurent parmi ces personnes. Cependant, la fréquence élevée des incendies incontrôlées, la pêche trop intensive et le braconnage au Sahel prouvent que les attitudes courantes envers la

mise en valeur du gibier et des forêts ne permettent pas de faire face de façon adéquate aux pressions économiques et politiques sur les ressources naturelles. Par exemple, bien que les bosquets forestiers sacrés, qui se trouvent parsemés parmi les populations mandéphones (Banama, Sénoufo, Mandingue, et Jola), conservent la biodiversité, ils sont tout aussi sujets aux pertes d'espèces causées par les incendies et la sécheresse que ne le sont les autres forêts.

Dans certains cas, on explique aux habitants locaux les relations réciproques positives de feed-back entre la production et la biodiversité. Dans le cadre de l'intervention IUCN à Bouna, par exemple, la conservation dans des fermes des arbres où des aigrettes et des cigognes peuvent faire leurs nids, favorise le contrôle des sauterelles et augmente la fertilisation des eaux se trouvant au-dessous des nids, laquelle, à son tour, augmente la production des algues et le nombre de poissons. Par l'intermédiaire de l'extension du projet IUCN, des groupes locaux commencent à saisir ces relations de façons nouvelles.

Etude de cas: Accord de Bouna

Dans d'autres cas, tels que le magazine de Walia, une publication traitant de l'écologie et des habitants de la Cinquième Région du Mali, il est plus difficile d'établir la relation entre le développement soutenable et la gestion des ressources naturelles. Mais il y a des signes indiquant que la sensibilisation des jeunes s'avérera aussi utile à l'avenir qu'elle l'a été au Kenya, par exemple.

Etude de cas: Walia

Dans la pèriode courante de transition entre, d'une part, la rupture de la compréhension et du respect traditionnels envers les animaux, et d'autre part, l'élaboration de nouveaux principes vis-à-vis du milieu, il existe la menace la plus grave pour les espèces rares et exposées au risque de disparition sur le plan international. Notre équipe conclut que la participation d'organismes donateurs internationaux est d'une importance cruciale pour la protection de ces espèces, dont le lamantin, l'éléphant, le dauphin à bosse, le chimpanzé, etc. Pendant cette période de privation dans le Sahel, c'est l'apport de fonds internationaux qui peut le mieux garantir cette protection. Malgré la génerosité gouvernementale (les sommes que le Sénégal affecte à l'entretien des ces parcs nationaux sont plus importantes que les revenus directs issus du tourisme), la tâche est si énorme qu'il y a moins

d'actions nettement réussies portant sur la biodiversité naturelle qu'il n'y en a qui visent la conservation des sols et des eaux ou l'entretien de la biodiversité agricole.

Dans presque tous les cas que nous avons observés, là où la biodiversité était menacée, il en etait de même pour les sources d'alimentation (par exemple, pour les pêcheries le gibier et les pâturages du Delta intérieur et le gibier du Parc Niokola Koba auquel on a recours en période de sécheresse) et/ou pour les sources de revenus (par exemple, les revenus issus du tourisme dans les Parcs de la Basse Casamance ou de Sine Saloum). On ne saurait, en réalité, séparer ces facteurs. Parmi les actions les plus réussies visant le soutien ou l'amélioraiton de la biodiversité figuraient celles qui unissaient des primes d'encouragement avec des thèmes relevant de la biodiversité. Ainsi, par exemple, les prix d'entrée au petit parc/réserve près Banjul le rendent-ils auto-suffisant. De même, le projet diversifié de jardinage à Louga (Sénégal) moyennant un soutien canadien, se fonde sur l'union des questions de productivité et de biodiversité. Enfin, le projet de développement des pêcheries au Niger, subventionné par la FAO, vise l'amélioration de la productivité et la conservation de la variété des espèces en faisant appel à une combinaison d'actions de gestion et de restrictions des équipements autorisés.

Etude de cas: Le Projet de jardinage à Gandiolas

L'impossibilité de séparer le développement soutenable de la conservation de la biodiversité, telle que celle-ci est démontrée par l'écologie culturelle des parcs nationaux du Sénégal, est traitée plus amplement à l'Annexe "Biodiversité."

ACTIONS TOUCHANT LES STRUCTURES SOCIO-ECONOMIQUES, LA POLITIQUE ET L'AUGMENTATION DES REVENUS

Primes d'encouragement socio-économiques

Partout dans la région, l'accès aux bénéfices en espèces, là où elles sont disponibles, a beaucoup favorisé les actions visant la gestion des ressources naturelles. Dans ces cas, les bénéfices en espèces, plutôt que la gestion améliorée des ressources, était typiquement le facteur qui poussait à entreprendre des actions. En général, lorsque les revenus en espèces sont disponibles,

l'assistance technique et d'autres intrants extérieurs sont nécessaires principalement en tant que mécanisme de "déclenchement," afin de surmonter les obstacles initiaux de nature technologique ou organisationnelle. En effet, la demande d'apports récurrents d'assistance extérieure est faible. Les encouragements commerciaux (bois pour faire des perches), les versements directs en espèces (la régénération de l'**Acacia albida** soutenue par l'UNSO) et l'engagement direct de villageois (projets de restauration à Guesselbodi et à Keita) pour des programmes de gestion des ressources constituent des sous-ensembles de cette même catégorie, lesquels ont produit avec succès des impacts évidents marqués sur les actions qu'observaient les membres de l'équipe.

Stimulations liées au marché. Etant donné la baisse de la productivité agricole, l'urbanisation en voie d'accroissement, le développement des infrastructures de transport et le développement de marchés régionaux et même locaux pour les produits allant de perches de construction à la nourriture et aux vêtements, des nombres croissants de petits fermiers ont recours à ces marchés en tant que sources de revenus non-agricoles. On a bien établi la relation directe entre la multiplication des boisements au Sénégal et des plantations d'Eucalyptus dans la Cinquième Région du Mali d'une part, et la valeur en espèces élevée des perches sur les marchés locaux d'autre part. Les boisements pour perches privés prennent un grand essor au Sénégal en raison du marché lucratif des maisons et de la construction nécessitant des perches d'Eucalyptus. On peut vendre une seule perche entre $2,33 et $3.60. L'abattage d'un quart d'hectare de perches par an peut rapporter $300; au bout de trois ou quatre ans, on peut récolter de façon presque continue un hectare d'eucalyptus.

Par contraste, les bois de village ont fait beaucoup moins de progrès dans le nord du Sahel, où les conditions soutenant la croissance sont moins favorables et que des apports plus considérables de main-d'oeuvre s'avèrent nécessaires pour les plantations artificielles. Le succès du plan d'aménagement de la forêt naturelle de Guesselbodi est basé sur la possibilité où se trouvent les coopératives villageoises de vendre du fourrage et du bois de feu naturellement régénéré aux prix de marché élevés à Niamey, qui se situe à 30 km par route nationale goudronnée. La stimulation du marché a joué un rôle prépondérant dans la réussite des projets des vergers et du jardinage.

De même, les actions de restauration et de conservation des sols commencent à se justifier économiquement dans l'arrondissement de Keita au Niger, étant donné qu'il n'existe à présent presque aucune plaine alluviale ou dune susceptible d'être mise en culture. Il n'y a donc pas d'alternative au rétablissement des pentes dégradées par l'érosion et des plaines inondables érodées par

couches.

Dans pareilles circonstances, les conditions macro-économiques et la demande de marché créent des possibilités de revenus en faisant des investissements dans les terres. De tels encouragements sont irremplaçables en ce qui concerne la réalisation d'améliorations de grande portée à long terme dans la gestion des ressources naturelles. Ainsi, on attend toujours que les tentatives de reboisement suscitent le soutien populaire dans la zone sahélienne-soudanienne (par exemple, la partie sud-ouest du Sénégal, Sikasso), où les habitants ne s'aperçoivent toujours d'aucune pénurie de bois qui soit économiquement pesante.

Versement directs. Bien qu'ils soulèvent des questions concernant la soutenabilité et qu'ils risquent d'établir des relations de dépendance, les versements en compensation des travaux accomplis réussissent bien à produire des impacts évidents, comme en témoignent le projet UNSO de la régénération de l'**Acacia albida** à Dosso, Niger et le projet de jardinage de la Mission méthodiste en La Gambie. Dans le cadre du premier, on verse aux fermiers 30 francs CFA par arbre **Acacia albida** planté ou protégé. On a régénéré plus de 380.000 arbres sur cinq ans, à un coût de $2,00 par arbre; cela laisse à croire que de tels procédés ont un rôle utile à jouer dans l'encouragement de mesures de protection des ressources dont le besoin est pressant, et notamment quand on les met en oeuvre en combinaison avec l'éducation et les services d'extension.

Les encouragements du type "nourriture en compensation du travail" s'avérent efficaces dans certaines conditions. Lorsque la privation devient très grande et que les villageois ont très peu de ressources auxquelles ils peuvent faire appel pour se tirer d'affaire, comme dans nord du département de Tahoua (Swissaid), on emploie ce type d'encouragement comme moyen de soudure pour aider les populations locales à mettre en place une gestion des ressources plus soutenue. Il aide également à susciter la participation populaire lorsqu'une atmosphère chargée de soupçons et de méfiance entre fermiers et fonctionnaires fait obstacle à d'autres formes de participation populaire. Enfin, on y a recours pour mettre en oeuvre des travaux publics à grande échelle ou l'extension des infrastructures, comme c'est le cas dans le Projet intégré de développement à Keïta, Niger. En revanche, les procédés "nourriture pour travail" ont les inconvénients qu'on trouve dans d'autres programmes de versements direct en espèces, et ils risquent d'encourager un sens de dépendance des autres.

Engagement direct. Nous avons observé plusieurs cas où l'emploi de villageois pour faire aboutir des investissments dans les ressources naturelles, servait avec succès à encourager la

participation plus active dans la gestion des ressources. L'action la plus réussie a eu lieu à Guesselbodi, où l'on avait engagé des villageois pour creuser des captages d'eau carrés et des diguettes en courbe de niveau, planter des herbes et instaurer la gestion des forets avoisinantes. A la suite de ce volet initial comportant l'engagement de villageois salariés, une coopérative villageoise prend possession des terres améliorées; on lui fournit les compétences et les conseils techniques nécessaires pour rapporter un bénéfice en monétaire résultant de sa gestion continue.

Table 3.4
Types d'interventions socio-économiques

Versements directs aux villageois pour la gestion des forêts et le contrôle des incendies
Versements directs pour la plantation ou la protection des arbres
Améliorations apportées aux infrastructures villageoises comme encouragement
Distribution gratuite de plants, de matériel de pépinière et de conseils de vulgarisation
Visites des fermiers à des sites "modèles"
Engagements à long terme faits par des organismes non-gouvernementaux
Nourriture en compensation de travail
Diffusion soutenue par les services de vulgarisation
Organisation de coopératives villageoises en vue de ventes de bois de feu
Encouragements de marchés
Encouragements visant à soutenir la productivité
Consolidation des institutions locales
Mise en accord avec les valeurs fondamentales
Distribution de moyens pédagogiques qui mettent l'accent sur la biodiversité
Prix en nature pour accomplissement

Prix et honneurs publics

Des bénéfices à une seule fin ou à réaliser en une seule fois encouragent également des actions en matière de gestion des ressources. Des visites rendues à des sites-modèles par des villageois venant d'autres régions ont déclenché leur participation au projet CARE-Koro (Mali) des brise-vent et aux activités du SWMU en La Gambie. La distribution de semis a suscité l'acceptation de la plantation d'arbres à Sikasso et dans de nombreuses localités. A Guesselbodi, la négociation de l'accès aux terres de culture se trouvant au sein de la forêt classée, a joué un rôle important dans la tentative de convaincre les fermiers que le projet PUSF s'était engagé sincèrement à réaliser une amélioration collaborative du niveau de vie des villageois. Des prix décernés au nom du président ont constitué un encouragement pour les pépiniéristes et les femmes du Senégal. Parmi d'autres exemples, on pourrait citer l'autodéveloppement subventionné et le recyclage d'étudiants ayant abandonné leurs études en matière de la mise en valeur agricole au centre de Caamen en La Gambie. Des plaques commemoratives, ainsi que des cérémonies de remise de prix auxquelles assistaient des représentants du Service des Sols et de la Conservation des Etats-Unis, aidaient à institutionnaliser le premier District de Conservation des Sols et Eaux de La Gambie.

Systèmes d'encouragements multiples. Les systèmes d'encouragements les plus complexes que nous avons notés étaient les systèmes d'extension qui avaient été organisés par des associations communautaires intégrées pour le développement rural au Sénégal (AJAC, CADEF, Koupentoum). Ces systèmes comportent une activité d'une importance fondamentale, dont on fait un usage tout aussi réussi dans d'autres contextes (OHV, SWMU): il s'agit du diagnostic mis à exécution sur le plan villageois, qui est souvent mené en coopération avec du personnel de vulgarisation. Par la suite, des groupes de villageois définissent les objectifs par secteur, les délais et les moyens qu'il faudra mettre en oeuvre pour atteindre ces objectifs. Beaucoup de projets appuyés par ces associations ont uni avec succès les bénéfices dont profitent les groupes avec ceux dont profitent les particuliers, afin de s'assurer d'un suivi réussi. Dans ces exemples, on a recours à deux sortes de'encouragements. Premièrement, les encouragements économiques (production agricole accrue, possibilités de se procurer des revenus sur le marché) servent de source de motivation, sans toutefois comporter des versements directs. On se procure des intrants coûteux au moyen de cotisations, de projets collectifs ou d'assistance prêtée par des organismes non-gouvernementaux; on s'en sert en tant qu'aiguillon pour soutenir les programmes d'auto-suffisance villageois, tels que les boisements. Des projets collectifs proposant des bénéfices partagés en commun ou répartis à tour de rôle, tels que des greniers, des réserves, des chantiers de bois, des puits, des troupeaux (lait, fumier, progéniture), le logement amélioré, etc., viennent également appuyer les encouragements moraux à la

participation populaire. L'Entente de Koumpentoum est typique de l'organisation de ces associations. Le jardinage irrigué aux bords du lac Guiers au Sénégal, la coopérative des bûcherons à Guesselbodi et l'action villageoise anti-désertification à Damana, Niger, subventionnée par l'IDA, sont à la tête des efforts pour orienter les systèmes d'encouragements multiples.

Etude de cas: Entente de Koumpentoum

Etude de cas: Gestion des forêts naturelles à Guesselbodi

La Politique et les Encouragements visant l'augmentation des revenus

Les interventions techniques réussies se poursuivaient le mieux dans un contexte englobant des circonstances commerciales convenables et des systemes de valeurs favorables. Les politiques nationales constituent un type de contexte de ce genre.

Les interventions qui étaient mises sur pied selon des politiques et qui n'etaient conçues que par des planificateurs extérieurs, des "experts" ou des administrateurs mal renseignés pour être imposées de manière unilatérale aux communautés sahéliennes, ont inspiré la méfiance et le manque de respect chez les fermiers, les eleveurs et les pêcheurs, attitudes qui persistent toujours. Ainsi, non seulement on ne prête pas généralement attention aux interdictions nationales d'abattage du bois, de mise à feu des broussailles et de la chasse, mais aussi ces interdictions gâtent les relations entre les administrateurs et les populations, en faisant souvent régner une atmosphère favorisant la corruption. Aussi, bien des projets doivent-ils dissiper cette attitude négative créée par la politique, au moyen du recyclage et de programmes d'extension produisant des influences réciproques faisant partie des tenatives d'arriver à des résultats tangibles.

Etude de cas: Coopérative des bûcherons de Guesselbodi

Dans les cas où la réforme des politiques nationales est occasionnée par les besoins qui se font sentir, elle produit parfois un effet stimulant sur la gestion des ressources, en encourageant la diffusion de pratiques innovatrices sur une vaste étendue (voir la Table 3.5). Le meilleur exemple consiste en l'exemption, accordée aux bûcherons de Guesselbodi, des prix usuels

de permis d'abattage, et en l'autorisation d'une mesure de contrôle autonome de la gestion de leur forêt. La FAO, par son projet d'aménagement des terroirs villageois à Banamba (Mali), a entrepris les mêmes sortes de mesures.

Table 3.5
Actions réussies relevant de la politique et de l'accroissement des revenus

Exemptions des coûts de permis d'abattage du bois accordées aux coopératives locales
Exemptions des amendes répressives imposées par l'Administration forestière dans les zones couvertes par projets
Négoications nouvelles concernant la législation régissant la gestion multisectorielle des ressources
Autorisation accordée aux organismes locaux de créer des structures institutionnelles non-gouvernementales
Augmentations des coûts des permis d'abattage du bois
Cession de la jouissance des arbres plantés aux planteurs
Loi rendant obligatoire de se servir de foyers à bois simples, connus et améliorés
Valeur en hausse des ressources
Incorporation des valeurs locales dans la gestion des ressources naturelles

Les changements de politique les plus valables sont sans doute ceux qui donnent aux communautés locales la liberté de mettre sur pied des systèmes de gestion des ressources naturelles dans les limites des principes directeurs globaux visant la conservation des ressources. Certain types de règlements se sont avérés essentiels dans ce contexte: (1) ceux qui effectuent la cession de l'Etat à ces communautés des droits de jouissance des terres et des arbres, bien que l'Etat affirme toujours le principe de jouissance centralisée presque partout en Afrique de l'Ouest francophone; (2) ceux qui permettent la création d'organismes en dehors des structures institutionnelles de l'Etat; et (3) ceux qui habilitent les autorités locales qui peuvent mieux contrôler des changements se produisant dans les sols, les eaux et les plantes que ne peuvent le faire les autorités centrales.

Etude de cas: Gestion des pêcheries au Niger

Les nouvelles actions cherchant à promouvoir la gestion des terroir villageois au Mali constituent une démarche pleine de

promesses qui vise la contrôle local responsable de ce terroir; cette démarche s'est déjà avérée fructueuse dans la région de Banamba (400-600 mm) sous les auspices de la FAO, ainsi que dans le Delta intérieur (200-400 mm) sous les auspices de l'IUCN. Les techniques de solution des conflits entre les éleveurs, les fermiers et d'autres habitants intéressés ont pour but d'alléger la pression exercée sur les pâturages se trouvant dans les terroirs villageois. En entamant des discussions entre le personnel d'assistance technique et les villageois, on a commencé à délimiter la gamme de la variété biotique dans ce terroir et à définir les différents types d'aménagement des terres dans le cadre d'un plan de gestion global. La modification de la politiques s'est montrée efficace à chaque fois qu'elle se fonde sur un soutien populaire solide.

Nous avons pu noter sur le terrain les influences de plusieurs actions de politique réussies. Par exemple, une loi malienne de promulgation récente exige l'emploi de foyers de terre améliorés à domicile. Par conséquent, on fait usage de ces foyers dans presque tous les villages et dans toutes les enceintes dans les Cinquième et Troisième Régions. Bien entendu, cette loi, quoique importante, ne constitue que la "clé de voûte" d'une action datant de dix ans, pendant lesquels du personnel d'extension, des volontaires, des organismes non-gouvernementaux et des projects publics expérimentaient ce foyer amélioré et s'occupaient de sa distribution générale. Suivent les autres facteurs qui contribuaient à la réussite de cette ligne d'action et qui sont difficiles à quantifier: une campagne de publicité nationale à laquelle participaient des projets et l'Union Nationale des Femmes Maliennes; les changements se produisant dans l'économie des ménages qui rendent plus précieux le temps que les femmes avaient consacré par le passé au ramassage de bois; les prix de bois en hausse et la pénurie de bois; et les valeurs en voie de modification par suite de la sécheresse.

Le Niger en fournit un autre exemple. Le préfet de Tahoua remarquait les microbassins, subventionnés par Swissaid, lors d'une tournée qu'il faisait dans sa région. Impressionné par les effets dramatiques produits sur la production de mil et d'arbres, il a ordonné la rédaction d'une fiche technique sur les microbassins. Ensuite, le préfet a ordonné à ses agents forestiers d'affecter les ressources disponibles de la "Nourriture en compensation du travail" à la construction de microbassins et à la plantation d'arbres là où celles-ci s'avéraient convenables. En faisant appel à des connaissances techniques minimales et à la sensibilisation de la population locale, un jeune agent a bâti des microbassins performants sur plusieurs hectares de pentes latériques dénudées près de Malbaza. Les taux de survie des plants de Prosopis est d'environ 80% en moyenne dans les microbassins.

La recherche est d'une importance cruciale pour la bonne politique. Les cartes de planification de la gestion des terrains au Mali, dressées par PIRT et subventionnées par l'AID, et les cartes de classification des forêts au Niger, dressées par le PUSF, en sont des exemples pertinents. On se sert beaucoup de ces instruments utiles de politique et de planification partout dans ces pays en vue de l'élaboration de nouveaux programmes de gestion des ressources naturelles.

COMPTES RENDUS DES ACTIONS

Ecologies culturelles

Les visites aux sites permettaient aux membres de l'équipe de rencontrer des individus et des communautés représentatifs des principaux groupes ethniques dans les quatre pays visités. Les écologies culturelles caractéristiques de ces groupes sont documentés historiquement (voir la Table 3.6.).

Par suite des impacts produits et par le développement économique et par la dégradation du milieu, notre équipe remarquait une tendance vers l'homogénéisation et la simplication des écologies culturelles sahéliennes. A mesure que décroît la diversité des ressources, les niches écologiques se rétrécissent. Ainsi, par exemple, des Diola (Jola), qui mettait par le passé l'accent sur la production du riz, ont été plus récemment contraints à cultiver plus de mil, de sorgho et d'arachides, comme les Wolof et les Mandingue leurs voisins, à mesure que l'eau disponible devient moins abondante. De même, la vie rurale nomade des Peuls, éleveurs de bétail, est en voie de disparition; ils s'engagent de plus en plus dans la garde des caprins dans des zones délimitées, à mesure que les pâturages diminuent et se dégradent. Il y a en même temps intensification de la concurrence humaine pour les ressources naturelles décroissantes et les marchés limités entre les groupes ethniques qui, autrefois, exploitaient des biotopes distincts. Cette situation rend simultanément les écosystèmes plus sujets aux pressions additionnelles exercées par les conditions climatiques et économiques, augmentant en même temps la pression sur les ressources en énergie humaine limitées.

Table 3.6
Les Principaux groupes ethniques représentés dans l'évaluation NRMS

Mali	Niger	Sénégal	La Gambie
Bambara	Haoussa	Wolof	Wolof
Sénoufo	Zarma	Lébou	Jola
Dogon	Bouzou	Serer	Mandingue
Peul	Wogo	Diola	
Bozo		Bassari	
		Mandingue	
		Peul	

Notre équipe a remarqué des variations importantes, quoique fines, dans les connaissances, stratégies et compétences organisationnelles en matière de gestion des ressources que possédaient ces groupes. De telles inclinations fournissent des possibilités d'investissments créatifs, tant public que privés, dans la gestion des ressources. Tirer profit de la spécialisation en matière d'écologie culturelle, contribue de façon évidente à la gestion améliorée du Parc de la Basse Casamance, des pêcheries sur le Niger et des pâturages dans le delta intérieur du Mali. Le fait de ne pas prendre en compte, de ne pas respecter ou de dénigrer les usages traditionnels des ressources conduit à des possibilités perdues, ainsi qu'à des situations allant de la déception ressentie par le comité des femmes pour le contrôle des incendies à Bignona, Sénégal à l'état de guerre sanglant entre les braconniers et les gardes dans la Parc de Niokola-Koba.

L'Echelle, l'intensité et les délais des actions

Notre Equipe a remarqué que les interventions réussies varient énormément dans leurs portées géographiques, leur intensité (dollars/hectare ou par personne) et leurs délais. Au Sénégal et en La Gambie, par exemple, les projets de gestion des bassins fluviaux l'emportent sur toutes les autres actions; mais les conséquences de ces projets pour les ressources naturelles, et notamment pour les questions de biodiversité, ont été ou minimisées ou négligées. Des barrages produiront des impacts sur des écosystèmes multiples englobant des milliers d'hectares, et, par conséquent, touchant des milliers de personnes. Le mesure des impacts est faite en fonction d'une, voire de plusieurs générations.

A l'autre extrémité des ces mesures de portée, d'intensité et de délais fixés, un fermier particulier habitant près Djenné a

restauré un champ de mil abandonné, afin d'y établir des cultures maraîchères et agro-forestières sur une période de quelques années seulement. Un autre fermier, habitant aux alentours de Sikasso, a planté une plantation de teck et de gmélina, sur une superficie de trois hectares, qui sera rentable dans entre cinq et dix ans.

Les impacts produits par les sept projets forestiers régionaux visités (PRECOBA, PAFOCSE, PARCE, PUSF, Swissaid-Sikasso, GTZ-Gambie et IDA-Damana), malgré un financement solide, ne se font sentir que légèrement sur des dizaines de milliers d'hectares. On prévoit des délais allant de trois à dix ans pour que s'accomplisse la transition des plantations industrielles et des projets de protection des réserves forestières aux petits boisements et d'aménagement des forêts naturelles. Il manque toujours à certains de ces projets des stratégies de vulgarisation praticables visant la gestion soutenue des ressources.

Les associations villageoises d'AJAC et de Koumpentoum sont d'une petite portée et d'une intensité moyenne; cependant, leur impact est très prononcé. Ces entreprises en cours datent à présent de douze à quinze ans et touchent chacune plusieurs milliers de personnes et d'hectares. Les questions de gestion des ressources naturelles sont incorporées dans des soucis liés aux différents secteurs, et, ce qui importe encore davantage, dans la vie quotidienne. Le projet CARE des brise-vent dans la Vallée de la Maggia a mis dix ans pour produire des résultats tangibles; en outre, il a exigé des services policiers et de vulgarisation suivis. La reproduction ailleurs de ce modèle ne s'achèvera que sur une pèriode aussi longue, mais il se peut qu'elle exige moins de services policiers et de vulgarisation en raison des effets de démonstration.

En général, notre équipe a constaté que la densité et l'intensité des relations mises en jeu par les services de vulgarisation tendent à varier en raison inverse des dimensions d'un projet et de sa portée géographique. Malgré leurs grandes dimensions, l'expérience de Guesselbodi (Niger), l'Opération Haute Vallée (Mali) et l'Unité d'Gestion des sols et des eaux (La Gambie) sont des exceptions. Les travaux de vulgarisaiton, faits dans le cadre de ces projets avec un personnel souvent local, ont été intenses, consciencieux, localisés et compréhensifs. De plus, les impacts de ces interventions sur les ressources naturelles et la communication de connaissances sont en proportion du nombre d'années consacrées au suivi de la vulgarisation, et en raison inverse de l'échelle du projet en question.

Types d'assistance technique

Tous types d'assistance technique (AT) se sont avérés réussis dans le cadre des interventions NRMS. La quantité de cette assistance technique varie, allant d'une absence complète dans certaines actions forestières privées à des apports massifs lorsqu'il s'agissait d'administrations de développement des bassins fluviaux. Il existe différentes dispositions de financement publiques et privées. Les dispositions privées comprennent des sources de fonds parmi les organismes non-gouvernementaux, mais il y a également d'autres modèles innovateurs. Dans la région de Sikasso au Mali, un fonctionnaire international africain a payé toutes les taxes par personne imposées à son village; en retour, les villageois ont fourni la main-d'oeuvre volontaire pour s'occuper d'un terrain-modèle de reboisement villageois qu'il promouvait. En La Gambie, le projet de rétablissement de chimpanzés de l'île des Babouins dépend presque entièrement de fonds privés et d'assistants volontaires expatriés. Les associations de développement villageois au Sénégal demandent des services d'assistance auprès d'organismes non-gouvernementaux et du Corps de la Paix; par ailleurs, elles imposent une taxe annuelle à leurs membres pour aider à couvrir les dépenses des coordinateurs villageois élus.

Les populations qui bénéficient des ces actions manifestent leur gratitude pour les travaux de vulgarisation intensifs, réguliers et à long terme, se fondant sur les relations réciproques entre actions et qu'on attribue normalement aux organismes non-gouvernementaux. Un village dans La Gambie a même remercié la projet SWMU d'avoir réconcilié des factions villageoises dans leurs communs intérêts. Notre équipe a constaté, par ailleurs, que davantage d'actions innovatrices en matière de connaissances et valeurs locales demandent davanatge de vulgarisation intensive afin de réussir. Enfin, les méthodes de vulgarisation paternalistes, et la vulgarisation de thèmes qui entrent en conflit avec les connaissances locales et avec les systèmes d'encouragement économiques existants, sont moins réussies que les approches de vulgarisation qui mettent en jeu des efforts réciproques.

Certaines interventions d'assistance techniques faites dans le cadre de projets bilatéraux et multilatéraux à grande échelle et comportant des approches de vulgarisation orientées dans une seule direction typiques de ces projets, se transforment progressive- ment en des approches plus interactives. Ce changement est souvent motivé par la préoccupation de la part des techniciens de produire, au nom des projets, des impacts tangibles avant l'évaluation de ces projets eux-mêmes. Parmi des exemples de ce phénomène, on pourrait citer le projet OHV au Mali, le volet du projet de reboisement à Sikasso qui est sous direction suisse, le projet d'agro-foresterie PAFOCSE, le projet des pêcheries de la

FAO au Niger, etc. Cependant, les services techniques des gouvernements-hôtes ne sont pas encouragés à adopter de telles approches là où les évaluations du personnel et des primes salariales d'encouragement ne sont pas liées aux résultats du projet. Ainsi, il se peut que l'établissment d'un lien plus étroit entre l'évaluation du personnel et les résultats favorables de la mise en place d'une gestion des ressources naturelles puisse améliorer généralement les apports de l'assistance technique.

Origine des interventions

Aucune source unique d'idées ou de "mécanismes de déclenchement" n'est associée aux réussites que nous avons observées. On peut citer des réussites dérivées des approches "vers le bas," "vers le haut," "politique-terrain" et "terrain-politique." L'interdiction, promulguée par le préfet de Tahoua (Niger), de l'abattage de la végétation verte, ainsi que sa recommandation de bâtir des microbassins en forme de demi-lune aux fins de reboisement, sont typiques des actions "vers le bas" qui n'ont eu qu'un succès technique limité. Par contre, les associations de développement villageoises au Sénégal, ainsi que les bois et vergers privés, sont typiques des actions réussies du type "vers le haut". Les décrets arrêtant la création des parcs sénégalais ont, dans certains cas, sauvegardé la biodiversité, tandis que la loi malienne des foyers améliorés a suscité un mouvement populaire. Il s'agit ici d'interventions dont le champ d'action s'est déplacé de la politique aux activités sur le terrain. La création de la coopérative de mise en gestion des forets de Guesselbodi, ainsi que son exemption de certaines formes d'impôts, sont des exemples d'actions populaires qui ont eu une influence sur la politique nationale. C'est la première fois au Niger que des groupes locaux obtiennent des droits de contrôle des ressources naturelles. La gestion mixte des pêcheries sur le Niger (Niger), réunissant le gouvernement et les associations de pêcheurs, est un autre exemple d'un mouvement populaire influant sur la politique. Cependant, et quelle que soit l'origine de l'action en question, un "animateur," un "courtier culturel," ou un groupe de pression d'assistance tecnique intervient d'habitude pour encourager les parties à modifier le statu quo en ce qui concerne les pratiques de la gestion des ressources. Le travail de l'UICN en matière de solution de conflits dans le delta intérieur du Mali est un exemple extrême.

CONCLUSIONS

Ce chapitre a fourni une vue d'ensemble abrégée de 70 interventions sur le terrain. Les données qu'il présente démontrent qu'il existe un grand éventail d'actions réussies en matière de gestion des ressources naturelles dans le Sahel. Mais

elles se sont toutes déroulées dans le contexte de la dégradation rapide du milieu. Bien qu'on ait gagné des batailles isolées, on perd la guerre. Afin que ces exemples isolés soient utiles à ceux qui prennent les décisions de politique et au personnel de terrain, pour élaborer une stratégie avec une meilleure chance de succès, il nous incombe de nous poser la question, qu'est-ce qui a bien réussi?
D'un point de vue, la variété des succès dont nous avons pris note suggère qu'il y a de nombreuses solutions possibles. Mais, bien que cette conclusion paraisse attirante par sa simplicité, elle n'est qu'une demi-vérité, et elle est d'une très petite utilité en ce qui concerne les lignes d'action à adopter.

Le procédé qui consiste à tirer des conclusions utiles à partir d'un ensemble si varié d'observations, est basé en partie sur la faculté de jugement et en partie sur l'analyse. Nous avons fait entrer ces deux opérations dans l'expression de nos conclusions dans le Chapitre 5 et des recommandations contenues dans le Chapitre 6. Les conclusions traitent des tendances sous-jacentes sur lesquelles toute politique future devrait se fonder. En y appliquant notre discernement le mieux possible, les recommandations distillent les principales approches répondant aux critères de la définition de la réussite que nous avons avancés dans le Chapitre 2.

L'Attribution des succès

La conclusion la plus importante qui émerge de nos observations sur le terrain est que les interventions ayant produit les impacts les plus marqués ont élargi la portée de la définition d'une intervention en matière de gestion des ressources naturelles; c'est-à dire une intervention comportant des approches visant à résoudre les problèmes auxquels doivent faire face les populations intéressées, et non pas simplement les problèmes relevant du "milieu" à lui seul. Les populations rurales du Sahel s'intéressent avant tout à atteindre un niveau de vie qui soit au moins stable, et, espèrent-ils, en voie d'amélioration. Cette espérance dépend historiquement de l'état actuel des principaux systèmes de production ruraux, et notamment l'agriculture, l'élevage et la pêche. C'est précisément parce que la dégradation menace à present visiblement ces systèmes de production que les populations font appel à la gestion des ressources naturelles pour accomplir deux actions, dont toutes les deux ont un effet sur leurs revenus: premièrement, protéger les ressources des sols et des eaux dont dépendent leurs capacités productrices (par exemple, l'éventail complet des mesures visant la conservation des eaux et des sols, l'amélioration de la fertilité du sol, etc.); et deuxièment, fournir de nouvelles possibilités de rapporter des revenus (production de perches, vergers et jardins, ventes de bois de feu et de fourrage, etc.) pour compenser les rendements

aléatoires et décroissants que donnent les activités productives usuelles.

La création de possibilités de revenus (notamment en stimulant les marchés locaux, en s'assurant de la jouissance sûre des terres, et en rationalisant les systèmes des prix des produits agricoles et forestiers), qui résultent de la gestion des ressources naturelles, constitue une intervention réussie, autant que l'introduction de technologies spécifiques telles que les brise-vent, l'**Acacia albida** et les digues en courbe de niveau. Là où l'on a pu profiter à la fois de la technologie et des possibiilités offertes, nous avons parfois remarqué des réponses dramatiques de la part des petits cultivateurs, soit sur leur propre initiative ou par un encouragement initial appuyé par le secteur public. Dans les actions les plus réussies que nous avons observées, les objectifs du secteur public et des participants n'étaient pas identiques. Au Mali, par exemple, l'action visant l'usage des foyers améliorés est destinée à sauvegarder les forêts, tandis que les femmes les ont adoptés, afin d'économiser du temps; de même, les projets de gestion de Guesselbodi visent le rétablissement des terres dégradées et l'accroissement de la productivité des forêts, mais les villageois y participent parce que ces projets rapportent des revenus en espèces. Enfin, des fermiers ont planté des eucalyptus parce qu'il peuvent gagner autant des ventes de perches que de l'agriculture, même si certains projets ont tenté, sans succès, de les convaincre de mettre sur pied des chantiers de bois afin de produire du bois de feu.

La Définition d'objectifs

L'attribution du succès à une intervention particulière dépend également de la manière dont les objectifs ont été définis. Selon l'objectif de la plantation et de la protection des acacias, le projet UNSO **Acacia albida** à Dosso a été un succès. Mais, bien que 380.000 arbres aient été plantés ou protégés dans quatre ans, seulement 10% des fermiers acceptent de poursuivre la régénération sans recevoir les paiements directs fournis par le projet. Et pourtant, il se peut bien que ces paiements directs constituent le seul moyen pour encourager les fermiers Zarma à Dosso à régénérer des arbres. Or, cette intervention peut se reproduire dans beaucoup de contextes dans le Sahel où la crise écologique et économique est grave.
Mais on ne saurait appliquer cette même modalité au Sénégal ou dans la Vallée de la Maggia, par exemple, où la plantation des arbres a pris son essor grâce à d'autres encouragements auxquels un soutien extérieur est moins nécessaire.

Les Délais

L'attribution du succès dépend finalement des délais fixès.

Notre équipe s'étonnait de constater que les foyers de terre améliorés, échec de longue date au Mali, étaient devenus ordinaires en 1987. Les brise-vent dans la Maggia, qui avaient été promus sans succès pendant six ans, occasionnaient de nombreuses difficultés relevant de la gestion ainsi que des privations économiques pour les éleveurs déplacés. Mais à présent, c'est-à-dire au bout de dix ans, on a franchi le seuil du succès. Bien que, au bout de cinq ans, des plantations forestières industrielles, mises sur pied par les projets suisses et PARCE à Sikasso, Mali et à Kafrine, Sénégal, respectivement, aient fait échec, les nouvelles expériences en matière de gestion des forêts naturelles qu'ils tentent, peuvent devenir des modèles de la réussite dans ces régions. Les boisements de perches d'Eucalyptus sont devenus rentables pour des fermiers sénégalais au bout quatre ans. Si on évaluait ces actions par rapport à leur contribution à la biodiversité ou à la fertilité des sols, on pourrait les considérer comme étant des échecs à court terme; mais il est possible qu'elles jettent les bases économiques d'investissements diversifiés à longue échéance. Enfin, le projet forestier IDA à Damana, Niger, n'a donné lieu qu'à quelques barrages d'arrêt et qu'à la plantation d'arbres plantés dans les champs ou pour donner de l'ombre. Et pourtant, l'approche de la gestion du terroir villageois qu'on y élabore conduira en toute probabilité dans les quelques années à venir à des actions susceptibles d'être reproduites et de conserver des ressources, dont on a besoin dans l'arrondissement de Filingué (Niger) frappé de sécheresse.

Bien des actions prometteuses entreprises dans le Sahel sont tout simplement trop nouvelles pour être bien appréciées. On peut classer dans cette catégorie les brise-vent, basés sur ceux de la Maggia, qui sont financés par CARE à Koro (Mali); l'aménagement de terroir villageois à Banamba (Mali); un projet de pisciculture et un projet d'horticulture diversifié aux bords du Lac Guiers (Sénégal); la réintroduction de gazelles dans le Parc de Djoudj (Sénégal), etc.

En règle générale, un délai minimum de dix ans est nécessaire pour que les actions de gestion des ressources naturelles mûrissent. Les délais nécessaires pour produire des impacts évidents semblent se prolonger en fonction de la nouveauté des techniques employées, la concurrence pour des ressources et le manque d'expérience de l'assistance technique. Par contre, les délais nécessaires sont plus courts quand il existe des encouragements de marché et des valeurs, politiques et structures sociales qui soutiennent les efforts déployés. On pourrait donc proposer une action systématique de contrôle dans toute la région, dans le cadre de laquelle on pourrait faire la collecte de données comparatives portant sur les interventions à différents stades de leurs cycles de vie, afin d'éviter leur résiliation prématurée, ou inversement, leur continuation injustifiée dans certaines

circonstances.

L'Importance du processus

Notre équipe a visité des interventions dont les impacts sur les ressources naturelles ne sont pas évidents. Les projets de puits et des jardins sont représentatifs. Quoiqu'ils améliorent l'accès à l'eau et qu'ils soient susceptibles d'accroître la productivité agricole à court terme, les impacts à plus long terme des jardins sur les niveaux phréatiques, sur la qualité des eaux et des sols, sur les droits de jouissance des terrains et sur l'organisation de la production restent incertains. Par ailleurs, nous n'avons remarqué que quelques cas où les jardins servaient à conserver ou à réintroduire la diveristé biologique. En revanche, il est possible que les puits et les jardins rehaussent l'état alimentaire des communautés, en mettant ainsi en disponibilité plus d'énergie humaine pour d'autres investissements dans la gestion des ressources naturelles. Il n'y a que très peu de projets de jardins, ou même aucun, qui aient été conçus pour répondre à ce but holistique à long terme. Le projet à Gandiolas fait exception. L'évaluation, faite par notre équipe, des conséquences possibles limitées pour la gestion des ressources naturelles de ces projets de jardins fait ressortir la distinction fondamentale entre, d'une part, les usages à court terme des ressources naturelles qui augmentent la productivité, et, d'autre part, l'amélioration à long terme de la gestion des ressources naturelles.

Il faudrait considérer beaucoup de projets, tels que les projets de jardins, de boisements, de stabilisation des dunes, de gestion des bassins hydrographiques et des forêts, etc., comme étant des éléments d'un processus qui amène une participation locale accrue et contribue aux connaissances spéciales que possèdent les organismes donateurs en matière de gestion des ressources naturelles. Notre équipe pensait que les projets proposant parfois très peu de produits tangibles, mais au sein desquels on laisse se dérouler dans le temps un processus de compromis et d'adaptation de techniques et de méthodes d'extension réciproques entre les organismes se chargeant de l'exécution et les participants, semblaient être les plus prometteurs: par exemple, l'Accord de Bouna, les brise-vent de la Maggia, Guesselbodi, Gandiolas, le projet forestier PRECOBA, le projet forestier IDA-Damana, et les pêcheries du Niger. Très souvent, "faire bien son travail," c'est-à-dire l'introduction de changements soutenables par petites augmentations en commençant par les bases, est tout aussi important que le fait de "faire ce qui convient."

L'Assimilation des valeurs locales

Les valeurs jouent un rôle critique dans toute réussite soutenue, et elles sont d'une importance cruciale pour la reproduction des actions. La prévention des incendies de brousse ne signifie, pour les populations Diola dans la Basse Casamance, que la nécessité de fournir du matériel et des encouragements organisationnels, car leurs forêts les tiennent tellement à coeur que ces incendies étaient par le passé presque inconnues. Les habitants outragés d'Oussouyé ont même chassé de la ville des charbonniers. Mais il faut déployer des stratégies radicalement différentes parmi les Sénoufo dans la région de Sikasso, pour qui la mise à feu de la brousse constitue un obligation quasi-religieuse demandée par leurs ancêtres. De même, les boisements coopératifs ou les travaux de construction de digues, qui sont acceptés volontiers par les populations Mandingues, pour qui la participation volontaire aux travaux publics est une seconde nature, seraient inconcevables parmi les Zarma plus individualistes du Niger.

Etude de cas: Comité des femmes pour le contrôle des incendies à Bignona

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Les Thèmes se rapportant à la gestion des ressources naturelles

Les matières descriptives présentées dans ce chapitre font émerger une série de thèmes ou d'enseignements se rapportant au succès. Nous les avons classés en quatre sèries et les présentons ci-après, sans ajouter de commentaires supplémentaires. Le lecteur trouvera en annexe une représentation graphique en abrégé, sous forme de tableau, de ces thèmes et des interventions qui les illustrent. Les thèmes les plus importants qui émergent de l'évaluation de notre équipe sont traités de façon intégrée dans le Chapitre 5, "Conclusions principales."

Les Thèmes qui émergent de l'évaluation menée dans le Sahel

Valeurs, Intérêt et Connaissances

La communication de connaissances doit s'harmoniser avec l'expérience et les connaissances locales.

Les populations s'intéressent à la stabilisation de la pro-

ductivité et à l'amélioration des activités de gestion des ressources naturelles.

Les changements de valeurs dans les activités de gestion des ressources naturelles proviennent de milieux et de contextes économiques en évolution rapide.

Il existe une soif de connaissances en matière de gestion des ressources naturelles en général, et de connaissances en matière de biodiversité agricole en particulier.

Les contextes culturel et religieux jouent un rôle important dans les activités de gestion des ressources naturelles.

Le succès à long terme des activités de gestion des ressources naturelles dépend de l'éducation améliorée en matière de conservation.

Solution de conflicts

La solution de conflits constitue un aspect important des activités de gestion des ressources naturelles qui n'est pas pris assez en considération et auquel on n'affecte pas assez de fonds.

La solution des questions relevant des droits de jouissance des ressources est d'une importance cruciale pour la réussite de la gestion des ressources naturelles.

La gestion des ressources naturelles n'est pas incorporé institutionnellement dans les structures des gouvernements sahéliens.

Il faut coordonner les activités des programmes avec les activités gouvernementales en cours.

On devrait encourager la participation des fermiers à l'exécution de la conception, à la gestion et à l'évaluation du programme.

Energie humaine pour la création de capital naturel

Les populations substituent leur énergie personnelle aux processus de création de capital naturel.

Les types courants d'analyses financières des activités de gestion des ressources naturelles ne reflètent pas la dynamique de l'économie rurale (agriculture, sylviculture, élevage, artisanat).

Engager des habitants locaux comme personnel de programme.

Employer des technologies que les fermiers peuvent enseigner les uns aux autres.

Initiatives et techniques

Il existe au Sahel beaucoup de techniques de gestion des ressources naturelles appropriées et praticables.

Il vaut souvent mieux intervenir sur plusieurs plans ou dans plusieurs secteurs que sur un plan unique ou dans un seul secteur.

Les interventions rapportant des bénéfices multiples et réduisant les risques au minimum produisent des résultats tangibles.

Les interventions de gestion des ressources naturelles sont susceptibles de donner un essor au développement organisationnel local.

Toutes choses égales par ailleurs, choisir des projets de gestion des ressources naturelles à petite échelle diversifiés qui se déroulent par petites augmentations.

Un engagement adaptable et à long terme vis-à-vis des projets augmente les chances de succès.

Aucun facteur unique ne conduit au succès d'une intervention donnée; aucun type simple d'intervention isolée ne réussira infailliblement.

Les activités de gestion des ressources naturelles qui accroissent la productivité peuvent stabiliser les populations rurales et conduire à des investissements dans des modalités plus intensives de l'utilisation des ressources.

L'écologie humaine de la biodiversité est un élément de première importance concourant au développment économique et à la conservation de la biodiversité.

On ne saurait coordonner de façon simple les bénéfices à long terme découlant des ressources naturelles, sans fournir aux participants des bénéfices à court terme.

Faire usage de technologies adaptables qui s'ajoutent aux pratiques traditionnelles, afin d'augmenter les chances de succès.

S'assurer que les programmes incorporent des délais qui se prolongent en fonction de la nouveauté des innovations prévues apportées aux techniques de gestion des ressources naturelles.

Employer des représentations graphiques, des démonstrations, des visites de terrain dans le processus de vulgarisation.

Insister pour que les techniciens et les usagers futurs fassent des analyses, le contrôle et des visites de suivi de caractère collectif.

QUATORZE ETUDES DE CAS

Matrice Récapitulatrice de Quatorze Etudes de Cas

cas	localité	échelle de l'impact	durée	effet sur les revenus	source	intensité de vulgarisation
Opération Barrages de Contrôle Haute Vallée	Mali	moyenne	courte	moyen à fort	externe, traditionnelle	moyenne à forte
Micro-bassins à Enadoujoum et Barrages de Contrôle dans Ourihamija	Niger, Departement de Tahoua	variée	courte	moyen	externe, traditionnelle	haute
Barrages de Retenue d'Eau et Conservation des Sols à Sintet, Gambie	Gambie, Région du Fleuve Central	moyenne	courte	moyen à fort	externe, traditionnelle	moyenne à forte
M. Ka, Pépiniériste Privé	Sénégal Région du Fleuve Central	basse	moyenne à longue	moyen à fort	privée, externe	faible à moyenne
L'accord Bouna	Mali, Delta Intérieur	moyenne	moyenne	moyen	externe, traditionnelle	haute
L'Education Ecologique dans la Cinquième Région du Mali	Mali, Cinquième Région	moyenne	moyenne à longue	faible, indirect	externe	basse à moyenne
Projet du Jardin de Gandiolas	Sénégal, Région du Fleuve	moyenne	courte	fort	privée, externe	basse à moyenne
Projet de la Multiplication des Graines de Lamin	Gambie, Région Haut Niumi	moyenne	moyenne	moyen	externe, traditionnelle	moyenne
L'Entente de Koumpentoum	Sénégal, Région de Tabacounda	moyenne	moyenne à longue	variable	mélangée	moyenne
La Gestion de la Forêt Naturelle de Guesselbodi	Niger, Départ. de Niamey	moyenne	courte à moyenne	moyen à fort	externe, privée	moyenne à forte
La Coopérative des Bûcherons de Guesselbodi	Niger, Départ. de Niamey	petite	courte à moyenne	moyen à fort	privée, externe	moyenne
Gestion des Pêcheries du Fleuve Niger	Niger	moyenne	longue	moyen	externe, privée	moyenne à forte
Comité de Contrôle D'Incendie des Femmes de Bignona	Sénégal, Commune de Bigona	petite à moyenne	moyenne	indirect	privée, externe	faible
Système de Vulgarisation de Haute Vallée	Mali, Troisième Région	moyenne à forte	moyenne à longue	indirect, moyen à fort	externe	moyenne à forte

OPERATION BARRAGES DE CONTROLE HAUTE VALLEE

Informations de Base

Localité: La Troisième Region du Mali

Caractéristiques Principales de la Localité: terrain de savanne doucement accentué et boisé entrecoupé de cours d'eaux saisonniers. La plupart des sols sont maigres avec un contenu elevé de sable ou de gravier latéritique. Pluvométrie annuelle d'environ 800 -1000 mm.

Superficie Concernée: Plusieurs milliers d'hectares

Caractéristiques spéciales: Dans certains endroits, des barrages de contrôle sont déjà connus par les villageois, ayant été initiés par les Pères Blancs il y a des années.

Utilisation Traditionelle de Ressources: Principalement cultures sèches sur piémonts avec certaine irrigation naturelle par submersion.

Nature de l'Initiative: Systèmes de barrages de pierre et de terre dans un certain nombre de régions traversées par des cours d'eau peu profonds.

Description de l'Initiative

Mesures Techniques Entreprises: Dans le village de Fadjibougou, 60 - 70 personnes se sont organisées pendant 17 jours pour construire un barrage de 70 mètres de long et deux metrès de hauteur en accord avec les conseils techniques du personnel du projet. Les pierres et la terre ont été transportés en charrettes et à byciclette par des villageois. Les techniques de construction sont relativement simples et tous les matériaux sont locaux.

Organisation Sociale de l'Initiative: La grande OHV (Opération Haute Vallée) financée par AID a commencé a développer ces barrages en réponse à la demande locale. Le personnel du projet, ayant adopté une vulgarisation plus interactive après environ 8 ans d'expérience, a cherché a utiliser le développement du barrage comme point de départ pour d'autres activités de gestion de ressources naturelles. La main d'oeuvre a été déployée par le

"tonw", qui est une organisation de travail basée sur les groupes d'âge. Le travail a été dirigé par un des chefs du "tonw" supérieur auprès duquel les villageois avaient exprimé confiance.

Systeme d'Encouragements Economiques: Les petits barrages pourvoient des benefices immédiats, mais des barrages supplementaires peuvent etre ajoutés tant que le permettent les ressources et l'énergie. Les fermiers reconnaissent de multiples bienfaits: niveaux d'eau ameliorés dans les puits villageois (5 - 6 mètres, au lieu de 6 - 9 mètres), réduction de dépenses d'extraction et de transport d'eau; restauration de la production de riz; production plus fiable d'arbres fruitiers; amélioration de l'accès à l'eau pour les animaux; amélioration de la pêche.

Données Socioéconomiques: Les bénéfices sont distribués de manière générale aux propriétaires terriens en amont, aux femmes, et aux chefs. Les effets sont de longue durée avec une maintenance convenable. La démonstration a amélioré la conscience locale de l'efficacité des barrages, et a renforcé la credibilité des agents vulgarisateurs et des techniciens de l'OHV. Le succès des barrages de contrôle, de même que d'autres bénéfices du projet tels que routes rurales, encourage les fermiers a expérimenter avec les diguettes en courbe de niveau ,le compostage, les boisements villageois et autres activités du projet.

Discussion Generale de L'Initiative: Ce cas illustre l'importance de combiner les bienfaits de longue et de courte durée dans les interventions techniques, et l'importance de l'aptitude du projet a répondre aux besoins locaux.

MICRO-BASSINS A ENADOUJOUM
ET BARRAGES DE CONTROLE A OURIHAMIJA

Informations de Base

Localité: Au nord du Département de Tahoua, Niger

Caractéristiques Principales de la Localité: Pluviométrie annuelle de 200 - 250mm. Sols sableux de plaine surmontés de plateaux latéritiques, pentes de collines et glacis alluviaux qui ont perdu la plupart de leur végétation Sahélienne épineuse.

Superficie Concernée: Plusieurs centaines d'hectares

Caractéristiques spéciales du cas: l'excès de cultivation et d'élevage des 20 dernières années a produit une dégradation sérieuse. La plupart des champs des plaines alluviales n'ont pas été inondés depuis plusieurs années parce que le lit du cours d'eau, profondément raviné, et le reste des champs du fond de la vallée étaient menacés par les pentes fortement érodées.

Nature de L'Initiative: Construction de barrages de contrôle de ravines et de micro-bassins en demi-lune.

Description de l'Initiative

Mesures Techniques Entreprises: Les barrages de contrôle on causé l'accumulation de plus de deux mètres de sédiment dans des ravines aux alentours de Inadougoum en seulement deux ans. Ainsi les cours d'eaux inondent les terres cultivées du fond. La construction de champs de micro-bassins en demi-lune ont restitué des pentes abandonnées à la production de bois et de céréales. Des rendements surprenants, pour cette zone de précipitation, de 500 kg/ha sont rapportés grâce aux micro-bassins. Les taux de survie des arbres ont été élevés, à presque 100%.

Organisation Sociale de L'Initiative: Swissaid a commencé a travailler dans la zone il y a plus de 10 ans; une activité intensive a commencé il y a trois ans. Les villageois ont demandé à Swissaid des services d'assistance en 1985, quand ils envisageaient abandonner les villages. Swissaid a fourni des outils manuels, et des services d'assistance technique en collaboration avec le Service du Génie Rural. Au départ, l'Alimentation pour le Travail a été fournie pour les villageois pour les encourager a rester en place durant la saison sèche et pour installer l'infrastructure nouvelle.

Système d'Encouragements Economiques: Les barrages de contrôle et

les micro-bassins ont fourni de bonnes récoltes de mil pour la première fois depuis des années. Soixante familles bénéficieront bientôt de la coupe de perches des plantations où les arbres on déjà atteint une hauteur de 2 a 3 mètres. Swissaid a aussi aidé les villageois a former une coopérative pour produire des clôtures en fil de fer pour lesquelles il y a une demande croissante de la part des efforts de reboisement locaux.

Discussion Generale de L'Initiative: Les Villageois étaient au courant du travail de conservation des sols d'un prêtre francais qui a habité a Ourihamija pour environ 20 ans, travail que les Suisses ont continué. Le prêtre a emmené quelques fermiers rendre visite à des sites similaires dans le Département d'Agadez, ce qui a incité la participation des villageois. Ce cas illustre que des situations dramatiques peuvent etre améliorées à travers des solutions techniques par étapes a long terme à haute intensité de main d'oeuvre executées moyennant la vulgarisation face-a-face. Certains problèmes techniques relatifs à l'installation de l'infrastructure ont surgi, mais l'agriculture a néanmoins vécu une récuperation miraculeuse à partir d'une situation désespérée.

BARRAGES DE RETENUE D'EAU
CONSERVATION DE TERRES A SINTET, GAMBIE

Informations de Base

Localité: Alentours du Village Sintet, Région du Fleuve Central, La Gambie

Caractéristiques Principales de la Localité: Pluviométrie annuelle de 700 - 800mm. Les affluents du fleuve Gambie découpent la zone. Des restes de forêt de galerie et la végétation de savanne boisée domine. Passé politique long et relativement cohésif.

Superficie Concernée: 3000 ha de bassins versants atteints par l'érosion des sols, le déboisement, et l'intrusion de sable et d'eau salée dans une zone de 700 a 800 mm de pluviométrie. Quarante-cinq hectares son directement concernés.

Caracteristiques Spéciales du Cas: La région Foni Jarrol a une identité agro-écologique et géopolitique distincte qui date de l'époque pré-coloniale. Le chef régional ou Sefo est un individu qui a une forte influence et dont l'appui en faveur de l'intervention a été jugé essentiel au succès.

Utilisation Traditionelle des Ressources: La culture du riz, principalement une culture de femmes, est faite sur de petites plaines saisonnièrement inondées par l'eau des pluies et de fleuve. La cultivation a l'amont se constitue de cultures de champs d'arachides, de mil, de sorgho et de maïs. La traction animale est courante.

Nature de l'Initiative: Des barrages de retenue d'eau, des diguettes en courbe de niveau et des petits barrages de contrôle de ravins ont été les interventions techniques principales. Les villageois ont été encouragés a s'organiser en un groupe de gestion de conservation.

Description de L'Initiative

Mesures Techniques Entreprises: Les barrages de retenue d'eau, les diguettes en courbe de niveau et les petits barrages de contrôle de ravins ont été les interventions techniques principales. Les méthodes topographiques de pointe sont utilisées pour placer les structures de conservation. Les tracteurs sont utilisés seulement pour déchirer les sols compactés et pour transporter les pierres.

Organisation Sociale de l'Initiative: Le Groupe de Gestion des Sols et de l'Eau (SWMU), âgé de six ans, et situé dans le Ministère de

l'Agriculture de La Gambie, fait une publicité active pour ses services de conservation des eaux et des sols. Il répond ensuite aux demandes d'aide des villages dirigées à la SWMU par les Agents Agricoles Régionaux. Après reconaissance des régions demandant des assistances, le personnel de la SWMU décide quels villages ont le plus grand besoin, et met en ordre de priorité le travail à faire. Le travail physique est organisé par comités de village, pendant que la SWMU fournit l'appui technique.

Système d'Encouragements Economiques: Des villageois qui autrement seraient partis en migration de travail de saison sèche, restent maintenant au village pour travailler sur l'infrastructure. Les encouragements d'Alimentation pour le Travail ont été évités parce que les effets écologiquement nuisibles de l'intrusion de sel et de l'érosion ont été reconnus, et des augmentations dramatiques de rendements ont été obtenus par la conservation. Aussi, des plaques et des récompenses ont été accordés par Le Service de Conservation des Sols des Etats-Unis.

Données Socioéconomiques: L'analyse économiqe des barrages de retenue d'eau évalue les taux de rentabilité internte à entre 26 et 34 pour cent. De multiples bénéfices se produisent dans la première année suivant l'installation. Ils comprennent: une production de riz et augmentée de fourrage; une augmentation dans la disponibilité d'eau; la réapparition d'espèces végétales "disparues"; la protection de l'habitat; et une réduction de l'érosion de sols et d'intrusion de sable.

Discussion Générale de l'Initiative: Ce cas démontre que la gestion integrée des bassins verants peut être obtenue par une combinaison de dévelopement d'organisation au niveau local et de services techniques fiables, en se basant sur des valeurs de conservation de ressources. Sintet fournit maintenant un site modèle pour d'autres villages de la région qui y rendent visite.

M. KA, PEPINIERISTE PRIVE

Informations de Base

Localité: Région de Tambacounda, Sénégal

Caractéristiques Principales de la Localite: La Région est une zone d'extension pour le bassin d'arachides et ses forêts qui sont opprimées par l'agriculture et la sécheresse. La pluviométrie annuelle a diminué à entre 600 et 700 mm. depuis le début de la période de sécheresse. Les sols varient de sableux a latéritiques.

Superficie Concernée: Plusieurs milliers par une combinaison de pépiniéries privées, de gestion de forêts naturelles, et de production de plantation.

Characteristiques Speciales du Cas: La confiance dans les encouragements du marché pour inciter une gestion fiable des ressources naturelles.

Utilisation Traditionelle des Ressources: Des pratiques recentes se sont concentrées sur la production extensive d'arachides en utilisants des intrants à haute intensité de capital.

Nature de l'Initiative: 157 pépiniéries privées ont été établies par les efforts du projet PARCE basé a Kafrine.

Description de L'Initiative

Mesures Techniques Entreprises: Le projet finance 50 pourcent des coûts de l'établissement de pépiniéres. Les arbres sont favorisés dans quelque niche écologique qu'ils puissent remplir. Le choix des espècess n'est pas imposé mais le projet fournit des conseils techniques pour promulger les espèces convenable pour certaines conditions particulières.

Organization Sociale de l'Initiative: Un réseau d'agents vulgarisateurs formés par le projet apprend aux villageois la gestion de pépiniéres et les techniques de vulgarisation forestière. Le projet fournit aussi certains services de courtage de marché aux pépiniéristes.

Systeme d'Encouragements Economiques: Les semis coûtent 15 francs CFA à produire et sont vendus pour 35 francs CFA. Certains

gouvernements locaux on commencé à acheter chez les pépiniéristes privés pour remplir leur propres buts de reboisement. M. Ka a vendu au moins 2500 plants en 1987 à des groupes en dehors de son village à 35 FCFA le plant. Les villageois ont appris que la production d'arbres peut ête économiquement compétitifs avec celle des arachides.

Données Socioéconomiques: M. Ka, le pépiniériste rencontré dans le village de Thoune, (un parmi trois dans le village) a établi sa pépiniérie dans un coin de son enceinte. Il a produit 2400 plants en 1986 et 5000 en 1987. (La production totale des trois pépinières en 1987 etait 9000 plants). M. Ka gère la production des pépinière de son village be'ne'volement, mais une grande partie du travail routinier est partagé par ceux des villageois qui ont commandé des pants. Il est reconnu en tant que chef en matière de promotion de plantation d'arbres dans la région. Pour son travail de pépiniériste et ses qualités de chef, il a été décoré par Président Abdou Diouf en 1987.

Discussion Generale de l'Initiative: Ce cas ilustre qu'une intervention de projet peut fournir une incitation pour une gestion améliorée de ressources.

L'ACCORD BOUNA

Informations de Base

Localité: La Région du Delta Intérieur du Mali.

Caractéristiques Principales de la Localité: Un des rares deltas intérieurs en Afrique. Pluviométrie annuelle de 200 - 400 mm. en moyenne. Les populations d'animaux, de plantes et humaines sont denses saisonnièrement. Une tradition d'écosysteme et d'économie très diverse.

Superficie Concernée: Plusieurs centaines de kilomètres carrés sur le fleuve Niger.

Utilisation Traditionelle des Ressources: Des systèmes d'élevage, de pêche, d'agriculture et de chasse complexes et qui se chevauchent. Les réglementations qui empêchaient la sur-utilisation des forêts et des pâpurages ont été obscurcies par de rapides changements historiques et climatiques.

Nature de l'Initiative: Par suite de plusieurs années de négotiations, en employant des techniques de résolution de conflit, les parties intéressées ont signé un accord sur l'utilisation commune des ressources.

Description de L'Initiative

Mesures Techniques Entreprises: L'Accord Bouna créera une série de lois sur les biens communs pour remplacer le mélange contradictoire présent de revendications de lignages villageois locaux, de règles promulgées par le Dina au XIXème siècle, de la loi franaise coloniale, et de règles nationales plus récentes sur l'accès aux biens communs.

Organization Sociale de l'Initiative: Essentiellement, L'IUCN aide les éleveurs de chèvres, les pêcheurs, les autorités locales traditionelles, et les autorités nationales qui se servent d'une série de petites forêts saisonnièrement inondées dans le Delta Intérieur du Niger. L'accord: 1) donne les droits de propriété des forêts aux villages; 2) place l'autorité de gestion locale dans les mains des dioros et des chefs de village qui avaient autrefois cette autorité. 3) formalise les droits de pêche qui existent déjà; 4) font respecter une politique interdisant la coupe des arbres pour enclos ou broutage 5) interdit la récolte d'oisillons de hérons pendant deux ans; 6) limite l'entrée de troupeaux de chèvres (broutage excessif de l'herbe bourgou et des arbres); obtient pour

l'accord l'appui des entités administratives indiquées du gouvernement Malien.

Système d'Encouragements Economiques: On a montré aux parties intéressées qu'avec une gestion convenable le fumier d'oiseaux augmentera la croissance des algues et la production de poissons pour les pêcheurs; les éleveurs de chèvres seront assurés le fourrage amélioré et de l'accès assuré à l'herbe bourgou en échange pour la cessation de la coupe des branches d'Acacia tortillis, (var. kirkii) pour les enclos et le broutage; les fermiers auront des vols de cigognes plus fiables pour aider avec le contrôle des sauterelles; Le gouvernement Malien remplira ses accords RAMSAR pour protéger les terres humides. Enfin, le contrôle local sera plus effectif à cause de l'attention constante des contrôleurs. En Janvier 1988, cet accord multi-dimensionnel avait encore besoin de l'approbation des administrateurs locaux et de l'Administration Forestière pour etre entièrement applicablee.

Données Socioéconomiques: Le coût total de cette initiative, de la publication Walia qui y est rattachée, et d'autres projets du Delta Intérieur est seulement de $712,000 répartis sur quatre ans.

Discussion Génerale de l'Initiative: L'accord Bouna exemplifie une intervention non-technologique pour améliorer la gestion de biens communs, en incluant la biodiversité, par la résolution de conflits. Elle démontre aussi qu'une ONG désintéressée peut servir de facilitateur neutre dans un procéssus de négotiation. Cette méthode de gestion de biens communs est unique dans le Sahel.

L'EDUCATION ECOLOGIQUE DANS LA CINQUIEME REGION DU MALI

Informations de Base

Localité: La Cinquième Région du Mali.

Caractéristiques Principales de la Localité: Le siège central de Walia est à Mopti. La cinqième région a l'écologie la plus complexe du Mali à cause de l'inondation saisonnière du Fleuve Niger dans une série de plaines et de lacs. Plus de neuf groupes ethniques et/ou linguistiques se partagent la région pratiquant des économies distinctes et exploitant des niches écologiques historiquement séparées. Dans un contexte de déterioration de l'environment et de crise économique, la diversité de la faune et de l'habitat ont catastrophiquement diminué par la sur-exploitation, les règles d'accès libre, et/ou des règles d'accès limiter impossibles à faire appliquer.

Superficie Concernée: Environ 78,000 kilomètres carrés.

Caractéristiques Spéciales du Cas: Walia a le but d'enseigner une gestion amélioree des ressources, reconciliant les bénéfices à court et à long terme, et harmonisant les buts de développement rural avec ceux de la conservation.

Nature de l'Initiative: Walia est un magazine polycopié, illustré, distribué à 25 écoles dans la Cinquième Région du Mali.

Description de L'Initiative

Mesures Techniques Entreprises: L'UICN, le Centre Candien d'Etudes et de Cooperation (CECI), CARE-Mali, et la branche régionale de l'Administration Forestière font conjointement le parrainage du magazine. Walia est publié trois fois par an. L'IUCN polycopie et distribue le magazine aux écoles puisque le système des postes n'est pas fiable. Ses articles discutent de la géographie, de la faune, de questions environmentales et de santé Maliennes, d'histoires traditionelles, d'écologie et de questions de ressources naturelles.

Organisation Sociale de l'Initiative: Les numéros individuels sont passés de lecteur en lecteur ce qui fait que les 4000 copies imprimées pour chaque numéro et destinées à un groupe d'age scolaire sont probablement lues par plus de 10,000 Maliens. En fait, sa popularité est si grande que Walia est maintenant lu à travers tout le Mali. Chaque numéro est suivi par deux jours de visite d'enseignement par le directeur du projet de l'IUCN et son homologue/traducteur Malien. Chaque tour de visites prend trois

mois à compléter.

Données Socioéconomiques: L'IUCN dépense $40,000 annuellement sur le projet.

Discussion Génerale de l'Initiative: Walia a mis en évidence les questions concernant les ressources naturelles de la région du Delta. Souvent, les enfants parlent à leur parents sur les changements écologiques. Les professeurs incorporent Walia dans le programme d'études. Des concours, des jeux et des projets basés sur le matériel de Walia ont un effet sensibilisateur en matière de ressources naturelles. Des efforts similaires on été essentiels au climat amélioré pour la préservation de la biodiversité en Afrique de l'Est.

PROJET DU JARDIN DE GANDIOLAS

Informations de Base

Localité: Région du Fleuve, Sénégal

Caractéristiques Principales de la Localité: Dans cette région du Sénégal les sols sont argileux et pauvres en matières organiques. La nappe phréatique est peu profonde. La pluviométrie annuelle est de seulement 300 mm, marginale pour la production naturelle de mil.

Superficie Concernée: Un hectare est directement concerné.

Caractéristiques Spéciales du Cas: Une pluviométrie diminuée a causé la perte de beaucoup de espèces utiles de plantes et d'arbres et l'isolement des individus qui sont restés.

Description de L'Initiative

Mesures Techniques Entreprises: Des petits jardins d'arbustes vivaces et d'arbres sont plantés sur un terrain mesurant un hectare. Aucun critère spécial de sélection n'existe à part les besoins exprimés. Le Volontaire Canadien voyage à travers le Sénégal pour trouver les graines de choix. Parmi les espèces choisies il y a celles qui sont utiles pour la production de médicaments, de cosmétiques, de nourritures et de condiments.

Organisation Sociale de l'Initiative: Un agent forestier travaille directement dans la formation et la vulgarisation avec un volontaire Canadien et des groupes de femmes dans 25 villages pour établir les priorités horticoles. Le groupe de femmes de Leona (53 membres) a établi, et maintient présentement le jardin. Des sous-groupes éxécutent de différentes tâches particulièrement l'arrosage pendant la saison sèche, et la culture intercalaire avec le niébé pendant la saison des pluies.

Système d'Encouragements Economiques: Ce projet ne fournit aucun encouragement économique direct. Les villageois participent parce qu'ils reconnaissent les bénéfices des plantes cultivées. Par example, le rétablissement des plantes médicinales peut réduire les dépenses pour les médicaments. De plus, la perte d'espèces a été accompagnée par une perte de connaissance ethno-botanique directe parmi la generation plus jeune des femmes. Ce projet aide a redresser ce problème.

Données Socioéconomiques: Le projet a bénéficié des recherches sur les graines énergétiques du Volontaire Canadien et de la

flexibilité programmatique de M. Faye, l'agent forestier local. Contre les voeux de ses supérieurs, il a changé la direction de l'initiative d'un projet conventionel de bois de feu à la forme présente. De plus, la perte des espèces a été accompagnée par une perte de connaissance de première main ethno-botanique parmi la génération plus jeune des femmes. Le projet aide a redresser ce problème.

Discussion Générale de l'Initiative: Sur une petite échelle, les activités du projet du jardin de Gandiolas, parainné par les Canadiens, dans le village de Léona, Louga, Région du Fleuve, au Sénégal, est un autre exemple du mariage réussi de la biodiversité et des intérêts de soutien ou d'augmentation de productivité. Cette intervention contribue à la divesrité florale et est basée sur la simple idée d'un projet répondant aux besoins locaux par la participation locale.

PROJET DE MULITIPLICATION DES GRAINES DE LAMIN

Informations de Base

Localité: Alentours du village de Lamin, Region de Haut-Niumi, La Gambie

Caractéristiques Principales de la Localité: Pluviométrie variable entre 600 et 800 mm. Les sols sont divers avec des sols légèrement évolués en hauteur, et des colluviums et des marécages asséchés sujets à l'acidification et à la salinisation le long des bolongs sous des conditions de sécheresse. Les densités de populations sont élevées mais se stabilisent par une migration ver le sud.

Nature de l'Initiative: Un programme pour introduire une variété de riz de cycle court dans la région du village de Lamin.

Description de L'Initiative

Mesures Techniques Entreprises: Une nouvelle variété de Pékin à 90 jours aide à restaurer la culture de riz dans les régions des terres basses touchées par la sécheresse. Le projet GARD financé par la USAID fournit des graines certifiées.

Organisation Sociale de l'Initiative: Le Personnel du Fonds pour Sauver les Enfants (SCF) a rassemblé un nombre d'individues et d'organisations dans ce programme. Le projet GARD dirige un terrain de démonstration près du village de Bakindig. Les membres du groupe de femmes de Lamin ont visité ce terrain et ont choisi le Pékin et d'autres varietés intéressantes pour mettre à l'épreuve dans leur propres champs. Le SCF surveille l'utilisation d'engrais et de pesticides. L'Unité de Contrôle de Sauterelles fournit le pesticide. Le SCF achète des graines pour distribution dans d'autres villages et une petite quantité est envoyée à la station de Recherches de Sapu pour des essais.

Au début de la saison des pluies, l'agent de développement de la communauté rend visite à Lamin et indique aux gens quand il faut planter. Le comité de dévelopement du village décide le jour des semailles communales. L'agent fournit aussi des informations sur les pratiques de culture pour les villageois. Il leur indique aussi quand il faut désherber. L'agent inspire la sympathie et la confiance. Les villageois ont même donné son nom à la variéte de riz Pékin (Danjomano). Un agent de vulgarisation agricole fournit des pesticides et pulvérise deux fois par an contre les scarabées.

Le groupe de femmes cultive les graines sous contrat avec le SCF pour avoir les graines certifiées pour la distribution. Elles fournissent la plupart de la main d'oeuvre sur le terrain.

Système d'Encouragements Economiques: Le SCF a garanti la récolte de 1985 et subventionné en engrais et graines dans six villages pour deux ans. Le groupe de Lamin a vendu 16 sacs de riz sur le marché libre en 1986 et a reçu environ 2000 Delasis (environ $250). Ceci a été remis au trésorier du comité de dévelopment du Village (VDC). L'argent a été mis en banque et est disponible pour l'utilisation par la communauté. Le SCF achète aussi du riz des individus à un prix déterminé par le village jusqu'à un maximum de 10 à 20 kg. par village. Le SCF est en train d'aider Lamin a s'enregistrer avec le centre de Sapu comme centre de multiplication de la variété Pékin. Ceci entraîne un transfert de connaissances techniques et administratives nouvelles. Enfin, le SCF a fourni des matériaux pour un entrepôt d'enmagazinage, alors que le VDC fournit la main d'oeuvre.

Données Socioéconomiques: La nouvelle variété de riz pousse bien sous les condition techniques prédominantes, son goût est bon, et elle mûrit en moins de trois mois. Les femmes savent bien que la monoculture du Pékin le rend vulnérable à la maladie, et elles sont en train d'expérimenter activement avec de nouvelles variétés pour renouveler la diversité biologique. Les hommes commencent à cultiver le riz dans les champs des terres plus hautes et commenceront à utiliser cette variété de façon à étendre les terres de culture.

Discussion Génerale de l'Initiative: Les gens de Lamin ont accepté la réalité d'un changement permanent dans les conditions de pluviométrie. Ils sont pressés de s'adapter à ces conditions. Ce cas illustre comment les buts de biodiversité et d'augmentation de production peuvent être intégrés.

L'ENTENTE DE KOUMPENTOUM

Informations de Base

Localité: L'arrondissement de Koumpentoum, Région de Tambacounda, au Sénégal.

Caractéristiques Principales de la Localité: Dans une zone de 1000 mm de pluviométrie annuelle dans le passé, la pluviométrie moyenne des seize dernières années depuis 1968 a été seulement 700 mm. Diam Diam se trouve sur des sols graveleux couchés sur du grès dans lequel on trouve des croûtes ferrugineuses. Des sols sableux légèrement évolués s'y trouvent. Tous sont portés à l'érosion. Diam Diam se trouve juste au sud d'une de forêt classée dans laquelle se trouvent des formations naturelles dégradées. La sur-utilisation pour le charbon, la construction, et les outils a provoqué la perte du Cordylia Pinnata; la dégradation climatique explique la disparition d'autre espèces. La nappe phréatique est tombée à 55 mm ce qui a causé le séchage de quelques puits.

Superficie Concernée: Plusieurs centaines d'hectares éparpillés dans l'arrondissement. L'adhésion totale de l'Association est de 1,240, environ 10 pourcent de la population des villages membres.

Caractéristiques Spéciales du Cas: L'Entente Koumpentoum a été fondée en 1974 à la suite de la première vague récente de sécheresse sahélienne par un groupe exceptionnel de villageois locaux inquiétés qui voulaient prendre action en matière de leur environnement. La participation est volontaire; certaines activités sont sont auto-financées. L'association a recu l'appui d'au moins une demi-douzaine d'ONGs et autres bailleurs de fonds, mais pour 10 ans a reçu l'appui constant des Services de Secours Catholiques.

Utilisation Traditionelle des Ressources: La terre est présentement utilisée pour la culture mécanisée de mil, de sorgho, et d'arachides. Sous des conditions de pluviométrie plus élevée, le coton a aussi été cultivé.

Nature de l'Initiative: Projet de dévelopement rural intégré, initié par la communauté.

Description de L'Initiative

Mesures Techniques Entreprises: Le village de Diam Diam a entrepris une série d'initiatives de gestion de ressources naturelles. En 1981, le village a mis à part 250 ha de terres villageois pour des activités de reboisement. Sept hectares de

plantations clotûrées pour l'Eucalyptus, les acacias australiens, et des espèces locales ont été plantés. Cinq hectares additionnels de terre sont clôturés pour un futur verger de village. Un boisement de 25 acres et des abrivents ont été plantés par le Coodinateur de l'Entente comme démonstrations. Le groupe de jeunesse de même que le groupe des femmes a planté 50 acres d'eucalyptus. Le pépiniériste villageois a rassemblé des graines d'une zône plus au sud pour commencer a regénérer des espèces d'arbres indigènes perdues ou devenues rares. De plus, sex hectares de champs par année sont fertilisés par un programme planifié, et l'échelonnement de mise en étable des animaux de troupeaux gerés collectivement, mais appartenant a des propriétaires individuels.

Système d'Encouragements Economiques:

Données Socioéconomiques: A part les initiatives en matière de ressources naturelles, le village de Diam Diam a construit un grenier collectif, un magasin coopératif, un petit dispensaire sans personnel, un entrepôt, et est entrain d'enmagasiner des briques pour construire une mosquée. L'Entente a acheté une batteuse de mil pour le village de Diam Diam, et l'association elle-même a acheté un moulin à mil. Aussi en cours est une combinaison adroite par laquelle des chèvres et des bovins partagés par leurs propriétaires sont utilisés pour créer le noyau de troupeaux individuels.
Les fonds furent d'origine générés à partir de champs collectifs et ce mécanisme est encore utilisé. Le comité espère recevoir de nouveaux services d'assistance technique pour lancer un nouveau programme de production de fourneaux améliorés au village. Le comité d'Entente aussi bien que les sous-comités de village magazinent des greniers collectifs, à Diam Diam. Récemment l'Entente a institué un plan d'épargnes obligatoire. Chaque année chaque homme doit contribuer 10,000 francs CFA et chaque femme 2,500 CFA au fonds. L'Entente a plus de 1000 membres et croi^t annuellement.

Organisation Sociale de l'Initiative: Le petit nucleus de l'organisation a reçu des assistances et de l'encouragement d'un agent vulgarisateur Sénégalais bien connu du nom de Mahmadou Cissoka. Après dix ans d'expérience, presque chaque activité est projetée par les villageoois-mêmes avant qu'ils cherchent de l'aide du dehors. L'initiative comporte des similarités avec le projet AJAC dans la région Casamance. Une organisation formelle représentative embrasse de nombreux projets au niveau de village and des sous-projets organisés par des groupes d'interêt volontaires. Chaque projet de l'Entente a une personne responsable

en charge. Chaque projet est surveillé par un sous-comité. Chaque projet cherche des assistances techniques et financières séparées, si elles sont nécessaires, ou d'un NGO ou d'un service de gouvernement. Des decisions de comite sur l'utilisation des ressources du comité sont prises par un comité exécutif composé d'officiers et de délégués des sous-comités.

Système d'Encouragements Economiques: Des encouragements divers existent dans les projets de l'Entente. Par exemple, à partir des gains des champs collectifs, des batteuses et des moulins ont été achetés qui diminuent les goulots d'étranglement de main d'oeuvre des femmes. Les courses faites au magasin coopératif local, bien ravitaillé, réduit le temps de voyage du client individuel. Les gérants des magasins reçoivent une indemnité basée sur le pourcentage annuel. Des perches en bois ont été vendues du boisement du village de Bamba Thialene. On s'attend bientôt à des ventes du boisement du village de Diam Diam bientôt. Bien que les pris soient bas, 200-300 francs CFA par perche, les revenus du terrain de 7 hectares seront significatifs. Des projets de multiplication de bétail fournissent aussi bien des bénéfices immédiats (lait) que des bénéfices à moyen terme dans le cas des bovins (engrais) et des bénéfices à long terme (agro-pastoralisme intégré) aux participants.

Discussion de l'Initiative: Les sources d'assistance sont diverses. Les Services de Secours Catholiques ont fourni les clôtures et des pour la composante forestière sous forme de subventions. Un volontaire du Corps de la Paix a donné des services d'assistance technique forestière pendant deux ans. Les ONGs financent la plupart des coûts de capital, mais les structures de groupes de travail traditionelles sont mobilisées pour le travail collectif, et des amendes (le double de la dépense initiale) sont imposées sur les participants qui persistent en délinquence.

Parmi les éléments les plus intéressants de cette intervention sont sa base dans une analyse de déterioration de ressources naturelles, et la détermination des villageois pour prendre action afin d'y faire face. La flexibilité continue et l'adaptation aux besoins et aux demandes des participants, et l'intégration des activités dans la vie du village constituent son empreinte. La gestion des ressources naturelles n'est pas une activité isolée à Koumpentoum.

L'ESSAI DE LA GESTION DE LA FORET NATURELLE DE GUESSELBODI

Informations de Base

Localité: La forêt naturelle de Guesselbodi 30 km. à l'est de Niamey, Niger.

Caractéristiques principales de la Région: Pluviométrie annuelle de 400 - 600 mm. Surfaces ;croûtes latéritiques sujettes à l'érosion par couches et par avec des dépôts éoliens dans les bas fonds. Cinquante pour cent de la couverture végétale de la forêt a disparu depuis 1950.

Superficie Concernée: Cinq mille hectares.

Caractéristiques spéciales de l'initiative: Les techniques de défrichages et de régénération intensifs en main d'oeuvre ont été utilisés pour revitaliser une forêt naturelle sévérement dégradee, et le projet a négotié l'indépendance de la coopérative des bûcherons de l'Administration Forestière.

Utilisation Traditionelle des Ressources: Exploitation opportuniste, criblée de conflits, par les populations locales, en parallèle avec des efforts de préservation de ressources et avec la répression de l'utilisation non autorisée par l'Administration Forestière.

Nature de L'Initiative: Creation d'un système de gestion à ressources et à buts multiples pour la forêt qui est rentable et qui s'appuie sur la participation populaire.

Description de l'Initiative

Mesures Techniques Entreprises: Division de la forêt en parcelles d'aménagement. Le projet a visé un programme intensif de restoration des sols qui inclut des diguettes en courbe de niveau, le paillage avec des branches et des brindilles, des d'eau en terre, un contrôle d'érosion mécanisée, et la coupe de peuplements naturels de Combretum mûrs, naturels, pour faciliter la régénération. L'agro-forestrie sur des terres agricoles, des plantations dans les zones défrichées, et la gestion des pâturages naturels pour la regénération complètent l'inventaire des activités. L'utilisation de la regénération naturelle et des semis directs peut considérablement réduire les coûts de reboisement dans les forêts sahéliennes.

Système d'Encouragements Economiques: Le bénéfice immédiat et significatif identifié par les villageois est l'emploi des gens locaux pour exécuter des tâches définies par le plan de travail.

Le programme de restauration par de travaux publics continue à évoluer. Les fermiers apprécient l'emploi qui élimine la nécessité de migration de travail de saison sèche. Le directeur du projet apprécie les possibilités de parrainage. Mais le prix élevé de bois de feu à Niamey rend possible que la forêt devienne rentable sur une base de rendement soutenue. Les gardes forestiers touchent des revenus en argent comptant de 40,000 CFA par mois. L'Administration Forestière a gagné 600,000 francs CFA pour son fonds forestier à partir de permis de coupe .

Données Socioéconomiques: Au début du projet, avec l'autorisation de l'Administration Forestière un lot de 40 ha de bas fond à l'intérieur de la forêt a été divisé en douze unités de culture pour des fermiers locaux qui depuis longtemps réclamaient ces terres. La seule responsabilité des fermiers était de protéger les abrivents. Ce transfert de bénéfices immédiats démontre que le projet étaist sérieux au sujet de ses intentions d"aider" les fermiers. Le transfert de bénéfices a facilité l'acceptation de stratégies de gestion avec bénéfices à plus long terme. Des individus ont réalisé des revenus en espèces de la coupe du bois; de nouveaux bûcherons continuent à prendre des permis. Ainsi il se répand des bienfaits substantiels sur un nombre de groupes d'interêt différents. Une production de fourrage augmentée dans des régions protégées, et de l'activité agriculturelle dans des régions interdites auparavant ont aussi été réalisées.

Discussion Générale de l'Initiative: La réforme de politiques sont advenus comme résultats de dix ans de négotiations intensives entre le projet, les fermiers locaux,l'Administration Forestière and l'administration nationale. Les projets présent demandent l'extension de ce modèle à plusieurs autres sites gérés par des donateurs. Mais beaucoup de questions restent. Le programme réussira-t-il aussi bien avec une assistance technique qui seulement 50 pour cent aussi efficace? Sans les possiblilites de main-d'ouevre publics de la saison sèche, les fermiers seraient-ils aussi enthousiastes? Est-ce qu'un programme de récolted de peuplements naturels peut servir d'incitation égal dans d'autres contextes? Sans l'appui technique et politique, est-ce que les bûcherons seraient capables de s'organiser de manière réussie et maintenir le contrôle de leurs ressources?

LA COOPERATIVE DE BUCHERONS DE GUESSELBODI

Informations de Base

Localité: La Forêt Naturelle de Guesselbodi à 30 km. de Niamey, au Niger.

Caractéristiques Principales de la Localité: La zone a une pluviométrie annuelle de 400 - 600 mm. Des surfaces dénudés de croûtes latéritiques et sujettes à l'érosion par couches et par ravinement. Cinquante pour cent de la couverture végétale de la forêt a disparu depuis 1950.

Superficie Concernée: Cinq mille.

Caractéristiques Spéciales du Cas: Des techniques de restaurationet et de régénération à haute intensité de main d'oeuvre ont été utilisés pour revitaliser une forêt naturelle sévèrement dégradée, et le projet a négotié l'indépendance de la coopérative de bûcherons de l'Administration Forestière. La CLUSA a surmonté des obstacles culturels et administratifs redoutables pour établir la coopérative locale parmi les fermiers de Zarma.

Utilisation Traditionelle des Ressources: Une méthode d'exploitation opportuniste et pleine de conflit par les populations locales jointe à des efforts de préservation de ressources et la repression d'utilisation non autorisée par le Service Forestier.

Nature de l'Initiative: Le Projet Planification et Utilisation des Sols et des Forêts, subventionné par la USAID, avec l'aide de la CLUSA (la Ligue Coopérative des USA) a encouragé sept villageois a former une coopérative de bûcherons et de gestion de la forêt.

Description de L'Initiative

Mesures Techniques Entreprises: Un programme de coupe selective reflètant la topographie et la susceptibilité du site à l'érosion est développée par les techniciens. Des coupes selectives de trois espèces visées de Combretum dans le peuplement sont basées sur le diamètre minimum de la tige. Les bûcherons récoltent les arbres. Un chantier de vente local adjacent à la route nationale principale a été établi.

Système d'Encouragements Economiques: La coopérative de bûcherons gagne de l'argent de plusieurs manières. Elle profite des ventes de permis et du bois au transporteurs à partir de son chantier

routier. En 1987, la coopérative a réalisé son premier dividende collectif de 200,000 CFA de permis forestiers et autres. L'Administration Forestière partage les profits qui sont contribués à son fonds de gestion des forêts naturelles. La partage des profits compense partiellement l'Administration pour sa perte d'amendes lucratives imposées préalablement pour la coupe illégale. Les transporteurs achètent de la coopérative parce que le bois est peu cher et parce que les quittances obtenues du boisement satisfont leurs exigences fiscales. Des gardes montés confisquent les animaux qui entren dans les parcelles de terrain protégées et les propriétaires subissent une amende.

Les techniques de gestion améliorées introduites dans cette forêt sévèrement dégradée fournissent des augmentations à long terme dans la productivité forestière et de fourrage. Le contrôle strict des parcours avec replantation d'espèces de fourrage a permis à la coopérative d'augmenter ses revenus venant du fourrage coupé. La coopérative fait une rotation de pâturage sur les 5 parcelles de forêt de 1000 ha, et peut imposer une amende aux violateurs.

Organisation Sociale de l'Initiative: Des efforts de vulgarisation extraordinaires et intensifs, débutant en 1983 fournissent une liaison vitale de communication et un mécanisme de transfert de responsabilité à la coopérative forestière. Les participants dans la coopérative doivent participer dans les techniques de gestion des forêts naturelles mises au point par le projet PUSF. Moyennant ceci, seuls les bûcherons locaux peuvent acheter des permis de coupe (1000 francs CFA par permis renouvelable) de la coopérative. Ces permis renouvelables leur permettent de couper et de vendre le bois naturel au boisement coopératif routier.

Données Socioéconomiques: La coopérative a utilisé les ressources forestières comme caution pour des prêts pour acheter des charettes pour le transport. Les bûcherons peuvent acheter des pemis, couper et vendre leur bois à la coopérative et mettre l'argen en poche immédiatemant. Ou alors, il peuvent racheter le bois de la coopérative, le transporter dans leurs charettes au marché eux-mêmes et le revendre à profit. Munis des papiers requis, ils n'ont pas à craindre la repression de l'Administration Forestière.

Discussion Génerale de l'Initiative: La décision du gouvernement nigérien de permettre à une coopérative de bûcherons de se former autour de la forêt de Guesselbodi est une des reformes de politique les plus réussies que l'on ait rencontré. La vente du bois semble bien organisée, mais la persévérance des expatriés pour soutenir et améliorer le programme dans l'interêt de sa multiplication est évidente.

LA GESTION DES PECHERIES DU FLEUVE NIGER

Informations de Base

Localité: Des villages insulaires le long du Fleuve Niger dans la République du Niger

Caractéristiques Principales de la Localité: Capture annuelle de 4500 tonnes en 1960 diminué à seulement 900 tonnes métriques en 1985 du a des courants d'eau annuels plus bas, de moins de varieté dans les flux saisonniers, et de l'exploitation des plaines alluviales du bassin du fleuve pour une culture de riz irriguée. Pendant cette même époque, la pêche journalière par pêcheur a décru de 13kgs. à 3.3 kgs. Certaines espèces ont pratiquement disparu dans la zone du sud, partagée par le Benin et le Niger, où plus de 80 pourcent de la pêche n'est pas mûre. De plus, le manque de matières organiques, les sources limitées de fourrage, les sécheresses périodiques et la compétition avec d'autres activités pour les ressources d'eau limitent le développement futur de l'aquaculture. Quoi qu'il en soit, les résultats de recherches du Projet de Développement des Pêcheries Nigeriennes-FAO, financées par le PNUD et l'USAID suggère qu'une gestion de ressources convenable peut doubler la production fluviale en question de 3 à 5 ans à 2000 tonnes métriques annuellement.

Superficie Concernée: 500 kilomètres du Fleuve Niger.

Caractéristiques Spéciales du Cas: La politique de la "Société de Développement Nigérienne", crée en 1979, est basée sur une revitalisation de l'autorité locale et de la participation populaire. La "Société de Dévelopement" est responsable pour le dévelopement régional et sectorial. Le Projet de Dévelopement des Pêches subventionné par La FAO a exploité cette occasion politique pour commencer à forger des relations nouvelles entre la Direction des Pêcheries Nigériennes et les communautés de pêcheurs.

Utilisation Traditionelle des Ressources: Une spécialisation ethnique dans la pêche utilisant un évantail de techniques saisonnièrement variées. La gestion et le contrôle des pêcheries est entre les mains d'autorités héréditaires quasi-rituelles.

Nature de l'Initiative: Dévelopement de nouveaux plans de gestion des ressources de pêcheries dans le cadre d'un projet de dévelopement des infrastructures.

Description de L'Initiative

Mesures Techniques Entreprises: Les propositions pour un plan de

gestion de pêcheries sont le fruit de deux ans de discussion fréquente entre le personnel du projet FAO, le personnel de la Direction des Pêcheries du Niger, et les pêcheurs. Les propositions de gestion comprennent des mesures légales à être instituées nationalement et des mesures locales identifiées par les associations. Les mesures légales interdisent certain formes d'attirail et diminuent l'utilisation saisonnière de certaines régions et de certains espèces. Les mesures locales couvrent la mise en oeuvre et la surveillance, limitant la participation de pêcheurs "inconnus", l'education des pêcheurs pour une pêche écologiquement saine, et l'identification des sanctuaires de poissons réservés pour la croissance et la reproduction.

Système d'Encouragements Economiques: Des plans ont été conçus pour l'éxécution par étapes afin de minimiser le perturbations éventuelles de l'économie locale. es plans visent la stabilisation de la base des ressources.

Organisation Sociale de l'Initiative: En 1985, les pêcheurs ont commencé a créer leur propres organisationa professionelles en consultation avec le personnel du projet. Ils on selectionné leurs dirigeants supérieurs, en équilibrant la représentation régionale, ethnique et "nationale". Les officiers supérieurs dans chaque communauté sont aussi les successeurs, pour chaque pêcherie régionale, à des postes anciens, traditionnels et encore respectés.

Discussion Génerale de l'Initiative: Encore un exemple de réforme de politique entraînant une gestion de ressources améliorée est fourni par les associations de pêcheries du Fleuve Niger. Des progrès futurs et l'institutionnalisation des réformes dépend du produit de dialogue poursuivi sous une seconde phase envisagée pour le projet.

LE COMITE DE CONTROLE D'INCENDIES DES FEMMES DE BIGONA

Informations de Base

Localité: Commune de Bigona, au Sénégal

Caractéristiques Principales de la Localité: Sur les plateux on trouve des sols légerement férralitiques bien asséchées alors que d'autres comportent des sols tropicaux, ferrugineux lessivés, et des sols faiblement évolués éoliens ou alluviaux. On note dans les environs de Bigona une mosaique complexe de genres de végétation: forêt primaire, forêt claire humide, savanne boisée ouverte, et savanne secondaire arbussive. La végétation de marécage de manerons est en régression. La pluviométrie de cette zone a varié dans le passé entre 1000 mm et 1400 mm annuellement. Depuis 1969, la pluviométrie a éte considérablement plus basse.

Bigona se trouve à l'intérieur de l'ancienne division Mandinka de Foni, mais la population est presque entièrement Dioula.

Superficie Concernée: La détermination de la région affectée est difficile, puisque ceci est une intervention aux implications principalement didactiques. Un petit lot a été reboisé, et les femmes ont l'intention d'y installer un verger collectif. Quoi qu'il en soit, un nombre indéterminé d'hectares ont été protégés de l'incendie grâce à la grande vigilance de la population.

Caractéristiques Spéciales du Cas: Les hautes terres sont consacrées à la cultivation des arachides, du mil et du sorgho, les jachères plutôt aux arbres isolés ou à la brousse de savanne. La forêt claire, humide est la zone d'huile de palme et de culture de riz irrigée. Le pâturage non contrôlé des bovins est pratiqué durant la saison sèche. Avec la culture des arachides, la mécanisation est devenue plus significative. Les précoces contrôlés faisaient partie des pratiques traditionelles d'utilisation des terres de même que la protection stricte de nombreuses forêts sacrées.

Caractéristiques Spéciales du Cas: Crée par le Service Départemntal des Eaux et des Forêts, il répond aux soucis des femmes dans plusieurs conscriptions de Bignona. L'idée de former le groupe a surgi de mesures de publicité données au problème de désertification Sénégal, la reconnaissance parmi les femmes elles-mêmes de l'importance du problème, et de l'appel du Président Diouf pour un programme national pour combattre la désertification.

Nature de l'Initiative: Le groupe de Contrôle d'Incendie des Femmes de Bignona est un groupe de volontaires non payées avec des

buts didactiques et d'influence politique qui se consacre à la préservation du restant des forêts.

Description de L'Initiative

Mesures Techniques Entreprises: Le comité a planté un boisement communal a Bignona. Les femmes ont été décisives a l'extinction d'incendies dans la commune de Bignona, qui a aussi bien des espaces ouverts sur courants de végétation que des huttes aux toits de chaume susceptibles à l'incendie. Le groupe reçoit des graines, des plantes, des conseils techniques, et parfois des aides alimentaires de la partie de l'Administration Forestière. Il reçoit des contributions financières pour mener des sessions de sensibilisation, des petits outils pour le combat d'incendie, et des subventions occasionnelles du Projet de Protection d'Incendie Canadien (PPPFC), basé a Zighinchor.

Organization Sociale de l'Initiative: Les femmes mettent l'accent sur le fait que le succès techniques est surtout une question d'organisation. Le groupe se constitue de 47 membres originaux qui ont soutenu leur interêt malgré des ressources limitées. Le comité a un commission executive, et deux sections basées dans deux conscriptions de village. Pendant les trois dernières années, les difficultés du travail et les contraintes d'espace et de matériel ont découragé beaucoup de participantes, mais maintenant celles qui sont restées ont décidé d'allerde l'avant. Les femmes s'organisent. De petites tâches telles que l'arrosage sont prises au niveau de la conscription ou par des plus petits sous-groupes de femmes. De plus grandes tâches, telles que le défrichement de la brousse ont été executées par l'effort du groupe entier ou par des jeunes hommes qui ont été persuadés à les aider. Le contrôle d'incendies mobilise le groupe entier, dont certaines puisent l'eau, d'autres appliquent l'eau, et d'autres encore se servent de râteaux et de pour contrôler les flammes. Sur une période de 3 ans, le comité a aussi organisé des sessions de sensibilisation extensives avec des femmes dans beaucoup de communautés rurales pendant la Quinzaine de La Femme annuelle. Inquiètes au sujet de l'attitude des jeunes envers leur environement, les femmes ont demandé au directeurs des ecoles d'intégrer les questions environmentales dans leurs programmes d'études.

Système d'Encouragements Economiques: En ce moment, les encouragements sont principalement de nature morale et socio-politique. Le comité recˆoit l'appui de l'administration et jouit du respect de la population. De plus, le femmes sont inspirees par des croyances culturelles profondes auquelles la forêt est un symbole clef de richesse. (Une pancarte se lisait: "La forêt, notre mère nourissière"). Les femmes ont bien vu que leurs ancêtres les plus éloignés ont reconnu que les grands arbres

étaient essentiels à la maintenance de l'humidité des sols, facilitent l'infiltration, et protégaient la terre des vents désséchants du nord.

Présentement, les femmes donnent bénévolement leur temps. Malgré cela, elles espèrent des bénéfices économiques de leur boisement et du verger qu'elles envisagent. Les femmes disent qu'elles aimeraient être formées en techniques de gestion de pépiniéries. Elles ont déjà demandé au préfet quatre hectares pour planter des arbres; et elles ont déjà Commencé à diversifier leurs efforts de plantation d'arbres.

Données Socioéconomiques:

Discussion Génerale de l'Initiative: Les valeurs peuvent Bouer un role important dans la mobilisation de populations pour une gestion saine de ressources naturelles, bien que les interventions réussies demandent un mariage de connaissances nouvelles et de valeurs essentielles. Le Comité de Contrôle d'IFcendie des Femmes de Bigona du Sénégal, dans une région de la Forêt de Guinée dévastée par la sécheresse, fournit un example du rôle essentiel des valeurs.

Les contraintes principales bravées par ces femmes semblent être An matière de buts contradictoires de leurs encadreurs supposés, le Projet de Contrôle d'Incendie Canadien, qui ne s'intéresse pas au reboisement. De même, l'administration et les agents de l'Administration ForestièrE semblent surtout interessés par la valeur de propagande du Comité de Femmes plutôt que de s'adresser aux buts des femmes. Les femmes sont frustrées par le manque de subventionement et aimeraient obtenir des assistances d'un ONG ou du projet De dévelopement de petites entreprises de l'USAID pour du capital initial.

SYSTEME DE VULGARISATION DE L'OPERATION HAUTE VALLEE

Informations de Base

Localité: La troisième Région du Mali.

Caractéristiques Principales de la Région: Terrain de savanne boisé, doucement accentué, entrecoupé de cours d'eau saisonniers. La plupart des sols sont maigres avec un contenu élevé de sable et/ou de gravier latéritique. Pluviométrie annuelle d'environ 800 - 1000 mm.

Superficie Concernée: Plusieurs milliers d'hectares.

Nature de l'Initiative: Dans les années récentes, le projet OHV dans la Troisième Région du Mali a conduit un programme de formation à la base rurale avec succès.

Description de l'Initiative

Mesures Techniques Entreprises: La formation se produit à trois niveaux. La formation professionelle des animateurs (agent vulgarisateurs) se produit à l'Institut Polytechnique à Katibougou. Le second niveau de formation est dirigé aux villageois. Le projet offre la formation dans plusieurs formes. D'abord, il y a le contact de masse par les media. Deuxièmement, l'instuction en petits groupes intensifs sur un thème particulier de vulgarisation. Les villageois sont instruits par un agent dans une série de techniques et l'instruction est fixée our coïncider avec le moment requis de l'application. Enfin, les contacts individuels entre les agent vulgarisateurs et les sites modèles ou de démonstration villageois sont organisés. Plusieurs modules techniques du type "Comment Faire?" ont été développés en réponse aux besoins notés.

Les modules des cours comprennent: des techniques de conservation de sols--diguettes , micro-bassins, barrages, plantation en courbe de niveau, etc.; préparation et utilisation de matières animales et autres matières organiques comme engrais(puits de compost et étables de compost); densité de plantation des cultures; l'utilisation des engrais chimiques; variétés de culture alternatives et graines améliorées; insecticides chimiques; fourneaux à bois améliorés en pierre; production de graines et utilisation de graines améliorées; préservation de graines et conservation de récoltes. Tous ces cours ont été enseignés sur le terrain et d'après les représentants de l'OHV, la diffusion des effets a été substantielle.

Organisation Sociale de l'Initiative: Le personnel de l'OHV ensuite surveille de manière constante les agents vulgarisateurs pour détecter les insuffisances dans cette instruction et pour les corriger. La formation est particulierement efficace quand elle est jointe au dévelopement d'associations de villages organisées (tonw villageois). Concernant la formation par petits groupes, de six à quinze villageois volontaires sont recrutes sur la base de

leur interêt dans un thème particulier de vulgarisation. Une fois mises au point, les groupes de village (tonw) appliquent les techniques sur le terrain, et, si les résultats sont favorables, les autres villages auront tendance à suivre leur exemple.

Système d'Encouragements Economiques: Des différences dramatiques de rendements de coton entre les champs où les techniques de vulgarisation ont été employées et les champs ordinaires ont été constatées par les fermiers. Des épargnes de temps et d'énergie, et la sécurité augmentée des fours améliorés ont été cités par les fermiers.

Discussion Générale de l'Initiative: Des discussion avec les fermiers ont permis à l'équipe de voir des résultats concrets d'activités d'instruction: barrages, puits de compost, fours améliorés, etc. La reconnaissance de l'importance de l'instruction aux sources rurales est un obstacle majeur pour beacoup d'initiatives subventionnées par donateurs et est la réussite principale du programme OHV. Les suites sont souvent négligées meme dans les programmes d'instruction bien-intentionnés. Dans la région OHV les impacts de vulgarisations sont limitées, et les fermiers gardent des soupçons au sujet de l'honneteté du technicien et sa diligence en matière de traitement de credit et de marché de coton. De l'autre côté, les techniciens surestiment souvent les connaissances de base des fermiers au sujet d'intrants et de marchés, alors même qu'ils sousestiment leur sophistication en matière d'évaluation de propositions techniques. En contraste, les problèmes logistiques associés avec l'instruction et la vulgarisation sont plus facilement résolus.

CHAPITRE 4
LA VIABILITE FINANCIERE DES INTERVENTIONS REUSSIES

INTRODUCTION

Le présent chapitre résume les résultats de l'analyse financière de douze interventions séparées en matière de la gestion des ressources naturelles, ou de combinaisons de ces interventions. Seuls les éléments de base de l'approche, ainsi que les résultats des analyses, sont présentés ci-après; un compte rendu complet des hypothèses, de la méthodologie et de la problématique se trouve dans l'Annexe financier (Volume III) de ce rapport.

Les Problèmes

Ce chapitre traite des problèmes suivants:

Est-il logique, du point de vue financier, que les fermiers fassent des investissments dans l'amélioration des terres, dans le but d'augmenter leurs récoltes? Etant donné l'opportunité d'une mesure d'amélioration telle, par exemple, que la construction de diguettes en courbe de niveau, qu'est-ce qui pourrait les décider à réaliser ce projet, en y affectant à la morte-saison le temps libre qu'ils pourraient tout aussi bien consacrer à d'autres usages, ou en augmentant leur travail à la pleine saison?

Quel devrait être le rôle des donateurs? Puisque les donateurs ont à faire face à la gravité de la désertification et de la dégradation des ressources, il est évident que ceux-là ont beaucoup d'occasions de jouer un rôle important, en aidant les petits cultivateurs à prendre des décisions rationnelles en ce qui concerne la gestion des ressources naturelles, et en donnant suite à ces décisions. Dans quelle mesure les donateurs, aussi bien que le secteur public en général, devraient-ils **partager** avec **les fermiers-participants** les **coûts** des investissements dans les ressources naturelles?

Interventions soumises à l'analyse

Six catégories d'interventions, énumérées dans la Table 4.1, ont été examinées. Elles comprennent les trois types principaux d'interventions techniques qu'observaient notre équipe, à savoir la conservation des sols et des eaux, l'amélioration de la fertilité du sol et l'agro-foresterie.

Table 4.1
Les Interventions étudiées

Brise-vent
Acacia albida
Haies vives
Produits chimiques agricoles
Engrais organiques et compost
Banquettes en courbe de niveau

On a étudié ces interventions, tant séparément qu'en combinaisons, afin de tester visant le choix des agencements d'éléments de gestion qui sont les plus intéressants du point de vue financier. Au total, douze interventions ont fait l'objet d'analyses, dont les résultats sont présentés dans des sections suivantes de ce chapitre.

Méthodologie

L'approche de l'analyse financière repose sur une prémisse clé: une action est réussie financièrement dans la mesure où elle pousse les fermiers à continuer de la mettre en oeuvre, une fois que des "projets" ou des organismes extérieurs auront cessé d'y apporter leurs contributions; et dans la mesure où, en servant de démonstration, elle incite les fermiers à se servir eux-mêmes de ces mêmes techniques. **N'importe quelle approche peut s'avérer intéressante aux fermiers du point de vue financier, pourvu qu'on les rémunère.** Il existe des mesures qui, tout en produisant un fort impact favorable sur l'environnement, ne sont pas d'un intérêt financier suffisamment marqué pour pousser les fermiers à les adopter; dans cette optique, il se peut que les gouvernements décident de **partager les coûts et les risques** en fournissant des la rémunérations. Pourtant, dans ce chapitre et dans l'Annexe Financière, on cherche à identifier les mesures qui possèdent en elles-mêmes un intérêt financier.

L'emploi de simples analyses coûts-bénéfices suppose qu'on dispose de données sûres et en quantités suffisantes. Mais, en ce qui concerne les interventions entreprises par les petits fermiers, il existe rarement de telles données, surtout concernant des bénéfices. En calculant les coûts, nous faisons entrer en compte les meilleures estimations possibles des apports qu'on considère comme étant nécessaires à l'investissement en question (heures de main-d'oeuvre, plants, engrais, etc.). Notre méthologie comprend une approche double, décrite ci-dessous, pour calculer les bénéfices. Par ailleurs, on a élaboré un cadre de

calcul générique, selon lequel il est possible d'étudier chaque intervention, soit séparément soit en combinaison avec d'autres.

Au cas où les bénéfices (augmentations des récoltes) ne seraient pas connus, on exprime les résultats en fonction des augmentations minimum des récoltes que doivent réaliser les fermiers, afin de récupérer les coûts d'investissement, calculés d'après la valeur estimée de leur temps de travail. Ce cadre permet de comparer la valeur de ces heures de main-d'oeuvre à la morte-saison, à celle de la pleine saison d'ensemencement.

Lorsque les bénéfices sont connus de façon plus précise ou qu'on peut raisonnablement les estimer, les résultats sont exprimés comme bénéfices nets actualisés.

Dans ce chapitre, les résultats des analyses financières sont synthétisés à l'intention du grand public. Une lecture du Volume III fournira aux lecteurs intéressés les détails analytiques portant sur la méthodologie, les hypothèses concernant les taux d'escompte, les cultures, les rendements et les prix, les impacts des interventions sur les augmentations des rendements dans le temps, le rythme et l'agencement d'interventions, la succession et la combinaison des cultures et la valeur des heures de main-d'oeuvre et à la morte-saison et à la pleine saison.

Hypothèses sous-tendant les cas fondamentaux

Rendements des cultures avec et sans interventions

Dans l'absence d'interventions, on présume que les rendements des cultures diminueront dans le temps, sous les effets multiples de l'érosion, de la perte de substances nutritives et d'autres formes de dégradation. Par contre, à mesure que des interventions sont mises à exécution, ces rendements peuvent diminuer à des taux plus ralentis, rester constants ou même augmenter. Deux question exigent qu'on y prête une attention marquée:

Délais au bout desquels se produisent les premiers impacts. Les banquettes en courbe de niveau, ainsi que des engrais chimiques et organiques contribuent à l'augementation des rendements dans la première saison où l'on met en oeuvre ces mesures. Les haies vives, les brise-vent et surtout, l'Acacia albida, ne produisent un impact qu'au bout de plusieurs années.

Durée de l'impact. En général, les mesures de conservation des sols et des eaux (telles que les diguettes en courbe de niveau) ne conduisent pas à des augmentations soutenues de

rendements, puisque leurs effets sont finalement limités par les quantités substances nutritives en disponibilité dans le sol. Par contre, des mesures d'amélioration de la fertilité du sol, dont l'Acacia albida, améliorent la qualité du sol avec le temps.

Le bilan des différence dans les délais nécessaires à la production des impacts des interventions influe de façon importante sur les bénéfices que rapportent les fermiers. (Il faut remarquer que les deux effets mentionnés ci-dessus tendent à marcher en sens inverse.) Ceci est expliqué et représenté graphiquement à l'Annexe financière.

Les Risques

La notion de risque est un facteur important sous-jacent qui influe sur les attitudes des fermiers et sur l'opportunité du soutien public à fournir à des mesures spécifiques. Et pourtant, étant donné que le degré de risque varie d'une zone écologique à une autre, les risques ne sont pas inclus formellement dans le cadre de calcul. Or, les récoltes réalisées dans le cadre des interventions étudiées sont calculées en se basant sur les hauteurs moyennes supposées des pluies. On aurait voulu idéalement établir le lien entre les récoltes et la pluviométrie annuelle dans le cadre de calcul; mais, pour ce faire, il aurait été nécessaire de disposer de mesures de pluie et de récoltes sur plusieurs années. Dans les pays du Sahel, ces données ne sont pas disponibles. On suppose, donc, la pluviométrie moyenne, parce qu'il n'existe pas de preuves sur lesquelles se baser pour prédire que, dans le courant de l'année suivante, les précipitations seraient soit au-dessous soit au-dessus de la moyenne. Cette hypothèse est ainsi aussi valable que celle posant des précipitations abondantes ou qu'une autre postulant le manque de pluies.

Les différences entre les récoltes reflètent les conséquences des pluies abondantes ou peu abondantes. On peut exprimer ces conséquences dans la cadre des analyses de sensibilité, en supposant des récoltes initiales (première année) différentes de celles supposées au Volume III. Dans des conditions de pluies peu abondantes, la réduction annuelle des rendements des cultures, dans l'absence d'interventions, est calculée sur des bases plus petites, ce qui entraîne, par conséquent, des changements dans les résultats financiers.

La notion de risque divient particulièrement importante par rapport aux résultats de l'emploi d'engrais chimiques. Là où les fonds en espèces ne constituent pas un empêchement, les engrais chimiques peuvent produire un effet positif prononcé sur les récoltes et sur les bénéfices financiers. En revanche, si la pluie fait défaut lors de l'application de ces engrais, il y a de

hauts risques de dégâts aux récoltes, et même la perte totale des recoltes, découlant de l'emploi d'engrais chimiques. Les zones de pluviométrie basse sont également celles où le rythme et les hauteurs de pluies sont les plus variables; aussi y a-t-il un degré de risque inadmissible associé aux engrais chimiques dans les zones arides, malgré un taux de rentabilité apparemment élevé. En général, les résultats des analyses financières ne sont valables que dans les zones où les interventions satisfont aux critères techniques d'applicabilité pour la zone en question.

Analyse et résultats

La figure 4.1 montre le rythme, les niveaux et la durée des augmentations estimées de récoltes pour chaque intervention prise séparément, ainsi que pour les combinaisons principales d'interventions. Y figurent quatre interventions séparées et une combinaison d'interventions: banquettes en courbe de niveau, brise-vent, Acacia albida, et la combinaison d'interventions comprenant brise-vent, banquettes et engrais organiques.

Les courbes d'interventions séparées pour banquettes, brise-vent et engrais organiques suivent les mêmes voies que la courbe correspondant au cas de base de la production agricole traditionnelle, mais à un niveau plus élevé. La courbe d'Acacia albida trace une voie divergente, comme le fait la courbe représentant l'intervention combinée (banquettes, brise-vent et engrais organiques). La conclusion la plus importante qu'on peut en tirer, c'est que toutes les interventions font bénéficier aux fermiers de temps supplémentaire avant qu'il ne faille remettre leurs terres en jachère. Là où divergent les deux courbes, l'une représentant le cas de base et l'autre l'intervention en question, la productivité des terres est en voie d'amélioration, signifiant ainsi qu'on pourra reporter la remise en jachère. Il s'agit ici d'un bienfait écologique important, car il y aura diminution des pressions contribuant à la nécessité de défricher des terrains additionnels pour remplacer ceux qu'on aura récemment laissés en jachère. Par ailleurs, en conséquence de ces pressions moins intenses, les terres laissées en jachère pourront y rester plus longtemps, ce qui redonnera encore plus de fertilité au sol. Aussi ces terrains seront-ils plus productifs, une fois qu'on les aura remis en cultures.

Les Tables 4.2. et 4.3 récapitulent les résultats financiers des interventions, pris tant séparément qu'en combinaison. Les résultats, calculés d'après les hypothèses énumérées au Volume III, sont exprimés en fonction des augmentations des récoltes au point mort (Table 4.2) et des valeurs nettes actualisées (Table 4.3). Les augmentations de récoltes au point mort constituent la moyenne des augmentations nécessaires sur la période prévue de vingt ans, pour rembourser les investissements d'argent et de temps encourus. Les résultats de point mort et ceux découlant des valeurs nettes actualisés s'excluent mutuellement; les premiers ne se basent sur des données portant sur les coûts, que pour la génération de résultats de point mort, tandis que les valeurs nettes actualisées sont basées sur des informations incomplètes sur des bénéfices dont la portée est limitée à des sites spécifiques. Il faut bien garder à l'esprit que les résultats doivent être interprétés avec circonspection: les informations servant à faire des hypothèses reposent sur les observations limitées faites par notre équipe; il se peut que ces données ne soient pas suffisamment représentatives pour pouvoir tirer des conclusions valables pour la région tout entière.

Figure 4.1
Impact of Interventions

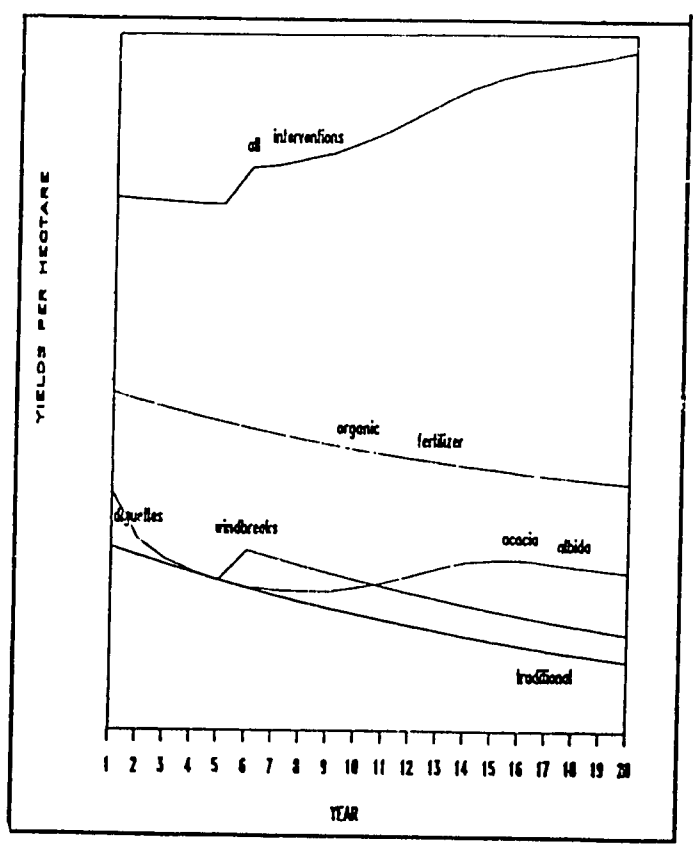

Table 4.2
Résultats au point mort:
Interventions séparées et combinées

INTERVENTIONS EFFETS	KG AU POINT MORT	RISQUE	DUREE DE L'IMPACT	EFFET GRN
INTERVENTIONS SEPAREES				
1. BRISE-VENT	18	B	M	C, P, S
2. HAIES VIVES	7	B	M	C, P, S
3. ENGRAIS ORGANIQUES/COMPOST	28	M - H	C	C, F
4. PRODUITS CHIMIQUES AGRICOLES	751	H	C	C, F
5. ACACIA ALBIDA, REG NATURELLE	7	B	L	C, F
6. BANQUETTES NOUVELLES	114	B - M	C	C, F
7. BANQUETTES DE REMPLACEMENT	26	B	C	C
INTERVENTIONS COMBINEES				
8. BRISE-VENT, ENGRAIS ORGANIQUES ET BANQUETTES DE REMPLACEMENT	69	B - M	M	C, P, S, F
9. BRISE-VENT, PRODUITS CHIMIQUES AGRICOLES ET BANQUETTES DE REMPLACEMENT	792	M - H	M	C, P, S, F
10. ENGRAIS ORGANIQUES ET BANQUETTES DE REMPLACEMENT	51	B - M	C	C, F
11. BANQUETTES DE REMPLACEMENT ET ACACIA ALBIDA	32	B	L	C, F, S
12. BRISE-VENT ET BANQUETTES DE REMPLACEMENT	44	B	M	S, C, F

N.B. La définition du risque est basée sur des facteurs quantitatifs et subjectifs, y compris des variations de la pluviométrie, la bonne exécution, des facteurs de coûts, etc., ainsi que la probabilité d'obtenir des valeurs nettes actualisées négatives. Dans les cas où il existe la possibilité que les récoltes baissent au-dessous des rendements tradtionnels en cas d'échec d'une intervention donnée, on a attribué à cette possibilité un poids important en calculant le niveau de risque.

Légende de la colonne "Risque": B = Bas, M = Moyen, H = Haut.

Légende pour la colonne "Durée de l'Impact": C = à courte terme, M = à moyen terme, L = à long terme.

Légende pour la colonne "Effet GRN": C = Conservation des sols et des eaux, F = augmentation de la fertilité, P = Protection, S = sous-produits. Seules les catégories principales sont énumérées; par exemple, les Acacia albida donnent des sous-produits, mais ceux-ci ne constituent pas d'impacts important produits par les interventions.

Table 4.3
Résultats des Valeurs nettes actualisées: Interventions séparées et combinées
(en milliers de francs CFA)

Interventions	VNA
INTERVENTIONS SEPAREES	
1. Brise-vent	882
2. Haies vives	11.953
3. Engrais organiques/compost	208.921
4. Produits chimiques agricoles	37.495
5. Acacia albida: régéneration naturelle	7.242
6. Banquettes nouvelles	-120.481
7. Banquettes de remplacement	3.821
INTERVENTIONS COMBINEES	
8. Brise-vent, Engrais organiques et banquettes de remplacement	219.599
9. Brise-vent, produits chimiques agricoles et banquettes de remplacement	48.173
10. Engrais organiques et banquettes de remplacement	218.716
11. Banquettes de remplacement et Alcacia albida	17.038
12. Brise-vent et banquettes de remplacement	4.703

N.B. Les risques, les durées des impacts et les effets NRM sont identiques à ceux figurant à la Table 4.2.

Interventions séparées

Brise-vent. En comparaison avec d'autre interventions, un taux de bénéfices positif, mais relativement bas. Il faudrait une augmentation moyenne des récoltes de 18 kg/ha sur la période prévue de vingt ans, afin que les brise-vent justifient les investissements de temps et d'argent faits par les fermiers. Outre les augmentations des récoltes représentés à la Figure 4.1, les brise-vent peuvent également rapporter des revenus découlant de ventes de perches, de bois de feu et d'autres sous-produits. Le degré de risque de cette intervention est bas, car les brise-vent ne causent pas directement une réduction des récoltes, par opposition aux engrais dans des conditions de pluviométrie basse. Cette intervention produit un impact écologique global à moyen terme.

Haies vives. Tout comme les brise-vent, les haies vives rapportent des bénéfices positifs et s'associent à des conditions requises basses d'augmentations de récoltes au point mort. Cette intervention, dont le degré de risque est bas, produit un impact écologique global à moyen terme. Certains sous-produits (bois de feu et perches) peuvent en résulter.

Selon les hypothèses mises en jeu, la construction de haies vives s'avère nécessaire en tant que protection contre le bétail et des animaux sauvages. L'avantage principal d'une haie vive consiste en les économies de temps et de ressources qu'on réalise, puisqu'il n'est plus nécessaire de ramasser des broussailles et du bois pour en faire une clôture morte, ce qui nécessite également de l'entretien. Un deuxième bienfait découle des augmentations de récoltes par rapport à celles des champs non-protégés. Le taux de rentabilité des haies vives pourrait baisser encore davantage, ou même être négatif, si les clôtures ne servent pas de protection, et ce, en raison des effets marginaux sur l'augmentation des récoltes et de la période d'années nécessaires à l'efficacité des haies.

Engrais organiques et compost. Compte tenu des hypothèses de départ, les engrais organiques et le compost sont très intéressants. La valeur nette actualisée est haute, et la condition requise d'augmentation de rendement au point mort est basse. Mais on attribue un moyen ou haut degré de risque à cette intervention, parce que l'application d'engrais sans pluviométrie suffisante pendant la période d'application, risque de causer des dégâts aux cultures. En outre, cette intervention ne peut se reproduire que dans les zones où les terrains sont relativement abondants, et où la production agricole et l'élevage peuvent coexister, sans qu'on entre en concurrence pour les terres.

Produits chimiques agricoles. Les produits chimiques agricoles s'associent à une condition requise d'augmentation de récoltes au point mort très élevée, et à une valeur nette actualisée basse par comparaison à l'intervention d'engrais organiques. Il existe deux conditions qui limitent la portée de cette intervention: premièrement, il faut que les fermiers puissent disposer d'espèces ou de crédit afin d'acheter des intrants, ce qui met hors de jeu la plupart des fermiers dans le Sahel, excepté au sein de grand projets bien organisés; et deuxièmement, il faut une pluviométrie assez élevée pour réduire le risque de brûlure des cultures à la suite de l'application des engrais chimiques. En somme, cette intervention n'est susceptible d'être appliquée que de façon limitée, mais, là où elle convient, elle peut être intéressante.

Acacia albida. L'intervention d'Acacia albida consiste en la protection of semis régénérés naturellement aux champs, en vue d'augmenter la densité des peuplements moyenne courante de 15-20 arbres/ha à la densité optimale de 50-60 arbres/ha. Cette intervention, dont le risque est considéré comme étant bas, donne des bienfaits à long terme économiques et en matière de fertilité du sol. Quoique positive, la valeur nette actualisée est basse, en raison du délai relativement long (6-10 ans) qui doit s'écouler avant que ne commencent à se manifester les bénéfices (augmentation des récoltes) résultant des investissements des fermiers.

Banquettes en courbe de niveau. L'intervention des banquettes en courbe de niveau fait cas exceptionnel. Etant donné la gravité de l'érosion des sols dans la plupart des pays sahéliens, il n'y a qu'un choix qui se présente: ou le fermier construit des banquettes, ou il perd ses terres. Par ailleurs, il est à remarquer que beaucoup de fermiers, et notamment ceux habitant la Cinquieme Région du Mali, entreprennent déjà des actions en réponse aux besoins pressants de conservation du sol et de l'eau, en bâtissant leurs propres modèles de capatges d'eau. Bien que ce système augmente les récoltes et conserve les sols, il ne s'avere pas aussi efficace dans ce domaine que les banquettes bâties le long des courbes de niveau. Pour les fermiers qui ont déjà fait des investissements de temps et d'efforts personnels, il leur reste de reconstruire des banquettes le long des courbes de niveau. Ces fermiers auront déjà extrait, cassé ou transporté aux champs des pierres; il ne leur restera qu'à les déplacer dans d'autres endroits. La valeur nette actualisée des banquettes est positive, quoique faible. En ce qui concerne de nouvelles banquettes, la valeur nette actualisée est négative, en raison des investissements importants d'heures de main-d'oeuvre exigés.

Pourtant, cette valeur nette actualisée négative ne signifie pas que les nouvelles banquettes soient à déconseiller. Là où l'on en a besoin, il peut y avoir des circonstances extrêmes qui justifient ces investissements de temps. L'existence de très peu de possibilités d'emploi alternative est typique de la plupart des pays sahéliens. Par conséquent, il ne reste aux fermiers que de se décider à faire les investissements nécessaires dans l'amélioration des terres, sans lesquels l'érosion leur ferait les perdre tout à fait. Aussi la protection des terres prend-elle une importance beaucoup plus grande, qu'on ne saurait expliquer en ne se basant que sur les seuls résultats financiers.

Interventions combinées

Les Tables 4.2 et 4.3 récapitulent les résultats de point mort et des valeurs nettes actualisées pour cinq combinaisons d'interventions. Or, les combinaisons qui donnnent le meilleur rendement financier ne sont pas nécessairement les combinaisons optimales du point de vue technique. La disponibilité de main-d'oeuvre, en particulier, peut constituer un empêchement lorsqu'on met en oeuvre des interventions multiples. L'agencement valable d'éléments concourant à la gestion efficace et mis à la disposition de petits fermiers, dépend de la sélection d'actions dont les apports en main-d'oeuvre sont complémentaires (morte-saison et pleine saison, apports de travail importants ou non, etc.), ainsi que de celles donnant des suites de bénéfices complémentaires (augmentations des récoltes dans l'immédiat, enrichissement du sol à long terme). Le Cas n° 8, qui réunit brise-vent, engrais organiques et banquettes, est particulièrement bien équilibré de ces deux points de vue.

Brise-vent, engrais organiques et banquettes (n° 8). C'est cette intervention combinée qui retient le plus d'intérêt financier pour les fermiers. L'augmentation au point mort des récoltes de 69 kg/ha/an pour la période de vingt ans prévue est relativement basse; en effet, les fermiers pourront, en toute probabilité, profiter à l'avenir d'augmentations encore plus grandes. Si l'on connaissait l'augmentation des récoltes, la valeur nette actualisée par hectare serait de presque 220.000 francs CFA/ha. Ce chiffre dépasse le total des valeurs nettes actualisées liées aux interventions isolées, étant donné l'effet synergique de la combinaison de plusieurs interventions.

Brise-vent, produits chimiques agricoles et banquettes (n° 9). Cette intervention combinée ressemble à celle que nous venons de décrire, à la différence des engrais chimiques, achetés par les fermiers, qui se substituent aux engrais organiques. Cette substitution change pourtant complètement son intérêt financier. Puisqu'on paie en espèces les engrais chimiques, la

condition requise d'augmentation de rendement au point mort augmente de beaucoup, jusqu'à 792 kg/ha pour la période de 20 ans, par comparaison avec la même intervention dans le cadre duquel on applique plutôt des engrais organiques, qu'on n'achète pas. Cette intervention comporte un degré de risque moyen ou haut; sa mise en oeuvre est de portée limitée dans les pays du Sahel

Engrais organiques et banquettes (n° 10). Les engrais organiques et les banquettes de remplacement rapporteront des bénéfices financiers intéressants là où il existe les conditions nécessaires. Cette intervention comporte un degré de risque allant du faible au moyen.

Banquettes et Acacia albida (n° 11). Le risque associé à cette intervention est faible. La valeur nette actualisée, ainsi que les conditions requises d'augmentation de récoltes, sont positives, mais relativement basses.

Brise-vent et banquettes (n° 12). Tout comme les Acacia albida, les brise-vent ne produisent des bénéfices qu'au bout de plusieurs années. Ils exigent, de plus, dès le début, une affaectation de main-d'oeuvre pour la plantation et le désherbage, et qu'on affecte des débours en espèces à l'achat de plants. Les banquettes nécessitent, de plus, l'emploi de beaucoup de main-d'oeuvre dès le départ. Quoiqu'il en soit, la valeur nette actualisée est positive, et la condition requise au point mort d'augmentation des récoltes est relativement basse.

Différences régionales

En se basant seulement sur ces résultats, on ne saurait faire des commentaires profonds sur les différences régionales, ni sur les modalités de changement des résultats à mesure qu'on réalise des interventions dans différentes zones climatiques. On pourrait cependant présumer que les interventions, mises à exécution dans la zone soudano-guinéenne, donneront des résultats plus intéressants du point de vue financier, que si elles sont réalisées dans la zone sahélo-soudanienne. La raison principale de cette différence est la pluviométrie, plus abondante dans la zone soudano-guinéenne.

Analyse de sensibilité

Une analyse de sensibilité a été effectuée dans le cadre de l'intervention (n° 8) la plus intéressante du point de vue financier, comportant brise-vent, engrais organiques et banquettes en courbe de niveau. On a analysé les paramètres suivants: taux d'escompte, prix de marché, rendements initiaux et le taux d'épuisement du sol dans le temps. Cette analyse

consiste à mettre, de chaque côté des hypothèses sous-tendant le cas de base, un maximum de +/- 50%, afin de tenir compte des scénarios optimiste et pessimiste. Par exemple, le taux d'escompte du cas de base de 20%, multiplié par 50%, donerait 30%. Par la suite, cette intervention serait étudiée de nouveau, en se servant du taux de 30% et en gardant constantes les autres variables aux niveaux du cas de base. Les résultats de la modification des valeurs nettes présentes, selon qu'on varie les hypothèses sous-tendant le cas de base, figurent à la Table 4.4.

Table 4.4
Analyse de sensibilité: Intervention combinée N° 8

HYPOTHESE FAISANT L'OBJET DE CHANGEMENTS	VALEURS NETTES ACTUALISEES (EN MILLIERS DE FRANCS CFA ET EN CHIFFRES RONDS)						
	-50%	-25%	-10%	CAS DE BASE	+10%	+25%	+50%
TAUX D'ESCOMPTE	378.8	281.9	241.5	219.6	200.9	177.6	148.2
PRIX DE MARCHE	191.2	205.4	213.9	219.6	225.3	233.8	248.0
RENDEMENTS INITIAUX	190.5	205.1	213.8	219.6	225.4	234.1	248.7
BAISSE DES RECOLTES	261.9	239.5	227.2	219.6	212.3	201.9	186.1

La valeur nette actualisée du cas de base pour l'intervention n° 8 est de 219.6 francs CFA/ha. Le taux d'escompte est le paramètre le plus sensible des quatre paramètres étudiés. Si l'on augmentait le taux d'escompte réel du cas de base de 20% à 30%, la valeur nette actualisée baisserait jusqu'à 148.200 francs CFA/ha. Le paramètre le plus sensible après le taux d'escompte était le taux de baisse de récoltes dans l'absence d'investissements compensatoires de gestion des terres et des ressources.

Les résultats ne semblent pas réagir de façon critique à des changements dans les hypothèses du cas de base. Même étant donné des changements aussi grands que de +/- 50% des hypothèses du cas de base, les résultats restent contenus dans les limites de la possibilité de realisation financière, parce qu'ils sont toujours tous positifs.

Pour ce "meilleur des cas" il est encourageant de noter que le résultat initial positif est suffisamment robuste; même avec des changements positifs ou négatifs de 50% de quatre paramètres clés, toutes les VNA qui en résultent, restent positives.

CHAPITRE 5
CONSTATATIONS PRINCIPALES DE L'EVALUATION

INTRODUCTION

Cette section présente les conclusions principales tirées de la présente étude des interventions réussies en matière de gestion des ressources au Mali, au Niger, au Sénégal et en La Gambie. Une revue de la gamme des interventions sur le terrain auxquelles nous avons rendu visite, fait tout de même ressortir les modalités, communes à tous les programmes, d'après lesquelles les interventions réussies ont pu gérer l'agencement des facteurs touchant le cycle de dégradation des ressources. Chaque constatation, ainsi que la discussion qui la suit, dépeint une partie du portrait d'ensemble; et, prises dans leur ensemble, ces constatations sont à la base de nos recommandations spécifiques visant une stratégie AID pour les ressources naturelles au Sahel.

CONSTATATIONS

1. L'application intensive d'énergie humaine a effectué la régénération de terres dégradées et a créé des micro-milieux productifs.

Les Potentialités

Notre équipe a constaté des preuves généralisées de l'application intensive de l'énergie humaine à la régénération des terres dégradées et à l'exploitation productive de ces terres. La régénération naturelle de l'Acacia albida, la plantation de brise-vent et l'emploi de barrages de captation d'eau figurent parmi les méthodes principales qu'on met en oeuvre pour créer des "micro-milieux," qui sont à l'abri de la dégradation du milieu général. Ayant déjà été contraints à faire des investissements dans leurs terres, un certain nombre de fermiers ont fait le prochain pas, celui de diversifier leurs activités; en effet, des potagers, des boisements, des vergers et la production de fourrage ont fourni des nouvelles ressources de secours, et ces activités diversifiées ont en même temps créé des possibilités de revenus en espèces.

Angel Togo, âgé de 55 ans et fermier ayant des revenus moyens habitant près de Biandagara dans la Cinquième Région de Mali, s'était décidé à planter des eucalyptus en tant que brise-vent afin de protéger son champ, d'une superficie de 5 hectares, de l'érosion qui le travaille. Il a par ailleurs permis la régénération naturelle de l'Acacia albida. A la suite de ses plantations réussies d'eucalyptus, il a planté plus de 3000 arbres supplémentaires dans les cinq dernières années. Il a creusé un

puits et a semé des fruitiers, des légumes et des épices, en y affectant le produit de la vente de perches, produit qu'il a réalisé en trois ans. Cet investissement, constitué presque exclusivement de main-d'oeuvre, lui permet de disposer de revenus en espèces durant toute l'année qui complètent ses récoltes de mil et de sorgho, d'un ensemble diversifié de sources de revenus qui sont, dans une large mesure, à l'abri des changements du climat, de récoltes de céréales augmentées et d'un volume sur pied d'eucalyptus et d'autres arbres ayant une valeur en capital sur le marché d'entre $16.000 et 23.000.

Comme exemple d'une intervention à plus grande échelle, on pourrait citer le projet de gestion de forêts naturelles, soutenu par l'AID, qui a été mis sur pied à Guesselbodi, Niger. Par l'intermédiaire des coopératives villageois qu'il a aidé à créer, ce projet a appuyé des investissements dans la protection des sols et dans la gestion, lesquels ont fait transformer une superficie de 5000 hectares de plateaux improductifs en zones de production de revenus, et ont permis la vente d'herbes destinées au fourrage et de bois sur les marchés urbains. Dans chaque village, le projet a, au début, affecté des manoeuvres villageois salariés à l'amélioration des terres, y compris des mesures telles que la construction de banquettes pour contrôler l'érosion, la plantation d'herbes et la construction de captations d'eau. Ensuite, il a encouragé la formation de coopératives villageoises pour gérer les zones nouvellement productives. Notre équipe a visité des villages dans lesquels ces nouvelles possibilités rapportaient suffisamment de revenus pour engager des manoeuvres villageois à plein temps, et pour générer un bénéfice pour la coopérative de $800 par an.

Questions demandant qu'on s'en occupe

Etant donné que les petits cultivateurs, les administrations et les organismes donateurs s'aperçoivent de façon intensifiée de la gravité de la crise du milieu, la possibilité d'interventions productives visant la gestion des ressources a été rendue plus grande. Dans les zones les plus menacées, l'acceptation de techniques améliorées de la part des fermiers a augmenté, car la crise du milieu a mis en relief les options qu'ils doivent affronter. A l'avis de beaucoup d'entre eux, l'agriculture sèche traditionnelle telle qu'on la pratique actuellement, n'est plus viable. En revanche, on a vu suffisamment d'interventions fructueuses sur le terrain à grande échelle et à long terme, pour constituer une gamme de modèles de développement réussis. Dans les douze mois écoulés, les gouvernements nationaux et la communauté internationale ont insisté de manière beaucoup plus intense sur les ressources naturelles. L'attention prêté par l'AID dans ce domaine coïncide avec une augmentation importante des prêts accordés par la Banque Mondiale pour l'environnement et les

ressources naturelles, ainsi qu'avec le développement de programmes mis sur pied par la France, les Pays-Bas et les pays scandinaves.

Dans chacun des quatre pays et dans toutes les régions auxquelles nous avons rendu visite, l'absence de droits de jouissance des terres constituait un empêchement important quant aux initiatives des fermiers. Les investissements dans les terres ont rehaussé les enjeux juridiques, sociaux et économiques en ce qui concerne les droits de propriété, dans le contexte de ces cas. S'il est impossible, comme c'est actuellement le cas, d'être le propriétaire des ces terres, on atténue alors la bonne volonté des personnes qui, sans cela, auraient consacré de l'énergie humaine et des capitaux à l'amèlioration des terres. Dans cette optique, les systèmes ambigus des droits de jouissance traditionnels dans le Sahel constituent un luxe que l'économie rurale ne peut plus se payer. Les interventions réussies que nous avons étudiées ont choisi l'une de deux approches: ou elles ont négocié des exemptions spécifiques de lois régissant la jouissance des ressources, ou bien, elles ont réussi en dépit de ces lois. La souplesse et l'usage multiple demeurent des priorités importantes, et la clarification des droits et obligations des gestionnaires locaux de ressources est nécessaire.

Quoiqu'un nombre restreint de fermiers prennent des initiatives individuelles, la majorité n'en prennent pas. Il existe une pénurie marquée de compétences techniques bien définies parmi les fermiers et au sein des organismes de vulgarisation qui leur prêtent assistance. Par conséquent, il va falloir faire de grands efforts pour améliorer la formation des agents techniques, pour réorienter les prestations traditionnelles des agents forestiers, allant des services de police à l'assistance sur le terrain et pour remédier aux goulets d'étranglement en matière de ressources (manque de transport, semis, ensembles techniques) qui empêchent les agents vulgarisateurs d'apporter l'assistance aux fermiers prêts à agir. Il est vrai que les programmes pour sensibiliser les petits cultivateurs en matière de conservation des ressources sont d'une portée restreinte et d'une couverture irrégulière; cependant, leur portée peut être élargie, par exemple en employant des systèmes de communication en masse.

2. Les "fermiers-innovateurs" sont des modèles édifiants puissants.

Les Potentialités

Partout dans la région, l'équipe a constaté la soif de techniques et de connaissances pour la protection des terres. Beaucoup de techniques utiles peuvent être mises en oeuvre, même

lorsqu'on prend en compte les contraintes techniques et financières des fermiers pauvres. Les innovateurs ruraux ont servi de modèles édifiants, permettant ainsi aux autres d'observer l'application des techniques et de comprendre comment les mettre en oeuvre.

Les innovateurs ressemblaient à d'autres petits cultivateurs par leur état socio-économique; ce n'étaient pas typiquement des personnes isolées vivant en marge de la société, qui, en rompant avec les traditions, n'auraient pas eu grand-chose à perdre. En règle général, c'étaient des originaires de la région et des membres respectés de la communauté. **Ce qui les caractérisait le plus et les séparait des autres, c'est qu'ils avaient subi des influences culturelles nouvelles, et qu'ils avaient eu accès, par le passé, à des revenus en espèces.** L'un parmi eux avait servi et voyagé dans l'armée française; un autre était maçon traditionnel; un autre était vendeur d'articles d'artisanat à temps partiel; des missionnaires avaient enseigné à un autre à lire et écrire; et d'un autre, ses fermiers-collègues disaient tout simplement "qu'il a voyagé."

Leurs premières entreprises rencontraient souvent le scepticisme et, parfois, la raillerie de leurs voisins, mais on a, par la suite, imité leurs succès. Des milliers de petits fermiers ont suivi l'exemple des jardiniers réussis habitant dans les bassins fluviaux et près des cours d'eau. Un fermier qui avait planté des eucalyptus a, jusqu'à ce jour, fourni des semis à cent autres fermiers habitant quatre villages aux alentours; actuellement ceux-ci plantent aussi des eucalyptus. On constatait que ses voisins les plus proches avaient des arbres qui avaient déjà atteint une hauteur de dix mètres.

Questions demandant qu'on s'en occupe

D'après des discussions avec des donateurs et des fonctionnaires, il existe peu de mécanismes permettant d'établir des rapports avec les petits cultivateurs qui ont mené à bien leurs propres entreprises. Que ce soit à cause de la pauvreté de l'Afrique sahélienne ou des tendances de l'assistance administratives, **le secteur public a trop peu étudié les façons de tirer profit du petit nombre de réussites et d'encourager les projets des fermiers-innovateurs.**

Cependant, beaucoup de projets de développement bien réfléchis ont reproduit des éléments clés des interventions réussies mises sur pied par des fermiers-innovateurs. Dans ce contexte, on a fait visiter à des fermiers traditionnels habitant des régions visées par les projets, d'autres fermiers ayant mis en oeuvre de nouvelles techniques. Par exemple, dans le cadre du projet CARE à Koro (Mali), **quatorze** fermiers pauvres, accompagnés d'un nombre restreint de personnel du projet et des services de vulgarisation,

ont rendu visite aux brise-vent dans la Vallé de la Maggia au Niger. Deux ans après cette visite, **dix fermiers** sur le groupe original de quatorze **ont planté avec succès des brise-vent**; de plus, **les travaux faits par chacun d'entre eux ont été reproduits par plusieurs fermiers habitant dans les villages de ceux-là, ou bien dans d'autres villages.** L'Unité de Conservation des Eaux et des Sols en Gambie a aussi réussi à appliquer cette technique de vulgarisation.

L'approche consistant à faire visiter des entreprises-modèles à des groupes de fermiers, a donné des bienfaits éducatifs accessoires. Les coûts de cette approche soutiennent bien la comparaison avec ceux occasionnés par les équipes de spécialistes étrangers, qui se rendent sur place pour persuader les mêmes fermiers d'appliquer des méthodes que ceux-ci n'ont jamais observées. Par ailleurs, nous avons observé d'autres actions visant l'augmentation de la sensibilisation aux questions portant sur les ressources naturelles. Un magazine pour enfants, publié dans le delta intérieur du Mali, s'occupe de la préservation de techniques et de connaissances que, cette voie de communication mise à part, les jeunes sont en train de perdre. De même, des campagnes de publicité nationales, l'utilisation des mass-media et la formation de conseils villageois et de cercles féminins se sont avérés utiles dans le cadre de plusieurs programmes. Il se peut que les conséquences de ces actions soient difficiles à mesurer par rapport aux critères régissant l'élaboration de la plupart des projets; cependant, nous avons observé plusieurs actions de ce genre qui concouraient à une participation publique générale à des coûts relativement faibles.

3. Des changements de politiques publiques ont entraîné l'augmentation des primes d'encouragement en vue d'une gestion plus rationnelle des ressources naturelles par les petits fermiers.

Les Potentialités

Notre équipe s'est familiarisée avec plusieurs programmes dont les succès dépendaient de mesures relevant de la politique. Le succès du projet de Guesselbodi est lié très étroitement à l'autorisation dont bénéficient les coopératives villageoises, de gérer les ressources locales (dans les limites du plan de gestion gouvernemental approuvé), et à l'exemption d'impôts perçus sur les entreprises commerciales, La potentialité de revenus au moyen des coopératives a encouragé la participation des villages. Partout dans la Cinquième Région du Mali, l'USAID a négocié une suspension des amendes infligées par les agents forestiers dans les zones de couverture du Projet de Reboisement Villageois. Les fonctions policières exercées par ces agents, ainsi que l'autorité dont ceux-ci abusent pour imposer des amendes excessives à leur propre

compte, a engendré de la méfiance à l'égard des agents et de leurs messages. La cessation de ces fonctions a augmenté l'acceptation des services sur le terrain de la part des villageois, en fournissant un mécanisme plus constructif par lequel on a l'accès à l'assistance technique dont on a tant besoin.

Parfois, le soutien et l'engagement politiques ont produit des résultats dramatiques. L'intervention visant l'introduction répandue de foyers à bois faits de terre a finalement réussi, en raison du grand nombre d'années consacrées à la vulgarisation et à la formation sur le terrain, à la mobilisation des organismes locaux, aux campagnes de publicité nationales et à la mobilisation politique directe par l'intermédiaire du Parti, y compris l'adoption d'une loi exigeant l'usage de foyers améliorés dans tous les ménages. Les deux premiers mécanismes sont mis sur pied depuis beaucoup d'années. Par la suite, il paraît que la publicité nationale, la mobilisation politique et l'adoption de la loi susmentionnée ont garanti le succès de cet effort, car, dans tous les villages auxquels nous avons rendu visite, la plupart des ménages employaient des réchauds de terre améliorés. Le Projet Keita, au Niger, fournit un autre exemple de la participation à grande échelle réalisée au moyen de la mobilisation politique: plus de 50% des fermiers dans l'arrondissement tout entier ont mis en oeuvre, sous la direction du préfet régional vigoureux et engagé, de nouvelles techniques de gestion des ressources.

Questions demandant qu'on s'en occupe

La résolution de conflits, en tant que fonction publique, prendra une importance croissante dans les années à venir; cependant, n'ayant pas été mise suffisamment en relief, elle n'a pas reçu de financement adéquat. A mesure que la crise du milieu dans le Sahel a empiré, les conflits potentiels entre des parties se faisant concurrence sont devenus plus marqués, y compris ceux opposant les fermiers et les éleveurs; l'agriculture et les bêtes sauvages qui, chassées de leurs habitats naturels, menacent les récoltes en voie de décroissance; et les producteurs entre eux-mêmes qui cherchent l'acces aux terres fertiles. Le Projet UICN vise principalement, dans les alentours de Youvarou (Mali), à réunir des pêcheurs, des fermiers et des éleveurs afin de créer un mécanisme équitable et soutenable permettant de **répartir les ressources en eau peu abondantes et les droits de propriété** dans les systèmes écologiques complexes du delta intérieur. La législation actuellement en vigueur a été rédigée pendant la période coloniale; elle sanctionne les relations entre personnes et entités selon une intelligence inadéquate en matière de besoins et de pratiques relatifs à la gestion des ressources locales. Par contre, un projet de développement au Sénégal déploie ses efforts dans des villages se trouvant dans un parc national pour animaux sauvages. Ce projet reconnaît bien que les villageois **font**

concurrence aux animaux sauvages pour les mêmes terres, et que les règlements généralisés régissant la protection des animaux sauvages seront insuffisants, à moins que les villageois ne trouvent **de nouveaux débouchés économiques** qui allégeront la pression que subissent les terres environnantes.

D'après notre expérience, la question la plus importante relevant de la politique publique est celle des droits de **jouissance des ressources.** La jouissance des terres est, du point de vue juridique, mal définie dans les quatre pays visités. Dans les limites des pratiques régissant l'exploitation des terres, telles que celles-ci sont stipulées traditionellement sur les plans des villages ou des districts, les fermiers ne bénéficient que de droits d'usage. C'est le secteur public, et en réalité l'Etat, qui détient les titres de propriété; il n'existe aucune protection officielle de la propriété privée. Et pourtant, la crise du milieu a créé le **besoin** de faire des investissments dans les terres privées, afin de les protéger de la dégradation. De plus, le manque de sécurité de la jouissance **réduit les encouragements** à faire de tels investissements. La concurrence plus intense pour les ressources a réduit davantage la sécurité de la jouissance pour les petits cultivateurs. Enfin, à mesure que des structures impersonnelles viennent s'ajouter à l'organisation communale, le système de droits mal définis se prête progressivement aux **abus** par ceux ayant accès aux organes du pouvoir.

Le manque de jouissance des terres faisait obstacle à la reproduction des interventions réussies dans tous les pays auxquels nous avons rendu visite. Cette question se posait à maintes reprises au cours de nos entrevues avec des fermiers, des agents sur le terrain et du personnel des projets. Bien que quelques projets se soient procuré des exemptions de jouissance des terres et d'autre législation, leur couverture et leur impact restent locaux. Des projets réussis ont souvent eu lieu malgré les conséquences néfastes des lois en vigueur; cependant, même dans ces cas-ci il est évident que la jouissance des terres fait obstacle à la reproduction d'autres interventions. Nous avons constaté des cas où des interventions réussies ont augmenté la valeur apparente des terres, ce qui rend plus difficile aux fermiers futurs d'obtenir des droits semblables d'accès aux terres (voir la case ci-après).

LES REGLES COUTUMIERES DE JOUISSANCE DES TERRES SE PRETENT AUX ABUS

Aux alentours de Djéné (Mali), on a planté il y a 18 mois un petit jardin sur une parcelle de terre de deux hectares très dégradée et dont personne ne faisait usage. Le fermier qui l'avait plantée

avait obtenu, auprès des autorités locales, l'autorisation de l'exploiter. En constatant son succès, un autre fermier a soumis une demande d'accès à la parcelle de terre adjacente, qui était également dégradée et non-cultivée. Mais, puisque la valeur potentielle de cette terre a été démontrée, le deuxième fermier a recontré plus d'obstacles à sa demande que ne le faisait le premier. Trois autres fermiers ont soumis des demandes pareilles auprès des autorités locales. Comme l'enjeu augmente de valeur, même le premier fermier, qui a, depuis, creusé trois puits, construit une clôture et planté une grande variété de récoltes jardinières, d'arbres et d'ceréales, n'est pas certain qu'il dispose de sa parcelle de terre à l'avenir.

A mesure que la concurrence potentielle pour les ressources naturelles s'annonce plus acharnée, il est probable que la jouissance des terres prendra une importance plus grande en tant qu'**obstacle** à la participation populaire massive qui sera nécessaire pour stabiliser le milieu sahélien. De même, certaines questions spécifiques prendront également une importance pour des localités particulières, puisqu'elles exigeront des solutions de nature locale que même une réforme de
la législation nationale ne sera pas suffisante pour prendre en compte. Les droits des éleveurs et des fermiers en zone transhumante se trouvant en concurrence figurent parmi les questions principales. Les droits de jouissance des ressources constituent une question juridique et socio-économique complexe, inséparable de l'organisation des sociétés sahéliennes. Il serait simpliste de supposer qu'il existe une seule solution connue à ce problème, telle que l'adoption de droits de propriété individuels à l'occidentale, par exemple. Toutefois, avec le changement en cours du contexte de la production rurale au Sahel, la clarification des droits de gestion des ressources locales, y compris la jouissance des arbres au Mali et au Niger, devrait être une conditions nécessaire précédant la participation à l'échelle locale.

La tentative de stabilisation du milieu sera accueillie, dans le meilleurs des cas, de façon difficile. Le manque de considération des **obstacles législatifs entravant les interventions privées entraînera la hausse des coûts, ainsi que la baisse du taux de succès,** de tous les efforts régionaux visant la gestion des ressources naturelles.

4. Les Interventions réussies en matière de gestion de ressources ont amélioré le climat pour les travaux futurs.

Les Potentialités

Les activités en matière de gestion de ressources améliorent le climat pour les travaux futurs, même lorsqu'elles n'atteignent pas directement les objectifs finals proposés. Nous avons constaté que, lorsque des fermiers étaient amenés à se lancer dans une activité visant les ressources naturelles et qui rapportait des bénéfices immédiats, ils s'engagaient dans d'autres entreprises de même nature. Quoique cette première activité ne contribuât que de manière restreinte à la gestion globale des ressources naturelles, celle-là était assez intéressante pour encourager la participation des fermiers, et ainsi, pour contribuer au développement à long terme. Et pourtant, on a très souvent refusé de tenir compte de cette leçon importante en élaborant des stratégies pour les ressources naturelles du Sahel.

Dans les zones de niveaux phréatiques élevés dans les quatre pays visités, la plantation d'eucalyptus a constitué l'intervention initiale en matière de ressources naturelles pour bien des fermiers. Les tiges longues et droites de cet arbre se prêtent de manière idéale à la vente de perches de construction. Cependant, hors des effets bénéfiques sur la rétention des sols lorsqu'on en plante pour former des brise-vent, les eucalyptus ne produisent que très peu d'effets de ce genre sur le contrôle de l'érosion, sur la fertilisation du sol ou sur la protection générale du milieu; en outre, comme c'est le cas pour n'importe quelle espèce d'arbre, on doit bien peser la concurrence potentielle pour les eaux souterraines lorsqu'on en plante à proximité des cultures.

Mais, pour les fermiers, l'eucalyptus a souvent constitué une source de revenus en espèces (à raison de $3-5 par arbre âgé de trois ans, en moyenne), et une réserve en capital d'arbres sur pied susceptibles d'être récoltés et vendus lorsqu'il y a perte des récoltes. L'accès à ces "réserves de capital" a accordé à beaucoup de petits fermiers la liberté accrue d'entreprendre des mesures visant la protection du sol, mesures qui sont intrinsèquement plus risquées à leur avis, puisque leurs terrains en cultures en sont directement touchés. Nous avons rencontré plusieurs fermiers qui, après avoir fait des plantations d'eucalyptus réussies, s'étaient occupés de la régénération naturelle de l'**Acacia albida**, de la plantation de neem sous forme de brise-vent, de banquettes en courbe de niveau et de haies vives. Parmi d'autres technologies innovatrices figurent les vergers.

Questions demandant qu'on s'en occupe

Il faut apprécier les bienfaits écologiques découlant des différentes interventions, par rapport à leurs impacts micro-économiques directs **et** à leur influence sur l'allègement des pressions exercées sur le milieu pris dans son ensemble.

Par exemple, les banquettes exigent qu'on construise de

petites rides, de 20 à 30 cm de hauteur, le long des courbes de niveau suivant la pente d'un champ. Leur avantage principal consiste à réduire les écoulements pluviaux, réduisant ainsi la perte de la couche supérieure du sol et améliorant l'infiltration des eaux de pluie. L'analyse financière (micro-économique) des ces banquettes montre leur taux de rentabilité élevé pour les fermiers, puisque les coûts sont faibles, qu'elles sont faciles à construire et que les demandes en main-d'oeuvre ne se font pas sentir pendant les périodes de pointe et qu'elles peuvent augmenter directement les récoltes pendant la première saison de récolte suivant leur mise en place. Cependant, des études plus approfondies ont indiqué qu'elles ne produisent pas une amélioration directe de la fertilité du sol. En effet, en produisant une rétention plus efficace de sol et d'eau, elles ne font que **ralentir le taux** de déterioration du sol à travers les saisons de culture successives. Il y a éventuellement réduction de la fertilité du sol. Malgré tout cela, les banquettes ont pour effet macro-économique la prolongation de la période pendant laquelle on peut cultiver un terrain, en **prolongeant ainsi la période de jachère** et en concourant directement à l'amélioration de la qualité du sol des terres en friche.

Le Projet CMDT (Compagnie malienne de Développement des textiles) au Mali fournit un exemple saisissant de la nécessité d'apprécier les interventions dans un contexte global qui prend en compte les relations réciproques Cette intervention énorme visant une population de 30.000 habitants sur une superficie de 130.000 hectares, appuie la production cotonnière dans la Troisième Région du Mali, où les terres sont relativement fertiles. La décision de principe de maintenir des prix de production élevés pendant la récession sur les marchés internationaux, ce qui a forcé la CMDT à s'endetter, a beaucoup aidé à faire durer la participation des fermiers pendant une période d'une importance critique pour la mise en place du projet. Par suite du redressement des prix, des intrants d'engrais, de l'assistance technique, des outils agricoles et des techniques améliorées ont causé l'augmentation importante des revenus de ménage moyens. 95% des ménages dans la zone de couverture de la CMDT possèdent des charrues attelées. Mais il y a un phénomène plus intéressant: la portée des techniques améliorées et de la "maîtrise des ressources," qu'ont rendues possibles les revenus en espèces découlant de la production cotonnière, s'est élargie pour inclure les céréales traditionnelles. **La production moyenne par personne** (notamment du sorgho et du mil) **a augmenté** au pas, en même temps que, sur le plan du pourcentage des revenus, les fermiers sont devenus plus dépendants des marchés internationaux, qui s'avèrent parfois inconstants.

5. Les interventions réussies en matière de ressources naturelles comportaient et des éléments et des encouragements socio-

économiques.

Les Potentialités

D'après nos observations, le succès de 75 interventions ne saurait être attribué aux seules méthodes techniques. Des encouragements socio-économiques ont fait réussir des techniques d'une valeur marginale, et leur absence a voué d'excellentes approches techniques à l'échec. Quoiqu'on fasse ressortir cette leçon des observations faites sur le terrain et qu'on en traite dans les rapports d'évaluation, on ne la prend pas en compte lorsqu'on en vient à préparer la série suivante de projets. Des bois communaux ont fait échec partout dans le Sahel, bien que, d'après nos observations, des fermiers privés labourant des terrains adjacents aient des plantations d'arbres robustes produisant des perches et des fruits vendables sur le marché. A la suite de quinze années d'efforts intensifs, les taux d'acceptation des foyers faits de terre au Mali, au Niger et au Sénégal et en La Gambie étaient négligeables. Mais ces mêmes efforts, lorsqu'on en fait dans un agencement convenable de facteurs comprenant la mobilisation socio-politique et des intermédiaires économiques locaux, ont conduit à un taux d'acceptation d'au moins 60% parmi les populations des régions du Mali que nous avons visitées.

Nous n'avons constaté aucune solution de grande envergure, laquelle, si elle était reproduite des milliers de fois, garantirait la stabilisation du milieu sahélien. Cependant, il existe des actions susceptibles de produire des impacts globaux extrêmement constructifs; la réforme du système de jouissance des terres, l'amélioration de l'efficacité avec laquelle on fait la cuisine et, en général, les techniques améliorées de gestion des sols et des eaux pourraient être mises en oeuvre presque universellement. **Il est peu probable qu'une seule approche suffise, et l'adoption de ces initiatives, parmi d'autres, dépendre plus des encouragements locaux que des priorités fixées globalement.**

En ce qui concerne les interventions techniques particulières (par exemple, brise-vent, **Acacia-albida**, banquettes, haies vives), elles ont toutes un rôle utile à jouer; les conditions écologiques au Sahel sont trop diverses pour qu'on puisse en choisir une comme étant meilleure que les autres. En effet, la diversité des écosystèmes dans le Sahel témoigne en faveur d'une gamme d'options permettant aux populations de chosir celles qui répondent à leurs besoins.

Questions demandant qu'on s'en occupe

Pour les petits cultivateurs vivant le plus près des limites

minimes de la subsistance, la réduction des risques au minimum est l'une des leçons les plus importantes pour leur survie. Comme nous l'avons vu dans la section précédente, pour ces fermiers, **l'option rationnelle de premier choix parmi toutes celles relevant de la gestion des ressources, ne sera pas infailliblement la mesure qui porte au maximum les bénéfices à long terme. Bien au contraire, il se peut que ce soit celle qui augmente les marges à court terme pour l'acceptation de risques.** Le choix des options qui répondent le mieux à cet objectif dépendra non seulement des conditions particulières dans la localité, mais aussi des choix plutôt personnels que doivent opérer les ménages individuels (y compris l'âge, le nombre des personnes à charge, les expériences personnelles, la santé, les réserves de céréales et d'espèces, les bonnes ou mauvaises récoltes de l'année précédente, le soutien en espèces que fournit des parents habitant en milieu urbain ou outre-mer, etc.). Les différents choix que doivent faire les hommes et les femmes sont particulièrement importants à cet égard, puisque les deux groupes détiennent des droits différents concernant la répartition des ressources et de différentes charges de travail. En proposant et en démontrant une gamme d'options valables, on augmente la superficie où le transfert de la technologie peut avoir lieu.

Des **combinaisons** d'approches peuvent être plus intéressantes du point de vue financier et plus solides du point de vue écologique, que ne l'est une approche prise individuellement. Par exemple, l'**Acacia albida**, qui produit une influence constructive sur la fertilité et la rétention du sol, ainsi que sur les rendements agricoles à long terme, ne présente qu'un encouragement financier à court terme assez faible. La période de huit ans qu'il faut pour réaliser des bénéfices est trop longue pour pousser les fermiers à en planter, et elle met une relief les risques de l'insuccès. Comme nous l'avons vu, les banquettes rapportent des revenus à court terme qui vont en diminuant au bout de quelques années. Mais les combinaisons des deux éléments augmentent immédiatement les récoltes, permet une marge près du terme permettant de réserver un pourcentage des terres à la plantation d'**Acacia albida** et augmente le **bénéfice financier au-delà du niveau atteint par l'une ou l'autre de ces deux interventions à elle seule.** Du point de vue écologique, la combinaison des interventions représente et la gestion améliorée des ressources disponibles et l'enrichissement de la base même des ressources.

Il faut parfois mettre un minimum de dix ans pour juger du succès ou de l'insuccès d'une intervention particulière. **Les stratégies ayant poursuivi fermement une série limitée d'options, qu'on considérait comme étant particulièrement appropriées, qu'elles s'avèrent ou non finalement réussies, entraînent une perte de temps précieux avant de mettre en valeur la gamme complète d'options susceptibles de susciter la participation populaire.**

Comme c'est le cas pour la planification centralisée, ce qu'on gagne en rationalisation, on perd en adaptations et en compromis constructifs avec la réalité, lesquels donnent souvent des solutions qui coûtent moins chères, qui sont plus faciles à mettre en oeuvre, qui sont plus intéressantes et qui peuvent résoudre des problèmes dont la génération actuelle de planificateurs ne se doutait même pas.

Les objectifs originaux du projet de Guesselbodi, mis sur pied il y a huit ans moyennant l'assistance de l'AID, diffèrent beaucoup de ceux d'aujourd'hui, car, **selon une excellente évaluation à mi-parcours du projet, on se rendait compte que les objectifs originaux étaient d'une importance secondaire par rapport aux nouvelles possibilités créées par les activités sur le terrain.** Le projet a, donc, changé d'accent en mettant en valeur la participation locale par l'intermédiaire des coopératives villageoises qui rapportent des revenus résultant de la gestion des terres. La vente d'herbes sous forme de fourrage, qui représente la moitié des revenus des coopératives villageoises, ne faisait même pas partie intégrante du projet original.

La distinction nette entre les motifs publics et privés continuera d'exiger des approches flexibles et multiples de la stabilisation des ressources au Sahel. Il faudra que l'attention du public soit portée sur une série de mesures visant des localités particulières, au-delà d'une réforme de politique et de l'adoption de moyens pour encourager des initiatives privées. Par exemple, la conservation de la diversité biologique constitue une contribution publique au bon fonctionnement de l'économie à l'avenir. Les approches dervont varier suivant les espèces des animaux et de plantes exposées aux risques, et selon les solutions apportées aux conflits en matière de ressources entre l'homme et le milieu qui les menacent. Dans beaucoup de cas, la dégradation du milieu, intensifiée par la concurrence pour les ressources entre les populations, devra être considérée davantage par la création de nouveaux modèles d'activités économiques, plutôt que par la seule amélioration des techniques de gestion des ressources.

6. Les intiatives soutenables ayant rapporté des bénéfices dans l'immédiat ont conduit à la participation des petits cultivateurs.

Les Potentialités

La responsabilité publique dans l Sahel consiste à réaliser la stabilisation du milieu dont dépendent les systèmes de production ruraux. Cependant, pour produire un impact global important, les mesures prises par les petits cultivateurs doivent comporter **des encouragements suffisants pour mobiliser une participation nombreuse.** Mais étant donné les empêchements vis-à-

vis des ressources publiques, **les coûts budgétaires récurrents de ces mesures d'encouragement doivent être assez bas pour que le gouvernement soit en état** de payer leur reproduction répandue. C'est entre ces deux limites que se situe la gamme de mesures realistes visant la participation pour protéger les ressources du Sahel.

Questions demandant qu'on s'en occupe

Bénéfices immédiats

Nous avons observé plusieurs approches de l'encouragement de la participation des petits cultivateurs. **Cette diversité** d'approches mérite d'être étudiée. Nous traiterons ci-après de quatre études de cas, afin d'approfondir des questions se rattachant à la gamme complète de ces approches. Dans les quatre cas, **la réussite dépendait des bénéfices financiers dont on assurait la distribution aux participants.** Chaque cas laisse à croire que, si l'on pouvait reproduire les mêmes conditions, il y aurait des enocuragements équivalents conduisant à la participation des petits cultivateurs.

Au sein du Projet IDA (l'Agence de Développement International de la Banque Mondiale), à Damana, au Niger,les personnels du projet et de vulgarisation **travaillent en collaboration pour de longues périodes, avec des communautés villageoises entières**, afin de les sensibiliser aux bienfaits de la gestion améliorée des ressources. Le mécanisme qui déclenche la participation des villageois consiste en des investissements que le projet propose de faire pour mettre sur pied les infrastructures villageoises désirées. En compensation, des mesures de plantation d'arbres, de conservation du sol, de rétention d'eau, etc., doivent être entreprises au moyen de main-d'oeuvre fournie par les villages. Le projet a bien réussi à susciter les efforts qu'il demande de la part des villages, mais à des coûts relativement élevés. Par exemple, le projet a fait creuser un puits qu'un village avait demandé de faire construire pour obtenir de l'eau potable (le niveau phréatique était à 60 mètres), à un coût d'environ 2 millions de francs CFA ($8000). Le personnel du projet juge de son succes en prenant en compte le développement d'ensemble du village, et non seulement le nombre d'arbres plantés, de contours creusés, etc. Et pourtant, la reproduction de cette approche à une grande échelle entraînerait des dépenses importantes, et elle ne se ferait que lentement. Quoiqu'il en soit, le projet établit des relations fructueuses entre le développement local, les infrastructures et la gestion améliorée des ressources.

Le Projet **Acacia**, mis sur pied par l'UNSO à Dosso, a adopté une approche tout à fait différente en englobant la recherche, les services de vulgarisation et la diversification, elle se concentre

sur un résultat de première importance: l'encouragement de la régénération naturelle de l'**Acacia albida**. Et pour ce faire, **elle offre une mesure d'encouragement principale,** c'est-à-dire un **versement en espèces direct** pour chaque arbre qu'on aura protégé. Les résultats sont frappants: dans cinq ans, 386.000 arbres ont été mis à l'abri. En d'autres termes, le projet "achète" à court terme la participation des fermiers, en prévoyant le moment où les fermiers eux-mêmes commenceront à profiter des augmentations à long terme des récoltes.

Le Projet CWS (Church World Services) au Sénégal a plutôt insisté sur des approches favorisant les intérêts financiers des fermiers et visant l'acceptation au moyen de la sensibilisation, de la formation et d'informations techniques. Quoiqu'il fasse également appel aux intérêts financiers personnels commerciaux des petits cultivateurs, le projet **n'a pas encore eu recours à des subventions ni à des versements directs en espèces ou en nature.**

Enfin, le Projet PUSF, établi à Guesselbodi, Niger par l'USAID, fait appel **à un effet combiné de mesures d'encouragement plus nuancé.** On affecte des ressources du projet au versement de salaires à des travailleurs villageois s'occupant de l'amélioration des sols, de la rétention d'eau et de la sylviculture. Quand on inaugure la gestion d'une nouvelle zone, on met sur pied une coopérative villageoise qui récoltes des herbes et du bois de feu dans cette zone, en les vendant pour satisfaire à la demande dans la région de Niamey. **L'offre d'emploi suscite une participation initiale, et le produit des ventes permet aux coopératives de continuer d'engager la main-d'oeuvre villageoise, ainsi que de rapporter des bénéfices annuels pour le village.** Dans la zone originale de 5000 hectares, cette approche a exigé que le projet et les services de vulgarisation y consacrent beaucoup d'heures; mais, on s'attend à ce que celles-ci se réduisent dans de futures actions, puisque cette approche elle-même a été mise à point.

Charges budgétaires soutenables

La question de la soutenabilité budgétaire est plus complexe. Le Projet CWS n'offre pas de subventions; en revanche, le projet et les services de vulgarisation affectent aux activités du projet des quantités plus importantes de leurs ressources peu abondantes (et relativement chères). Deuxièmement, on s'attendrait à voir un taux d'échecs plus élevé et des décalages plus longs dans les projets qui encouragent la participation, en comparaison avec ceux qui l'achètent. Il est possible que, en termes de coût unitaire, l'approche de l'UNSO consistant à "acheter" la participation soit la plus rentable.

Un risque en matière de développement se rattache aux approches adoptées par les projets CRS, IDA et UNSO: malgré le

niveau d'efficacité des résultats obtenus, "l'achat" de la participation à la gestion des ressources renforce la notion que la gestion amélioré des ressources sert les intérêts "d'autrui," et qu'il faut, par conséquent, la payer. Ce message, dont on voit l'effet de démonstration, risque de rehausser les coûts futurs des interventions en matière de gestion des ressources encourus par ces projets, ainsi que par d'autres projets dans les régions avoisinantes. L'approche du Projet Guesselbodi essaie de remédier à ce problème difficile en limitant ses subventions au stade de départ des activités; par la suite,les actions des coopératives villageoises constituent une réponse aux encouragements de marché.

Toutes ces approches, à l'exception de celle du projet CWS et, dans une certaine metsure, de celle du Projet Guesselbodi, rencontreront de grands obstacles si l'on les met en application à grande échelle. Elles comportent toutes des mouvements de fonds des organes centralisés à des particuliers; par conséquent, les possibilités d'abus se multiplieront avec chaque nouvelle action. L'expérience a prouvé que de tels abus peuvent rapidement l'emporter sur les résultats constructifs attendus.

Malgré ces avertissements, nous ne saurions écarter des approches comportant la rémunération de participants à court terme. Premièrement, il se peut, en fait, que la divergence entre les taux de rentabilité individuel et social découlant de la protection des ressources rende légitimes certains subsides initiaux. Deuxièmement, nous avons constaté que les fermiers pauvres acceptent volontiers la notion de gestion améliorée des ressources, mais aussi qu'il leur manque les connaissances techniques et les marges de survie qui leur permettraient de l'adopter. Dans le cas où de l'argent ou une autre mesure d'encouragement fournirait les marges nécessaires à l'assimilation de techniques, ces encouragements seraient compatibles avec le processus général de développement. Il est évident que, si l'on reproduisait cent fois l'intervention réussie à Dosso, l'accueil réservé à l'avenir aux mesures de protection des ressources ne deviendrait que plus chaleureux, malgré les autres limitation de cette approche.

Chacune des approches mentionnées ci-dessus pourrait s'adapter de façon à écarter les inconvénients et à tirer profit de leurs éléments utiles. Mais elles ont toutes mis l'accent sur des bénéfices immédiats et ont réussi à réaliser le degré de participation qu'elles avaient envisagé. De ce point de vue, elles peuvent se reproduire. L'évaluation de leurs impacts potentiels positifs ou négatifs sur le développement mérite d'être poursuivie d'une manière plus approfondie que celle permise dans les limites de ce rapport. La question d'être ou non soutenables du point de vue budgétaire dépend des ressources que les gouvernements nationaux et les organismes donateurs rendent disponibles. Dans cette optique, il paraît que trois sur les quatre approches sont

prometteuses.

On a écarté de cette section les actions privées, qu'on aura mises en oeuvre en réponse aux encouragements du marché ou, moins fréquemment, aux avantages à réaliser en matiere d'économie de main-d'oeuvre, de rendements accrus ou de réduction de risques. De telles actions partagent les points forts et du domaine privé et du domaine public; leurs existence témoigne du caractère suffisant des primes d'encouragement, et elles ne comportent aucune charge budgétaire pour le secteur public. Cependant, la reproduction de ces actions n'est pas automatique. Les fermiers pauvres ne sont pas prêts au même degré à courir des risques; de même, ils n'ont pas les mêmes marges leur permettant de le faire. Qui plus est, ils ne disposent pas tous des mêmes ressources matérielles ni des mêmes encouragements du marché.

7. Les impacts résultant des programmes réussis ne seront pas évidents à une grande échelle avant vingt ans au minimum.

Les Potentialités

Nous avons constaté que, au sein des interventions réussies les plus frappantes, les changements constructifs concourant au succès s'étaient produits bien avant que le succès lui-même ne devienne évident. Si une évaluation avait été menée il y a quelques années, on aurait pu considérer le programme des foyers maliens, le projet Guesselbodi et le projet des brise-vent de la Vallée de la Maggia comme étant des échecs. Dans chacune des ces interventions, des efforts pénibles déployés depuis des années sur le terrain rapportaient d'un seul jet les résultats espérés.

L'engagement à long terme, la capacité de tirer profit des erreurs et d'essayer de nouvelles approches, ainsi que la flexibilité permettant d'adapter des buts à de nouvelles possibilités à mesure que celles-ci se présentent, sont des facteurs contribuant au succès.

Questions demandant qu'on s'en occupe

Des techniques particulières, telles que les banquettes en courbe de niveau et les plantations d'eucalyptus, peuvent, comme elles l'ont fait par le passé, s'avérer avantageuses assez rapidement pour les fermiers. C'est le temps nécessaire pour amener la participation, plutôt que celui exigé pour rapporter des bénéfices une fois qu'une technique aurait été mise en oeuvre, qui constitue le vrai obstacle. En d'autres termes, c'est l'aspect humain, plutôt que l'aspect technique qui exige qu'on y consacre du temps.

Beaucoup de projets réussis ont mis plusieurs années pour forger des relations de confiance avec les populations locales. L'adaptation de techniques, ainsi que de systèmes d'encouragement en vue de leur dissémination, a souvent pris beaucoup de temps. Les conditions économiques des populations rurales, qui se sont transformées très rapidement, sont toujours en voie d'évolution. Même dans les interventions les plus reculées géographiquement auxquelles nous avons rendu visite, aucun fermier n'avait à subir des influences socio-économiques purement traditionnelles et établies une fois pour toutes. Bien des interventions les plus réussies considèrent la compréhension de ces changements, ainsi que la capacite de s'y adapter progressivement, comme des facteurs importants.

Là où des stratégies complexes multi-sectorielles se poursuivent (telles que celle du Projet CMDT au Mali), les conditions requises en matière de temps ont augmenté, étant donné la nécessité de ranger par ordre chronologique convenable les éléments d'une intervention bien agencée.

Tous les donateurs, les représentants des projets et les agents gouvernementaux et des services d'extension avec qui nous avons parlé, étaient fortement d'avis que le délai minimum pour la réussite des actions visant la gestion des ressources dans le Sahel est de vingt ans.

8. La création d'opportunités économiques augmentées pour la population locale a joué un role important dans les efforts de maintenir la diversité biologique qui ont réussi.

Le Potentiel

Une pression croissante sur la base des ressources a forcé un grand nombre de petits cultivateurs à échanger la stabilité future pour des gains financiers immédiats. Le conflit d'intérêts est implicite dans cet échange à plusieurs niveaux: entre les populations humaines et la faune; entre les utilisations de ressources en compétition (agriculture, élevage et pêche); entre la survie de cette génération et le potentiel économique de la génération nouvelle; entre les intérêts individuels et sociaux. **Le soulagement de la pression économique et la création de de nouvelles occasions de génération de fonds, bien que lents et ardus, ont eu plus de succès que les tentatives de simplement protéger les ressources que les populations locales n'ont autre choix que d'exploiter.**

Questions demandant qu'on s'en occupe

La diversité biologique est menacée par l'action des populations et aggravée par des crises de climat périodiques. Même là où les populations rurales ont le désir de maintenir la biodiversité, elles n'ont souvent pas beaucoup d'encouragements économiques pour le faire. Un vaste évantail de cas a établi qu'il est extrêment difficile pour les gouvernements d'éviter l'empiètement sur des zones protégées à moins que les populations aux alentours obtiennent un avantage dans leur préservation. Par contraste aux mesures d'amélioration de productivité des petits cultivateurs, l'élan primaire pour la biodiversité a tendance à venir du secteur public. Nous avons trouvé que le niveau d'engagement relatif à la biodiversité etait le plus élevé pour les populations les plus éloignées des conflits localisé--c'est à dire, pour celles qui se trouvent à une distance suffisemment grande pour voir la "grande image".

Du faitque les pressions économiques et environmentales varient nécéssairment d'un localité à une autre, leur soulagement peut requérir des délais de préparation relativement longs et beaucoup de travail patient au niveau "micro", comme dans le projet de l'UICN dans la Région du Delta Intérieur du Mali. Il y a un nombre de zones dans lesquelles le développement touristique peut fournir des opportunités de génération de fonds qui peuvent concurrencer avec succès avec le besoin à court terme de miner les ressources. En effet, plusieurs groupes de faune et de l'environement à travers le monde font une promotion active de ces méthodes. En particulier, des méthodes modèles réussies peuvent être tirées des efforts de tourisme plus dévelopés en Afrique de L'Est. Comme les exemples de l'Afrique de L'Est l'établissent, une protection active peut aussi être nécessaire en tant que composante d'une méthode de gestion combinée.

Etant donné la nature à long terme de l'effort, l'éducation environmentale peut contribuer à une amélioration de la compréhension--particulièrement parmi les enfants--de l'importance de la protection de l'environment et des solutions potentielles au conflit des concurrences pour les ressources. Le succès du magazine pour enfants Walia (Mali) suggère que les campagnes de publicité augmentées--y compris par radio, télévision et video--peuvent être un investissement solide à long terme.

CONCLUSIONS

A partir des constatations principales de notre évaluation, ainsi que des thèmes qui se répètent dans toutes les interventions visitées, nous avons élaboré les principes directeurs suivants:

- Fournir des indiciations de politiques nettes et uniformes en matière de jouissance des ressources, de droits locaux de gestion, de soutien politique et de mobilisation sur le plan national, et de prix et d'accès au crédit. Des positions cooordonnèes adoptées par les organismes donateurs devraient soutenir toute réforme de la politique nationale.

- Mettre l'accent sur l'encouragement de la participation locale. S'assurer que les options possibles fournissent un rentabilité adéquate à court terme, jusqu'à ce que les bénéfices à long terme commencent à se faire sentir. Offrir une gamme d'options techniques et socio-économiques, et tenir compte de la nécessité de la flexibilité et des adaptations dans l'exécution des projets.

- Mettre un accent beaucoup plus intense sur la formation au niveau local et sur la sensibilisation en masse. Les fermiers accueillent volontiers des connaissances en matière de gestion des ressources; mais les services ruraux de vulgarisation souffrent de compétences et de connaissances inadéquates. Les formateurs et les intermédiaires locaux travaillent plus efficacement et à moindre coût que ne le font des agents venant de l'extérieur.

- Continuer sur le succès des modèles locaux. Il faut consolider davantage des politiques visant à encourager les petits cultivateurs ayant réussi. L'exemple des "fermiers-modèles" peut produire une influence marquée et constructive sur les autres. Enfin, il faudrait tenir compte de la possibilité où se trouvent les fermiers réussis de créer des emplois pour les habitants ruraux les plus pauvres.

- S'assurer qu'il existe un engagement stable à long terme vis-à-vis du secteur des ressources naturelles. La courbe d'assimilation de connaissances peut exiger des délais assez longs. L'économie rurale est en évolution rapide; les projets aux cycles courts d'opérations ne tirent cepedant pas profit de cette évolution. Les projets abandonnés ont un effet de démonstration négatif.

CHAPITRE 6
LES PRIORITES

INTRODUCTION

Il existe à présent un éventail suffisamment varié d'interventions techniquement viables et économiquement attractives en matière de ressources naturelles pour arrêter le déclin des systèmes de production ruraux dans le Sahel. Des agencements améliorés d'éléments techniques sont possibles, voire nécessaires; mais il faut remarquer que la technologie n'est pas actuellement le facteur limitant dans l'augmentation de la productivité des petits fermiers au moyen de la gestion des ressources naturelles.

En effet, le défi important lancé en matière de développement consiste à amener l'acceptation générale des technologies appropriées. C'est, donc, une question de motivation humaine, qui relève en même temps de l'économie, des institutions et de la politique.

Les programmes comportant un agencement financièrement intéressant d'éléments techniques augmentent le taux d'adoption, en fournissant des effets de démonstration positifs; par ailleurs, leur reproduction dans d'autres contextes n'est pas limitée par les capacités institutionnelles du secteur public, ni par des considérations budgétaires.

Les organismes donateurs et le secteur public auront un rôle important à jouer dans la formation et dans les services de vulgarisation visant à rendre disponibles des approches viables aux petits cultivateurs; dans l'apport d'assistance technique pendant les stades initiaux des programmes; et dans le partage des coûts là où les bénéfices directs sont insuffisants pour amener la participation, mais où des bienfaits importants en matière d'amélioration du milieu justifient l'affectation prioritaire des budgets publics limités.

Dans ce chapitre final, nous faisons des recommandations quant aux principales options à choisir dans le cadre d'une stratégie de gestion des ressources dans les quatre pays visités. Par contraste avec les sections précédentes de ce rapport, ce chapitre ne se fonde plus exlcusivement sur les observations faites lors de notre évaluation sur le terrain; au contraire, nous intégrons les enseignements découlant de notre évaluation dans une compréhension plus générale des questions et des contraintes touchant la gestion des ressources dans le Sahel. La section finale de ce chapitre propose des priorités pour le soutien de l'AID.

Un Contrat avec les populations saheliénnes

Les interventions étudiées dans cette évaluation laissent à espérer que les actions visant la gestion des ressources naturelles peuvent remporter des succès, et qu'elles permettent, en outre, de pénétrer précisément dans les stratégies qui se sont avérées réussies. Mais mettre fin au déclin des bases de la production rurale dans le Sahel exigera des efforts concertés pour la génération à venir, lesquels seraient déployés en vertu d'un "contrat" à long terme conclu entre les populations sahéliennes, les gouvernements nationaux et l'ensemble international des organismes donateurs. Chaque partie au contrat devra partager les coûts de la gestion des ressources naturelles, selon des modalités propres à chacune. Les populations sahéliennes devront prendre à leur charge la plus grande partie de ces coûts, qui comprendront et des investissements réussis dans les terres et la souffrance humaine qui résultera de tout échec. En ce qui concerne le secteur public (réunissant les gouvernements nationaux et les organismes donateurs), il coûtera beaucoup moins cher, même du point de vue budgétaire, de partager les coûts d'efforts réussis que de porter remède aux conséquences des échecs.

La notion de "contrat" souligne la nécessité des efforts stables, à long terme et coopératifs. En nous basant sur les actions étudiées au cours de notre évaluation, nous ne croyons pas que la dégradation du milieu en elle-même soit changée complètement. En effet, il y a des chances pour qu'il soit improbable que cette dégradation, même à l'état actuel, soit arrêtée, quoiqu'il existe une technologie propre à le faire. Donc, avant de proposer une stratégie à long terme, il serait souhaitable de délimiter explicitement ce que peut réaliser une telle stratégie.

En fin de compte, nous définissons le succès en fonction des êtres humains, et non pas du domaine biophysique. Nous avons relevé des exemples réussis d'un processus comportant l'application de l'énergie humaine à des parcelles de terre bien délimitées, afin de protéger ou de développer les bases de production, en même temps que (et parfois parce que) il y a dégradation continue du milieu général. La protection des bases de la production rurale, en infuant sur les soucis prioritaires des populations rurales, donne les plus grandes chances de succès. Par ailleurs, la gestion intensive des terres agricoles réduit dans le temps, comme nous l'avons vu, les pressions sur le reste du milieu.

Les Perspectives d'avenir d'une stratégie des ressources naturelles

Il faudra faire des efforts concertés dans quatre domaines:

biophysique, économique, institutionel et politique. On résume ci-dessous les perspectives d'avenir dans chacun de ces domaines.

Biophysique

But

Le but biophysique consiste à mettre sur pied des systèmes de gestion au moyen desquels le capital naturel est protégé et rendu capable de pourvoir aux besoins de l'écono-mie rurale. Il faudra entreprendre des actions en matière d'amélioration de la fertilité du sol, de conservation des sols et des eaux et de protection de la végetation.

On pourra réaliser, soit simultanément soit l'un à la suite de l'autre, les deux aspects des actions à entreprendre dans le domaine biophysique: premièrement, la diffusion des technologies existantes, et deuxièmement, l'amélioration à long terme des technologies et du plasma germinatif, en augmentant ainsi la potentialité productive des ressources naturelles. De ces deux aspects, c'est la diffusion des technologies existantes qui constitue le besoin le plus pressant, car celles-ci suffisent déjà pour faire face aux besoins immédiats. Il faudra consacrer du temps à la recherche et aux essais sur le terrain des méthodes améliorées, procédés qu'on pourrait déclencher avec profit cependant qu'on déploie des efforts importants pour diffuser les méthodes existantes.

Les Perspectives d'avenir

Figurent dans la table ci-après les principales mesures qu'on propose d'inclure dans la liste des options possibles. Chaque démarche s'est démontrée réussie sur le terrain et répond aux critères de la définition du succès avancés au chapitre 2; de plus, chacune d'entre elles peut être incorporée dans les ensembles d'éléments techniques satisfaisant au critère d'intérêt financier (Chapitre 4) pour les petits fermiers.

Mesure	Lieu où elle a été observée
Traitement cyclique de substances nutritives par les plantes, et notamment par les plantes vivaces ligneuses	Toutes régions
Traitement cyclique des substances nutritives par les animaux	Toutes régions
Application d'engrais minéraux	Zones de pluviométrie élevée
Fixation microbienne de l'azote	Zones de cultivation de légumineuses vivaces ou annuelles
Banquettes en courbes de niveau dans des champs	Zones de pluviométrie élevée
Microbassins	Zones de basse pluviométrie
Paillage de broussailles	Toutes zones
Barrages d'arrêt	Toutes zones
Brise-vent	Toutes zones
Haies vives	Toutes zones, surtout celles de pluviométrie élevée
Barrages de protection contre l'infiltration d'eaux salées	Zones côtières et bassins fluviaux
Stabilisation de dunes	Zones de basse pluviométrie
Conservation de la biodiversité	Périmètres déterminés, toutes zones

Economique

But

Le but économique consiste à augmenter les possibilités de génération de revenus au moyen de bonnes pratiques de gestion des ressources naturelles, ainsi qu'à tirer profit de changements dans le contexte socio-économique conduisant

à de nouvelles possibilités de gestion des ressources naturelles.

Perspectives d'avenir

Des possibilités existent dans les domaines suivants :

Marchés et revenus en espèces. Les marchés ouverts aux denrées produites exerceront une influence sur l'application des technologies mentionnées ci-dessus. Dans les régions où la commercialisation de la production agricole est payée en espèces (coton, arachides), les fermiers auront des possibilités accrues d'acheter des semences améliorées, des engrais minéraux et des pesticides. Les marchés de produits non-agricoles, tels que les perches de construction, peuvent rapporter des revenus, réduire la dépendance des variations pluviométriques et ouvrir la voie à des nouvelles actions de gestion de ressources. Par contre, là où les producteurs dépendent pour leur survie de cultures vivrières de base (mil, sorgo, etc.), ce sont plutôt les heures de main-d'oeuvre qui constituent le principal facteur de contribution dont ils pourront disposer; dans ces cas-là, il se peut que le partage des coûts soit la meilleure option dont le secteur public pourra se servir pour fournir des achats limités d'intrants, tels que des semis.

Partage des coûts. La plupart des fermiers au Mali, au Niger, au Sénégal et en Gambie disposent de très peu de revenus en espèces qu'ils peuvent affecter à l'achat d'intrants. Leurs encouragements financiers, qui consistent en une augmentation des récoltes et non pas forcément en des espèces accrues, ne les poussent qu'à la prise de mesures conduisant à des bénéfices immédiats. Il est vrai que des mesures telles que les banquettes en courbe de niveau et la plantation d'**Acacia albida** peuvent être proposées, afin de réaliser des bénéfices et à court terme et à long terme. Nous avons constaté que c'est le niveau des bénéfices à court terme qui influe directement sur les taux d'acceptation. En ce qui concerne ces fermiers, il convient au secteur public de **partager les coûts** des actions dont le taux de rendement économique excèdent le taux de rendement financier.

Dans le premier cas, la différence entre les deux chiffres (le taux de rentabilité économique moins le taux de rentabilité financière) permet de mesurer le niveau de partage de coûts qu'il convient au secteur public de prendre à sa charge. Pourtant, il est important de reconnaître le fait que les coûts publics découlent du défaut de mise en place d'une gestion améliorée des ressources, dépassent d'habitiude de beaucoup la différence entre les deux taux; effectivement, le secours alimentaire, le sous-emploi urbain, les besoins supplémenmtaires en soins de santé, le déficit de la balance des paiements et les possibilités de

développement perdues, facteurs résulant en partie du déclin des systèmes de production ruraux, coûtent beaucoup plus cher **à posteriori** que ne le fait la part publique éventuelle de la gestion améliorée des ressources au niveau des champs de culture.

Partage des risques. Une perspective à long terme, qui est nécessaire aux effort importants qu'il faut fournir, doit forcément amener à l'identification des risques liés aux tentatives de mettre en place une gestion améliorée des ressources au niveau rural. Les actions ne peuvent pas toutes réussir, soit parce qu'elles ne sont pas bien executées, qu'elles ne répondent pas aux besoins locaux, ou que des facteurs institutionnels, climatiques ou économiques extérieurs empêchent autrement le succès. Le partage direct des coûts (par exemple le projet UNSO d'**Acacia albida** à Dosso) peut réduire les risques encourus par les fermiers; mais il n'est ni approprié ni réalisable institutionnellement comme méthode dans chaque situation, et ce au moins partiellement, parce qu'il fausse, au lieu d'améliorer, le décisions prises sur le plan des fermes en matière de répartition rationnelle des ressources, et qu'il met les fermiers dans la dépendance des programmes extérieurs. En genéral, les secteurs publics et privés doivent partager les risques à long terme. Tout comme un programme d'assurance, on peut bien établir avec une mesure raisonnable de confiance, que l'assureur, c'est-à-dire le secteur public, tirera profit du programme global, malgré l'échec de certaines actions individuelles. De même, les fermiers assurés peuvent mieux prendre des risques lorsqu'ils savent qu'ils sont à l'abri des conséquences catastrophiques.

A notre avis, la mise en disponibilité du **crédit** constitue la mesure de partage des risques la plus importante que puisse offrir le secteur public dans les dix ans à venir. L'accès au crédit pour les fermiers du Sahel est restreint et variable. Qui plus est, beaucoup de fermiers ne seraient pas en état de rembourser des prêts, même s'ils pouvaient en affecter le produit à de bons usages; c'est-à-dire, il est possible que la production augmentée ne rapporte pas les revenus en espèces nécessaires aux amortissements. Les systèmes ruraux de perception des impôts (souvent à raison d'un nombre fixe de francs par personne par an) font de prélèvements sur les mêmes réserves limitées d'espèces qui pourraient financer des investissements ou le remboursement de prêts. Les budgets des Etats son limités dans leur capacité de financement des crédits ruraux, mais, moyennant l'assistance apportée par des bailleurs de fonds, on peut élargir la portée des programmes de crédit, en calculant les sommes à rembourser d'après les dimensions et le rythme des bénéfices réalisés. Il existe, dans beaucoup de pays en développement, des programmes de crédit rural, y compris des fonds de roulement en combinaison avec la formation et la vulgarisation. Parmi des exemples de ces programmes dans le quatre pays englobés dans cette étude, figurent

deux programmes réussis, à savoir les programmes de crédit de la Compagnie Malienne de Développement de Textiles et l'emploi de main-d'oeuvre villageoise salariée en tant que crédit initial à Guesselbodi.

Institutionnel

But

Le but consiste à faire adopter les changements institutionnels nécessaires à encourager et à soutenir l'acceptation générale des technologies disponibles. On devrait bien reconnaître que les capacités institutionnelles ont constitué par le passé, et elles continueront de constituer à l'avenir, l'obstacle le plus difficile à surmonter. Il existe pourtant des possibliités pour améliorer l'approche du défi institutionnel.

Perspective d'avenir

La mise en oeuvre de pratiques améliorées en matiere de ressources naturelles, à l'échelle nécessaire pour arrêter la dégradation du Sahel qui s'accomplisse dans les délais nécessaires pour éviter une catastrophe humaine, est avant tout un problème de gestion. Jusqu'à ce jour, on a mal géré cet effort. On n'a pas pris en compte deux principes de gestion en particulier:

Affectation de ressources. Les engagements en matière de l'affectation de ressources financières et humaines de la part des bailleurs de fonds et des gouvernements nationaux ont été fluctuants; de plus, il y a eu une répartition inégale de ces ressources faite selon les priorités établies; enfin, l'affectation de ces ressources a été faite dans le cadre d'actions individuelles et à court terme, mais pas de façon a concourir au succès de la stratégie à long terme. La rationalisation de ce processus, y compris le respect du "contrat" conclu avec les populations sahéliennes, augmentera les chances de succès.

Séquence des tâches. Le problème de l'environnement sahélien ne peut pas être géré comme s'il s'agissait simplement de l'exécution d'un projet. En effet, la dynamique sociale et économique complexe ne se prête pas à la planification centralisée. Pourtant, il faudrait que certains volets soient bien en place avant de procéder à la réalisation des suivants. Une meilleure organisation des tâches par étapes bien coordonnées peut aider à fixer les priorités à court, à moyen et à long terme pour les actions publiques.

Ces questions de gestion servent de fondement aux tentatives de satisfaire aux besoins du développement. On traite ci-après de chacun de ces besoins dans la mesure où il se trouve en rapport

avec les autres besoins et avec l'effort dans son ensemble.

La formation et le transfert de compétences seront nécessaires sur le plan local. Des organismes ruraux, tels que les conseils villageois, les cercles féminins, les coopératives et les organismes non-gouvernementaux sur le terrain peuvent servir d'intermédiaires particulièrement utiles et soutenir les petits fermiers. Les investissements dans la formation sur ce plan tendent aussi à être avantageux dans des domaines du développemnt, en plus de celui dans le cadre duquel la formation a lieu.

Dans de nombreuses parties de la région, il faut donner aux agents de vulgarisation sur le terrain eux-mêmes une formation et des informations supplémentaires concernant la gestion des ressources naturelles, afin qu'ils puissent offrir de bons conseils aux fermiers. Les agents forestiers, en particulier, ont une formation dans des sujets de portée limitée, tels que la sylviculture et la protection des zones boisées (surveillance et imposition d'amendes pour l'abattage illégal); mais pas en matière d'intégration des arbres et des arbrisseaux dans la production agricole en vue d'une productivité accrue.

La formation et le transfert de compétnces aux intermédiares de terrrain demandent un temps considérable, et pour la formation proprement dite, et pour le perfectionnement des compétences moyennant l'expérience. Puisque le manque de tels intermédiares sur le plan local rique d'entraver la diffusion de la participation des fermiers, on devrait veilller à leur mise en place avant d'entreprendre des actions visant la dissémination de technologies.

Amélioration des capacités organisationnelles. Il manque aux ministères gouvernementaux et aux services concernés dans la gestion des ressources naturelles les compétences organisationnelles nécessaires pour gérer des programmes considérablement étendus. Les compétences en matière de gestion font tout particulièrement défaut aux échelons moyens de la direction des programmes. Quoiqu'il y ait eu une tendance à court terme à combler cette lacune en faisant appel à l'assistance technique expatriée, cette démarche de s'avérera pas soutenable du point de vue budgétaire si on compte élargir le champ d'action des interventions. Dans une certaine mesure, l'emploi d'intermédiares locaux évite le report de la mise en oeuvre jusqu'à ce que le problème à long terme soit résolu; mais cette solution ne réduit en rien l'urgence de la nécessité de commencer la formation nécessaire des effectifs.

La réforme institutionnelle peut également conduire à de très grands avantages. Les agents forestiers ont historiquement obtenu des augmentations importantes de leurs salaires, à raison de plusieurs fois leurs salaires de base, en imposant des amendes à

des villageois pour l'abbatage du bois; de ces amendes, il leur est permis de garder un pourcentage. De plus les agents forestiers on traditionnellement été des paramilitaires. Ces deux facterus (encouragements à l'imposition d'amendes et le service paramilitaire) on fait obstacle à l'établissement de relations productives, basées sur la confiance, avec les populations rurales. La création d'une atmosphère de confiance nécessitera non seulement les réformes nécessaires, mais aussi des modifications apportées aux programmes d'études des écoles forestières, afin d'inculquer aux agents une base de compétences dont ils auront besoin pour soutenir le développement rural (voir la case suivante).

Le Rôle des agents forestiers en voie d'évolution

A la suite d'une action coopérative entre l'Administration Forestière du Mali et le Projet de Reboisement Villageois (PRV) de l'USAID, les agents forestiers dans la Cinquième région du Mali on réussi la transition du rôle de gendarme à celui d'agent vulgarisateur.

L'imposition d'amendes aux villageois, ainsi que l'imposition parfois abusive d'amendes à leur profit personnel, qui duraient depuis des décennies, avaient suscité une tel degré de méfiance entre les villageois et les gardes que l'atmosphère nécessaire à la vulgarisation pacifique n'existait pas. On avait même documenté des cas d'agents qui avaient **loué des voitures** à leurs frais lorsque les véhicules administratifs tombaient en panne, afin de pouvoir continuer d'imposer des amendes. Les revenus qu'ils tiraient de ces amendes etaient suffisants pour compenser les frais de location.

Selon un accord conclu avec l'USAID, les agents affectés à la zone du PRV ne peuvent plus condamner les villageois à des amendes. On leur verse une prime pour compenser la perte de revenus, en leur faisant bénéficier en même temps d'une formation technique supplémentaire en matière de protection des ressources et de méthodes de vulgarisation. Par la suite, les autorités villageoises et des fermiers on constaté la création de relations réciproques avec les gardes forestiers beaucoup plus féquentes et plus positives partout dans la région. Par ailleurs, l'assistance technique fournie par l'Administration Forestière a contribué de façon importante au succès de nombreuses actions entreprises par les fermiers privés que notre équipe a visitées.

La recherche est un besoin aussi pressant dans le domaine de l'adaptation et de la diffusion de la technologie, questions relevant des sciences sociales, qu'elle ne l'est dans celui, relevant des sciences naturelles, de l'amélioration de la technologie. Il ne faut pas que les délais longs exigés par la

recherche précèdent la mise en oeuvre des techniques dont on peut disposer actuellement. Les résultats seront tout aussi utiles dans le cas où il y aurait une acceptation générale des mesures existantes, et une amélioration du climat conduisant à des innovatins additionnelles.

Politique

But

Le but en matière de politique consiste à créer un climat de politique qui fournisse, ou du moins cesse d'entraver, des encouragements rationnels à la participation des petits cultivaters et facilite des investissements dans la gestion des ressources naturelles. Bien que les chagements de politique appropriés ne suffisent pas toujour à amener la participation, ceux-ci produiront un effet répandu qui servira de complément nécessaire à d'autres mesures répondant à des buts plus précis.

Perspectives d'avenir

Nous recommandons trois domaines prioritaires en matière de réforme de politique:

Jouissance des terres. Comme il a été indiqué plus longuement au Chapitre 5, la gestion des ressources dans le milieu sahélien en voie de dégradation, exige qu'on fasse des investissements de temps et d'argent dans des parcelles de terre individuelles. La jouissance sûre des terres est essentielle, si l'on veut que les fermiers croient en la rentabilité de ces investissements. La question des droits de jouissance des terres se pose dans les quatre pays visités.

Droits de gestion des ressources. Investir les villageois d'une autorité de gestion des ressources locales, est un procédé qui est déjà en cours dans bien des régions, et qu'on poursuit souvent dans le cadre d'un accord de projet spécifique comme c'est le cas à Guesselbodi. Dans ce projet, et dans le mouvement visant l'aménagement du terroir villageois, les villageois sont encouragés à rechercher des possibilités productives découlant de la gestion du milieu, une fois qui'il d'tiendront l'autorité et les droits de répartition leur permettant de profiter de ces possibilités. On pourrait ajouter à ce procédé des directions précises relatives aux responsabilités de gestion et aux pratiques admissibles. Mais au fond, ce procédé résulte de la constatation que la gestion de l'environnement est un processus décentralisé qui, dans tous les cas, n'entre pas dans le champ de contrôle effectif des autorités centrales; le manque d'autorité pour gérer de façon responsable les ressources naturelles n'écarte pourtant pas la possibilité de les dégrader.

Au moyen et au long terme, **les prix** des produits forestiers et de la production agricole doivent refléter leurs vraies valeur économiques. L'exploitation du bois de feu destiné à la consommation directe ou à la vente sur les marchés commerciaux (d habitude dans les villes), représente une cause importante de la diminiution des forêts. Etant donné que le bois est pris en tant que marchandise gratuite, les prix ne reflètent pas le coûts de remplacement, et l'épuisement incontrôlé de cette ressource continue. Or, le bois de chauffage coupé par des villageois à leur propre usage n'est pas sujet aux impôts; cependant, le bois coupé destiné à être revendu sur le marché est sujet aux **prix de permis**, qui sont actuellement moins chers que les couts de la culture des arbres. Le Sénégal et le Mali on récemment augmenté de façon importante ces prix de permis; le Niger prend en considération une augmentation similaire. En effet, un hausse des prix de permis sont éventuellement nécessaires, afin de donner un essor à la production rurale de bois (qui serait exempt d'impôts) et de promouvoir des amélioratiuns dans l'efficaceté de la consommation. La possibilité d'effets defavorables sur les pauvres en milieu urbain découlant d'augmentations de prix (impôts) doit être mise en balance avec les effets de l'épuisement continuel des forêts sur les systèmes de production ruraux. Depuis une décennie, les prix urbains de vente au détail du bois sont en forte hausse (là où ces prix ne sont pas contrôlés officiellement) du fait de la rareté de cette marchandise. La question à long terme consiste, donc, à savoir si les prix du bois augmenteront dans le cadre d'une structure d'encouragements soutenable visant la conservation des ressources, ou bien si cette hausse des prix sera le résultat d'une pénurie croissante de bois.

Questions relevant de la programmation de l'AID

La possibilité où se trouve l'USAID d'établir un contrat à long terme avec les populations du Sahel est soumise à des restrictions de nature institutionnelle et budgétaire. Nous soulevons ci-dessous les questions dans ce domaine exigeant une étude plus approfondie, puisqu'elles influent sur les avis orientant la stratégie que l'AID devra poursuivre.

Protéger les investissements de l'AID signifie qu'on s'assure que chaque mission de l'AID dispose chez son propre personnel d'assez d'expertise pour pourvoir contrôler les activités en matière de ressources naturelles, collaborer avec les organismes intéressés du pays-hôte et des bailleurs de fonds et identifier les investissements prioritaires. Dans le cas où les engagments pris par l'AID dépasseraient par leur portée sa participation dans les projets individuels, la continuité institutionnnelle aux échelons des missions et des sous-régions deveiendra plus importante. Dans

les missions et au siège de l'AID à Washington, on élabore déja des **indices de contrôle** des progrès réalisés dans le domaine de la gestion des ressources naturelles. De tels indices peuvent constituter un outil de gestion particulièrement précieux que rendrait plus efficace le contrôle des actions à long terme, ainsi que celles menées par plusieurs bailleurs de fonds, qui dépassent les cycles usuels de programmation. Des séances officielles, consacrées à la formation et à l'echange de vues au bénéfice du personnel de mission chargé des ressources naturelles, faciliteront la communication réciproque d'informations et d'expertise entre pays.

Limiter les nouvelles charges en matière de gestion que doivent assumer les missions est un objectif qui sera plus facile à atteindre là où la gestion des ressources s'intègre dans les portefeuilles existants. Les deux thèmes principaux en matière de gestion des ressources, à savoir une productivité agricole améliorée et la promotion des entreprises rurales et de la génération de revenus s'harmonisent bien avec les programmes en cours de l'AID.

Le maintien de connaissances spéciales adéquates pour contrôler la gestion des ressources sera plus facile si l'AID affeccte ses ressources limitées à un ou plusieurs domaines d'importance durable. Une approche visant de multiples thèmes augmente les chances que les objectifs de projets individuels dominent les programmes. A notre avis, les intérêts des gouvernements nationaux seront mieux avancés, si chaque bailleur de fonds s'engage à partager la responsabilité de déployer une stratégie à lon terme, dans un ou plusieurs domaines précis.

Le processus de conception et d'evaluation de projets auront un effet important dans la définition du rôle de l'AID dans ce secteur. Les longs délais nécessaires pour parvenir au succès, ainsi que les changements non-évidents qui se produisent avant que le succès ne se manifeste, rendent nécesssaires des approches d'évaluation affirmatives qui reconnaissent que les objectifs originaux du projet risquent de devenir surannés. En plus de la mise à éxecution de plans qu'on aura déjà élaborés, la mise en oeuvre réussie d'une stratégie exige l'identification de nouvelles posibilités ainsi que le suivi de celles-ci, au fur et à mesure qu'elles se présentent. Il s'agit ici d'une question qui est difficile à résoudre, étant donné le risque de protéger de mauvais projets sous le prétexte de la nécessité d'un engagement à long terme. Les évaluations intermédiares qui déclenchent un processus coopératif de "rectification en cours" calibré par les objectifs stratégiques et au moyen d'outils tels que les indices de contrôle, peuvent servir à réorienter avec succès un projet, comme en témoigne l'evaluation intermédiaire du projet PUSF, exécutée par le Bureau africain en 1984

Recommandations soumises à l'AID

Priorités

Priorité no. 1: Faire diffuser les technologies existantes

Recommandation globale: En tant que priorité la plus pressante à tous niveaux de financement, mettre l'accent sur le **déploiement** des technologies existantes, dont les impacts positifs et intéressants du point de vue financier dans les fermes et les villages sont bien démontrés, et qui aident à satisfaire aux critères nécessaires d'uns système soutenable.

On a constaté que les technologies et les stratégies déployées porduisaient des impacts importants et durables sur la productivité des fermes et des villages en matière de nourriture, de fourrage, de bois et d'autres produits. Il semble que l'acceptation de la part des fermiers dépend autant de la réduction des risques que de la potententialité d'augmentation des rendements. Les occasions d'obtenir des revenus en espèces qui en même temps réduisent les risques économiques peuvent constituer une motivation puissante.

Priorité no. 2: Augmenter les potentialités Productives

Recommandation: Aux niveaux de financement moyen et élevé, soutenir les recherches visant à réduire les risques et à augmenter l'efficaceté des technologies et du plasma germinatif à rendements accrus. Prévoir l'introduction des résultats de ces recherches là où on a adopté avec succès des méthodes actuellement disponibles pour améliorer la gestion des ressources naturelles.

D'après les données recueillies, il faut agumenter les potentialités des fermes au moyen de technologies et de plasma germinatif à rendements accrus; cependant, on a constaté que le taux d'acceptation des TPGRA était bas dans les zones de cultures de mil et de sorgo où les risques dus à la sécheresse étaient élevés et/ou qu'il y avait une dégradation marquée des ressources naturelles. Ces mêmes données, receuillies sur le terrain, suggèrent que l'efficacité des TPGRA sera augmentée quand les méthodes existantes de conservation des sols et des eaux et d'augmentation de la fertilité auront été mises en oeuvre. Des recherches valables dans ce domaine sont déjà en cours, notemment à l'ISTRA (Sénégal). Des fermiers habitant des zones cotonnières ont appliqué économiquement des engrais minéraux là où des cultures de vente font partie intégrante de la rotation des cultures.

6 PRIORITES

Objectifs de la production soutenue

D'après notre évaluation et les données de recherche, nous considérons les objectifs de production pour les zones visitées comme étant nécessaires et réalisables. Les petits fermiers sont bien en état de soutenir les niveaux de production proposés, lesquels pourraient être atteints dans les 10 à 15 ans suivant le commencement des interventions appropriées.

A. Zone sahélo-soudanienne (450-750 mm): Option à financement réduit

Récoltes de mil et de sorgho

En augmentant les densités des arbres plantés aux champs, en limitant l'érosion et en améliorant l'emploi du fumier, on s'attendrait aux récoltes suivantes (variant selon l'état original des ressources naturelles):

- doublement des récoltes moyennes sans ou avec applications périodiques minimes d'engrais minéraux;

- probabilités considerablement reduites de perte des récoltes pour cause de sécheresse; et

- réduction considérable de la période de jachère nécessaire.

Produits forestiers et horitcoles

L'élaboration et l'exécution de plans de gestion des terres boisées villageoises, ainsi que le soutien de micro-entreprises agricoles conduiront à une augmentation des quantités de bois destiné à la production de perches et de combustibles, et des quantités d'autres produits tels que les gommes, le miel, les médicaments, etc.

Capacité permanente de support de bétail

Des provisions augmentées de fourrage de saison sèche, obtenues à partir de pâturages additionnels et de la gestion améliorée des réserves forestières, peuvent doubler la capacité permanente de support des terres, et augmenter simutanément et la quantité et la qualité du fumier destiné à la fertilisation du sol.

B. Zone sahélo-soudanienne: Options de financement moyen et élevé

Quoiqu'on dispose de données moins nombreuses documentant les impacts soutenables sur la production agricole produits par des investissements plus intensifs, un niveau élevé de financement devrait amener une augmentation des potentialités productives des enterprises agricoles, ainsi qu'un taux accru de déploiement d'interventions appropriées. L'action prioritaire de cette option d'apport de fonds reste celle de redonner au sol sa capacité productive.

Récoltes de céréales

On pourra doubler les récoltes, et même plus. Les prévisions probables en ce qui concerne une réduction des pertes de récoltes et des périodes de jachère nécessaires seraient à peu près identiques à celles faites selon l'option de financement réduit. Mais le taux de mise en oeuvre de technologies dépasserait celui de l'option réduite.

Gestion forestière

Les produits seraient les mêmes que ceux donnés dans le cadre de l'option réduite; mais il deviendrait possible de créer davantage de modèles et de former plus de personnel en matière de techniques de planification de l'utilisation des forêts (PUSF) et de gestion de projets, ce qui conduirait à des taux de vulgarisation accrus.

Capacité de support

L'objectif reste identique à celui de l'option réduite: doublement de la capacité de support dans les zones affectées. Cependant, des objectifs plus hauts seraient proposés pour les populations affectées.

C. Zones soudano-guinéennes (plus de 750 mm): Option de financement réduit

Comme il a été remarqué pendant notre évaluation et d'après les données de recherche comparant cette zone à la zone sahélo-soudanienne, la zone soudano-guinéenne se caractérise par une frequence accrue de cultures de rente, un couvert végétal plus étendu, et davantage de risques d'érosion et de lessivage.

Rendement des cultures

On fait toujours dans cette zone la collecte de données portant sur les potentialités de rendement sous une gamme de régimes de gestion; cependant, les rotations convenables de cultures de rente et de cultures vivrières de base, l'application restreinte d'engrais minéraux, la plantation répandue de semences améliorées, la mise sur pied de systèmes agroforestiers, l'emploi amélioré de fumier et des pratiques améliorées de traction animale devraient permettre d'atteindre les objectifs suivants:

- augmentations importantes de toutes les récoltes;

- réduction importante ou élimination des périodes de jachère nécessaires; et

- réduction importante des pertes de récoltes dues à la sécheresse.

Gestion forestière

La mise en valeur améliorée des forêts existantes donnera lieu à des augmentations soutenues de bois, de fourrage et d'autres produits.

Capacité de support

Il a été remarqué que, au début et à la fin de la saison des pluies, on se servait de la traction animale pour faire le labourage. Ce deuxième labourage semblait produire un impact sur la quantité d'humidité qui reste dans le sol d'une saison sur l'autre. De plus, des fosses à compost améliorées fournissaient aux entreprises agricoles des quantités importantes de fumier. On pourrait donc s'attendre à ce que l'emploi et de la traction animale et des fosses à compost s'accroissent.

D. Zones soudano-guinéennes (plus de 750 mm): Options moyenne et haute d'apport de fonds

Fertilité du sol

Des interventions additionnelles devraient comporter la recherche et des services de vulgarisation portant sur la mise en culture en allées en vue de la fertilisation du sol et de la provision de fourrage.

Mise en valeur des terres boisées

Etant donné les potentialités accrues de croissance des arbres, la mise en valeur des forêts pourrait comporter des plantations d'enrichissement d'arbres ayant une valeur élevée.

Capacité de support

Il faudrait affecter des investissements additionnels dans la recherche sur les cultures de légumineuses servant de fourrage, et dans la diffusion de ces cultures.

Recommandations faites par catégorie d'intervention

Chacune des recommandations proposées ci-après est basée sur l'hypothèse implicite que des mesures spécifiques seront réalisées conformément aux principes de viabilité financière et aux encouragements traités dans les sections précédentes de ce rapport.

Interventions biophysiques

Amélioration de la fertilité du sol

Recommandation. Aux niveaux les plus bas d'apport de fonds, affecter les ressources disponibles au soutien de la régénération des arbres poussant aux champs et à l'utilisation rationnelle du fumier. Aux niveaux plus hauts, soutenir les recherches sur les engrais minéraux et sur l'amélioration de la faculté d'adaptation améliorée de rhizobium.

Les systèmes les plus productifs que nous avons étudiés pendant l'évaluation possédaient au moins une capacité minimum pour effectuer le traitement cyclique de substances nutritives à la couche supérieure du sol, ainsi que pour faire bon usage des substances nutritives ajoutées au système.

Conservation du sol et de l'eau

Recommandation. Elargir le champ des actions qui réduisent l'érosion des sols et qui augmentent la capacité du sol pour retenir les eaux disponibles. A tous niveaux d'apport de fonds, soutenir la diffusion des mesures suivantes:

- banquettes en courbe de niveau construites dans des entreprises agricoles;

- microbassins;

- utilisation rationnelle des restes de brousailles et de récoltes;

- Barrages de contrôle de ravines

- Haies vives.

Au niveaux plus élevés, appuyer l'utilisation augmentée de barrages d'arrêt.

Dans les quatre pays visités, nous avons remarqué des systèmes améliorés qui limitaient les mouvements de sol et d'eau, et qui incorporaient des capacités relativement élevées de retenue de l'eau destinée à l'entretien des plantes.

Maintien de la couverture végétale

Recommandation. A tous les niveaux d'apport de fonds, soutenir la mise en place et l'entretien d'une couverture permanente constituée de plantes vivaces ligneuses sur une partie importante des terres agricoles ou villageoises. Des niveaux plus élevés permettraient un nombre accru de modèles et une diffusion plus rapide.

On a remarqué que les systèmes soutenables incorporaient d'habitude une couverture faite de plantes vivaces ligneuses qui opéraient le traitement cyclique de substances nutritives, contribuaient des matières organiques, réduisaient les pertes dues à l'érosion et à l'évaporation et fournissaient pendant toute l'année des approvisionnements en fourrage, bois et autres produits.

Institutionnel

Formation et développement humain

Recommandation. Aux niveaux de financement les plus bas, augmenter la capacité des personnels des secteurs public et privé pour gérer les sols et la végétation; encourager l'établissement de liens entre les secteurs de l'agriculture, de l'élevage et de la foresterie. Aux niveaux plus élevés, soutenir la formation avancée des personnels qui seraient, par la suite, en état de fixer les priorités et d'élaborer des plans de gestion des ressources naturelles nationales, régionales et sous-régionales. Il faudrait prêter du soutien aux activités suivantes:

- Transformer les cadres d'agents policiers en agents de vulgarisation.

- Former des agents dans les techniques suivantes:

  - Mise en valeur des haies vives
  - Construction de foyers améliorés
  - Gestion des brise-vent
  - Aménagement des peuplements naturels
  - Gestion et récolte de l'eau

- Affectation d'intermédiaires locaux

- Développer les compétences de gestion de projets et de personnel

- Développer des compétences en comptabilité et en contrôle de comptes, y compris la gestion de crédit

- Soutenir le développement de compétences nécessaires aux micro-entreprises.

- Organiser des visites de formation que des fermiers et des agents locaux rendraient à des "sites-modèles" dans le Sahel (Guesselbodi et la Vallée de la Maggia sont deux sites possibles).

Le succès de beaucoup d'interventions était attribuable à des modifications apportées aux personnels et aux institutions dans les secteurs tant privés que publics. Ces modifications étaient d'habitude introduites sous forme d'une gestion plus efficace des ressources existantes dans les villages et les fermes. Cette tendance mérite d'être soutenue; cependant, la formation supplémentaire s'avérera nécessaire pour développer la capacité pour fixer les priorités nationales en matière de gestion des ressources naturelles, et pour développer les technologies et les stratégies conduisant à une productivité augmentée.

Collaboration entre secteurs

Recommandation. Faire usage de portefeuilles diversifiés de l'AID, là où cela s'avère approprié, afin d'encourager la collaboration en matière de gestion des ressources naturelles parmi les services d'agriculture, d'élevage et de foresterie, avec lesquels les missions AID dans la région travaillent normalement en coopération.

6 PRIORITES

C'est dans les secteurs de l'agriculture et de l'élevage que s'ouvrent les possibilités les plus grandes de réaliser des augmentations de rendement soutenables dues à la gestion améliorée des ressources naturelles. Ce sont pourtant les services forestiers qui tendent à souligner davantage la protection des ressources en tant que mesure prioritaire. Des relations coopératives plus étroites entre les services concernés serviront le plus efficacement à effectuer l'intégration de la conservation des sols et des eaux, ainsi que l'amélioration de la fertilité du sol, dans les objectifs à long terme visant la production dans les secteurs agriculture et élevage. L'AID est en une position avantageuse de promouvoir une telle collaboration.

Orientation des ressources vers les objectifs stratégiques

Recommandation. Promouvoir des accords conclus entre les pays-hôtes et des organismes donateurs et concernant des objectifs stratégiques à atteindre sur une période de 20 à 30 ans. Soutenir la création d'un processus de coordination plus structuré, afin de contrôler les progrès réalisés et de répartir les ressources peu abondantes dont disposent les gouvernements et les organismes donateurs. Déployer des efforts productifs sur les bases de succès déjà réalisés, y compris le soutien de fermiers-entrepreneurs et d'innovateurs ruraux.

Etant donné les budgets en voie de diminution et des demandes croissantes, une stratégie à long terme de gestion des ressources aura les meilleurs chances de succès si elle vise les domaines de plus haute priorité. La plupart des organismes donateurs auxquels nous parlions ne se rendent compte à présent que de façon superficielle des activités en cours sur le terrain appuyées par d'autres organismes de ce genre. Il existe une répétition importante d'actions, notamment dans les projets pilotes, la recherche d'accompagnement et le soutien apporté au développement institutionnel, cependant que d'autres activités prioritaires restent sans financement. Par ailleurs, les leçons précieuses qu'on tire de son expérience sur le terrain dans le cadre des projets mis sur pied par un organisme donateur, ne sont pas souvent mises à la disposition d'autres donateurs. Parfois, les conséquences des déclarations de politique faites par plusieurs donateurs ne s'harmonisent pas les unes avec les autres, réduisant ainsi les possibilités du succès. Plusieurs donateurs, y compris la Banque Mondiale et des représentants de l'AID, ont fait mention du manque de procédés officiels de coordination et d'échanges d'informations. En effet, de fortes accumulations d'informations et de données, y compris les banques

de données des Systèmes d'Information Géographiques, ne se partagent que par l'intermédiaire de projets ou d'individus isolés. Même au sein de l'AID, il y a peu de mécanismes et de fonds affectés régionalement permettant des échanges d'informations entre pays et projets.

Modifications de politiques

Jouissance des ressources

Recommandation. Donner la priorité à la coopération avec les gouvernements des pays-hôtes et avec d'autres donateurs, en vue d'identifier et de mettre en oeuvre les politiques de jouissance des terres et des arbres qui mettent en place des systèmes de jouissance plus compréhensibles et plus sûrs.

On a constaté que les politiques de jouissance des terres et des arbres constituent une variable qui influe sur l'acceptation de la part des fermiers des pratiques de gestion des ressources naturelles à faire dans leurs fermes (Gestion des Ressources Naturelles). A l'exception d'un seul cas (PSUF/Niger), le climat de politique favorable ne résultait pas de la législation nationale; bien au contraire, il découlait des conditions locales. Il existe une forte accumulation de preuves indiquant que les politiques de jouissance favorables qu'on élabore en réponse aux conditions locales en voie de transformation, produisent un impact positif sur la productivité; par ailleurs, elles peuvent servir de modèles partout dans la zone agro-écologique.

Encouragements fiscaux

Recommandation. Soutenir les politiques déjà en cours visant à rehausser les prix des permis d'abattage dans les forêts naturelles, de manière à refléter les coûts à long terme de remplacement des approvisionnements en bois en voie de décroissance. Travailler en coopération étroite avec les gouvernements-hôtes et d'autres donateurs, et notamment avec la Banque Mondiale, en vue de fixer les niveaux appropriés et les délais de mise en oeuvre des taux modifiés. En vue d'augmenter les encouragements visant

la mise sur pied de systèmes d'exploitation des rendements soutenus, chercher à mettre en place une structure de taxation différentielle qui fasse exemption du bois récolté à partir des systèmes sous gestion (par exemple, Guesselbodi), toutes en augmentant les taxes imposées au bois récolté hors des zones sous gestion.

Au Sénégal et au Niger, les prix de permis ont augmenté brusquement au cours des années recentes. Au Niger, on prévoit une augmentation de 900% des prix de bois de feu, afin de diminuer la demande du bois dans les centres urbains. Par contre, notre évaluation a révélé que la demande de combustibles a, en réalité, fait promouvoir une mise en valeur plus rationnelle des forêts dans le cadre du Projet de Planification et Utilisation des Sols et Forêts au Niger, en encourageant des villages aux alentours de Niamey à produire du bois destiné à la vente sur les marchés urbains. Donc, la vitesse à laquelle de telles augmentations considérables d'impôts sont mises en oeuvre devrait se modérer, afin de s'assurer que cet encouragement ne soit pas sapé.

Economique et Financier

Financement de la gestion des ressources naturelles

Recommandation. Encourager la création de fonds de roulement gérés sur les plans villageois et local, en vue de fournir du crédit aux petits fermiers acceptant d'entreprendre la gestion améliorée des ressources. Le partage des risques par le secteur public entraînerait la demande de remboursements prélevés sur les récoltes augmentées prévues sur une période de cinq à dix ans.

"Encouragements contingents"

Recommandation. Proposer des versements en espèces ou autres encouragements, conformément à un ou à plusieurs mécanismes étudiés dans l'évaluation, afin de mettre en oeuvre des mesures spécifiques visant l'augmentation de la fertilité du sol. Faire en sorte que ces encouragements dépendent de la réalisation d'une série d'actions en matière de ressources naturelles. Mettre à l'essai et mettre au point de tels systèmes d'encouragements dans les zones de démonstration, en vue d'une application plus répandue à l'avenir.

Nous avons constaté que les restes de plantes vivaces ligneuses et des animaux étaient les deux sources principales de substances nutritives pour les plantes dans la couche supérieure, sources qui, étant donné leurs coûts périodiques bas, continueront de fournir la plupart de ces substances dans un

avenir prévisible. Mais la pression démographique qui va en intensifiant a rendu plus difficile l'entretien de cette couverture de plantes vivaces ligneuses; par ailleurs, les approvisionnements en fumier animal dépendent dans une large mesure de cette couverture. Aussi, bien qu'on remarque des bouquets denses d'arbres mûrs dans le champs, existe-t-il très peu de régénération naturelle et de capacité de support des animaux en voie de décroissance.

Or, plusieurs projets avaient élaboré des stratégies d'encouragements visant la plantation d'arbres aux champs, et notamment d'**Acacia albida** dans les zones de cultures de sorgho et de mil. L'un d'entre eux utilisait des paiements nominaux en espèces versés aux fermiers qui protégeaient de jeunes arbres. Des analyses économiques indiquent que cette approche est valable. Nous avons élaboré en outre une approche liant les fonctions de soin d'arbres plantés aux champs à l'assistance en matière d'utilisation d'engrais à base de phosphore (P). Selon cette approche, on fournirait une ou deux applications d'engrais à base de phosphore aux fermiers qui maintiennent une densité minimum de jeunes arbres. Les engrais de ce type, qui sont relativement immobiles, risquent de produire des effets résiduaires sur les récoltes pour une période d'entre huit et dix ans, pourvu qu'ils soient bien appliqués. Les restes des arbres aux champs auraient ainsi suffisamment de temps pour produire un impact important et croissant sur les récoltes. Dans ce contexte, il serait souhaitable de recueillir d'informations supplémentaires sur les coûts et la possibilité de réalisation de cette mesure.

Priorités de la recherche

Conformément aux lignes directrices génerales spécifiées dans ce chapitre, parmi les priorités de la recherche figureraient la recherche sur la fertilité du sol au moyen de systèmes agro-forestiers améliorés et sur l'emploi rationnel de fumier; sur les technologies améliorées de conservation des sols et des eaux; et sur la conservation améliorée de la végétation naturelle.

Les potentialités de recherche sont identifiées en fonction des possibilités connues en matière de productivité (production/délais/intrants), ainsi qu'en fonction des éléments qu'on considère comme étant nécessaires pour remplir les ojectifs stratégiques. Nous traitons de chaque possibilité de recherche, en soulignant les questions principales qu'il reste à poser.

Recherche sur la fertilité du sol

On fait des recherches sur la fertilité du sol depuis plus

de quarante ans dans la region sahélienne, notamment au Sénégal. Les recherches menées par les passe ont donné lieu aux conclusions suivantes:

- Les systèmes agro-sylvo-pastoraux dans le Sahel produisent de façon soutenue des récoltes de sorgho ou de mil atteignant en moyenne 950 kg/ha (+/- 200 kg/ha), avec des périodes de jachère très courtes. Cependant, la pression démographique est en train de les faire se désagreger. Quels sont les obstacles de nature biophysique, socio-économique, politique et institutionnelle entravant le redressement de ces systèmes?

- On a constaté que les systèmes mentionnés ci-dessus supportaient une densité démographique d'entre 50 et 60 personnes par km^2; mais ces densités sont à présent environ deux fois plus grandes. Comment pourrait-on se servir économiquement d'engrais minéraux, afin de compléter les tentatives de la gestion agro-forestière et l'emploi de fumier, afin d'augmenter les potentialités productives de ces systèmes? Dans quelles conditions convient-il d'appliquer des engrais minéraux avant de restaurer les ressources naturelles? Quels sont les obstacles à la réalisation de ces potentialités?

- Quels sont les obstacles qui empêchent de réaliser des bénéfices augmentés de la fixation d'azote par l'intermédiaire de microbes?

- Les niveaux admissibles de fertilité du sol exigent qu'on applique annuellement quatre tonnes de compost. Quelle est la production de compost qu'on pourrait prévoir dans des fermes dans les circonstances présentes, et comment pourrait-on augmenter cette production? Comment peut-on améliorer la mise en valeur de ce produit?

- La recherche sur la gestion agroforestière et la mise en valeur de fumier est basée, dans chaque cas, sur les types de sol et sur les zones agro-écologiques en question, mais pas forcément sur les cultures. Et pourtant, des technologies ont été appliquées avec succès à toutes les cultures dans une même zone. Quelles sont, donc, les technologies qu'on pourrait diffuser dans chaque zone agro-écologique?

- Dans la région semi-aride, l'ISRA semble être l'organisme qui mène le plus de recherches sur l'agrosylviculture et sur le compost, telles qu'elles s'appliquent à la fertilité du sol. L'ISRA a adopté une approche systémique de la recherche sur l'agrosylviculture, qui semble faire face efficacement aux obstacles de nature socio-économique. La recherche agroforestière a été inaugurée au Sénégal dans les années 1960, et les ensemencements en allées en zones semi-arides ont été

inaugurés près de Bambey il y a trois ans; ces deux actions réunissaient les apports coopératifs de plusieurs disciplines. (Le rapport définitif comportera un abrégé des résultats des recherches.) On nous a fait savoir que l'ICRISAT se lancera cette année dans la recherche agroforestière à Niamey, et que l'ILCA a déjà inauguré des essais d'ensemencements en allées en utilisant des espèces exotiques dans la zone sub-humide du Sénégal. De plus, les fermiers participant au projet USAID/Mali OHV emploient des engrais minéraux pour compléter un système amélioré de mise en valeur de fumier.

- On mène depuis vingt ans des recherches et des actions de diffusion en matière d'engrais minéraux dans la région semi-aride. Jusqu'à ce jour, la diffusion des ces engrais est la plus répandue dans les zones des cultures de rente (coton et arachides), tandis qu'on n'en fait qu'un usage restreint dans les cultures de sorgho et de mil. Des données de recherche provenant du Burkina Faso indiquent que les engrais minéraux en combinaison avec la pratique de banquettes reliées (en vue du captage des eaux) a entraîné une réduction des risques associés à ces engrais, ainsi qu'une efficacité augmentée.

Recommandation. Soutenir en tant que priorité les recherches sur l'agro-foresterie et la mise en valeur du fumier, afin de trouver les réponses aux questions posées ci-dessus. Soutenir la recherche sur les engrais minéraux dans la mesure ou elle complète les recherche sur l'agro-foresterie et la mise en valeur du fumier, en établissant la relation entre cette recherche et celle portant sur la conservation des eaux, y compris des techniques telles que les diguettes reliées. Mener ces recherches au moyen d'une approche systémique intégrée, comme les mène l'ISRA. On devrait encourager la coopération parmi les secteurs agriculture, sylviculture et élevage, en créant des équipes polyvalentes d'assistance technique, entre autres. Etant donné que les résultats des recherches peuvent s'appliquer à de grandes zones agro-écologiques, les missions de l'AID devraient se communiquer entre elles les résultats obtenus dans chaque pays.

Conservation des sols et des eaux

Comme il a été indiqué ci-dessus, figurent parmi les techniques de conservation des sols et des eaux efficaces, les banquettes en courbe de niveau, les captages d'eau, les brise-vent et le labourage en arrière saison. D'après les observations faites dans cette évaluation, les priorités de recherche comprennent:

- Banquettes en courbe de niveau. Premièrement, ces banquettes ne se sont pas avérées efficaces dans des sols sableux. La

recherche sur la mise en valeur des haies vives appuierait donc la conservation dans ces sols plus légers. Deuxièmement, on s'est demandé si le captage d'eau épuiserait ou non l'approvisionnement en substances nutritives dans la couche arable. Cette question devrait faire l'objet de recherches.

- Labourage en arrière-saison. Certains fermiers habitant la zone sub-humide de la Troisième Région du Mali labourent sur les déchets des récoltes avant la dernière pluie. Ils croyaient que, en adoptant cette pratique, des quantités augmentées d'eau seraient retenues dans le sol jusqu'à la prochaine saison des cultures, croyance qui était soutenue par la recherche menée par C. Charreau au Sénégal. On devrait quantifier cette recherche, car, si ces résultats sont vérifiés et qu'ils s'avèrent économiquement réalisables, ils méritent d'être développés et diffusés.

- Brise-vent. A ce qu'on prétend, des recherches menées par l'ISRA au Sénégal suggèrent qu'il faudrait résoudre les questions relevant de la politique en matière de la jouissance, avant qu'il ne se produise un taux d'acceptation augmenté de brise-vent. C'est actuellement sur le plan Départemental qu'on apporte des solutions aux questions soulevées par la jouissance des arbres dans la Vallée de la Majjia. Il se peut qu'on en tire des leçons à appliquer partout dans les zones.

Gestion de la végétation.

Il y a une forte accumulation de preuves qui suggère qu'une gestion améliorée de la végétation existante en vue de la production de bois et de fourrage serait plus efficace, des points de vue économique et écologique, que ne le serait l'introduction d'espèces nouvelles. En effet, l'introduction d'espèces de hauts rendements dans un système dont la gestion est mal assurée, a souvent produit des résultats médiocres. Par contre, l'aménagement des peuplements naturels en vue de la production de bois et de fourrage a réalisé des progrès importants dans le cadre du Projet de Planification et Utilisation des Sols et Forêts (PUSF) au Niger, et notamment en ce qui concerne l'estimation du volume de bois sur pied. Au Mali, on a également fait des progrès dans l'estimation du volume de fourrage contenu dans la végétation naturelle.

Les conclusions des recherches faites sur la capacité de support de la végétation naturelle serait d'une extrême importance pour l'élaboration de principes régissant la gestion des ressources locales, tels que ceux servant de fondement aux approches des terroirs villageois qu'on prévoit au Mali.

CONCLUSIONS: LE DEVELOPPEMENT SOUTENABLE DANS LE SAHEL

Ce rapport est basé sur des observations faites sur le terrain d'actions individuelles réussies. Nous avons recueilli des preuves abondantes qui supportent notre conclusion que, dans presque tous les contextes écologiques et économiques dans le Sahel, on met en oeuvre des approches isolées susceptibles de conduire à une productivité accrue et à des conditions de production plus stables au moyen de la gestion améliorée des ressources. Il s'agit, cependant, au fond, de rehausser le bien-être économique des populations habitant le Sahel, et non simplement d'améliorer l'état écologique lui-même. En d'autres termes, il s'agit de développement. Il serait erroné de conclure que, d'après la seule constatation que la gestion améliorée des ressources a créé des possibilités de développement soutenu, on pourra nécessairement s'assurer de la solidité du développement futur en mettant un accent beaucoup plus marqué sur les ressources naturelles. C'est, de certains points de vue, l'erreur relevant de la politique du développement qu'on commet à maintes reprises depuis trente ans.

En tant qu'équipe, nous entamons l'élaboration de programmes d'action en pensant qu'il faut justifier **économiquement** l'accent qu'on met sur les ressources naturelles. Partout dans notre évaluation, nous avons constaté que les bénéfices financiers qu'obtiennent les petits cultivateurs aident beaucoup à susciter leur participation. Les deux questions posées par les petits cultivateurs--savoir "Quel profit est-ce que je peux en tirer?" et "En quoi est-ce comparable à d'autres possibilités dont je pourrais profiter?"--doivent être reposées sur le plan macro-économique.

A la recherche de solutions économiques valables

Le chemin que, selon les prévisions, devait suivre le développement dans la période post-indépendance ne s'est pas ouvert pour les économies sahéliennes. Il y a eu des rendements décroissants et peu sûrs résultant des cultures de vente destinées à l'exportation. Les termes d'échange de plus en plus défavorables entre les cultures destinées à l'exportation et les principales importations ont réduit davantage les bénéfices découlant de la stratégie des cultures de rente. Au lieu de favoriser une augmentation d'exportations et une économie monétisée en pleine expansion, les conditions économiques ont donné lieu à un état de dépendance économique plus marquée, ainsi qu'à une diminution de la sécurité alimentaire, sur le plan national et dans les fermes. Quant à l'autre "force motrice de la croissance économique"--c'est-à-dire une économie urbaine stable et productive basée sur le traitement des denrées

alimentaires, l'industrie légère et un commerce en expansion--, elle a bafouillé et calé. Malgré des salaires bas et des coûts d'investissements alternatifs encore plus bas, les coûts rèels de la fabrication ont été élevés, au point d'être non-concurrentiels: des salaires exorbitants des dirigeants et personnel technique expatriés, la productivité relativement basse, les coûts d'entretien élevés et des approvisionnements en matières premières peu sûrs, en combinaison avec des prévisions trop optimistes en ce qui concerne les avantages économiques comparatifs de la fabrication, font de ce secteur une saignée à l'accroissement aussi bien qu'un facteur qui y concourt; et ce, bien qu'une part disproportionnée des investissements publics ait été historiquement affectée au développement et au maintien des infrastructures basées dans les villes.

C'est précisément parce que ces prévisions concernant le développement n'ont pas abouti, qu'on se préoccupe de nouveau de l'environnement. Certes, aucune des conclusions présentées dans ce rappport n'est nouvelle; en effet des publications qui datent de trente ou de quarante ans présentent de bons arguments en faveur de la protection du milieu avec plus d'éloquence que ne le fait cette évaluation. Quoiqu'il en soit, il semble dès à présent clair que les systèmes de production ruraux, soutenus par les petits cultivateurs, continueront de représenter la pierre angulaire du développement dans le Sahel, et qu'il sera impossible de soutenir cette production si les ressources naturelles continuent de se dégrader. **La justificaiton économique de la protection des ressources naturelles réside dans le fait que la dégradation des ressources va en rendant irréalisable la seule espérance pour une économie stable future dans le Sahel:** des systèmes de production ruraux basés sur la gestion de l'agriculture, de l'élevage et des eaux.

Quel niveau d'investissement est justifié pour protéger les ressources naturelles de base? Bien des observateurs réfléchis ont très justement exprimé leur souci que, bien que la protection des ressources soit prioritaire, les coûts budgétaires publics (assistance technique, formation, partage des coûts, etc.) sont tout simplement trop élevés pour permettre des interventions autres que quelques projets isolés, dont les impacts macro-économiques seront forcément négligeables. Leur souci est valable dans une certaine mesure; des donateurs et des gouvernements ont régulièrement mis sur pied des projets servant de "démonstrations," projets qui, même s'ils s'avèrent réussis, ne démontrent que ce que nous n'avons pas les moyens de reproduire.

On a beaucoup écrit en termes généraux afin de légitimer une mode populaire courante de pensée; par ailleurs, il est facile de fausser des analyses économiques, afin que des

conclusions basées sur la faculté du jugement paraissent irréfutables. Par exemple, d'un certain point de vue, nous pouvons tirer la conclusion suivante:

Le rythme de la dégradation du milieu est inquiétant. Il s'accelère à mesure qu'augmentent les pressions exercées par les être humains et les animaux. La pluviométrie moyenne va en baissant. Les zones agricoles se trouvant au nord de l'ancienne ligne isohyète de 700 mm sont en marge de la viabilité, même dans les années de pluies abondantes (du moins là où les pratiques traditionnelles restent en vigueur). Etant donné les récoltes en voie de décroissance et les populations croissantes, les déficits alimentaires dans les zones plus arides sont de plus en plus structurels, et non pas le résultat d'une pluviométrie exceptionnellement basse. Les coûts budgétaires publics à long terme d'une réponse aux déficits alimentaires structurels sont extrêmement élevés (expéditions urgentes de denrées alimentaires, urbanisation rapide, sous-emploi, etc.). Si les systèmes de production ruraux continuent de se désagréger, il n'y aura pratiquement rien d'autre pour combler les lacunes dans les économies sahéliennes. Donc, le bénéfice rapporté des investissements dans les ressources naturelles est potentiellement énorme; un haut niveau d'investissement dans ce secteur est non seulement justifié, mais aussi nécessaire.

Ce raisonnement, qui est logique des autres points de vue, ne prend pas en compte la dynamique de l'économie rurale. Le premier chapitre de ce rapport traite d'un "contexte en voie d'évolution rapide." Tout au long de notre évaluation, nous constations que le besoin d'innover pour faire face à de nouveaux obstacles et de nouvelles possibilités, constituait un motif plus puissant chez les fermiers et les responsables chargés de la gestion des ressources, que ne l'étaient des décisions visant la protection du milieu. Il nous incombe, donc, de récapituler les tendances sous-jacentes que nous avons pu dégager:

- Les populations locales ne sont pas encouragées à gérer ou à protéger les ressources dans l'absence de bénéfices découlant de ces actions. Là où des ressources telles que le bois et des produits forestiers sont mises en disponibilité en tant que marchandises gratuites, il est plus profitable, du point de vue financier, aux individus de les permettre de se dégrader par l'exploitation que d'affecter leurs propres ressources à leur protection. Même si des sommes importantes étaient affectées aux projets de protection des ressources, la dégradation des terroirs communautaires continuerait en toute probabilité, jusqu'à ce qu'elle se stabilise à des niveaux encore plus bas que ceux existant actuellement, pourvu, bien entendu, que la stabilisation soit encore possible.

- La simple stabilisation de la productivité agricole exigera la mise en oeuvre de mesures de gestion plus intensives sur des parcelles spécifiques de terres sous culture.

- Les prix relatifs à long terme des "facteurs de production" (terres, main-d'oeuvre et capital) sont en voie de changement. La densité démographique a augmenté, et les rendements moyens par hectare ont diminué. Par conséquent, la production agricole par personne est en voie de baisse depuis 1968. Les bénéfices résultant de la gestion intensive des terres sont, donc, potentiellement plus grands qu'ils ne l'étaient par le passé.

Nous avons trouvé très peu de preuves indiquant que les politiques publiques pouvaient déclencher des changements répandus dans les conduites des fermiers qui ne s'harmonisaient pas avec ces notions de la protection de leurs propres intérêts personnels. Mais nous avons bien constaté que, en calibrant les encouragements offerts, en fournissant des efforts de formation et de soutien, et en répartissant les coûts des risques, les actions publiques peuvent soit accélérer, soit interrompre la rapidité avec laquelle les changements positifs ont lieu.

Programmes d'action par pays

En se basant sur les faits, l'évaluation du Sahel englobant quatre pays vise à jeter les bases de l'action. Nous mettons l'accent sur les preuves telles qu'elles sont exposées dans les études de cas détaillées au Volume II. Les conclusions et les recommandations présentées dans ce Rapport principal font émerger une liste d'options répondant aux critères multiples des actions sur le terrain, qui sont valables du point de vue du développement. On fait déjà le prochain pas, qui consiste à faire usage de ces conclusions dans l'élaboration de programmes d'actions spécifiques pour chaque pays (Mali, Niger, Sénégal et La Gambie). Par définition, de tels programmes d'action ne devraient pas servir de prescriptions générales pour les actions à entreprendre dans n'importe quel cas. Bien au contraire, ils ont pour objectif de délimiter les interventions que doit entreprendre le secteur public, afin de tirer profit des possibilités spécifiques dans chaque pays. Quoique différentes, ces possibilités existent dans tout sous-secteur, comme il est indiqué dans ce rapport.

Quels en sont les coûts?

En répondant à cette question inévitable, nous devons faire entrer en compte tous les éléments dont nous avons déjà traité:

- Dans le cadre des actions menées localement (par des fermiers, des éleveurs et des responsables des ressources locales), on ne

saurait réaliser un impact répandu qu'en tirant profit d'encouragements à la gestion améliorée des ressources et au rapport accru de revenus, et ce, selon des modalités que les gouvernements ont les moyens de soutenir et de reproduire. Quoique les investissements initiaux dans les actions de démonstration risquent d'être coûteux, les approches entraînant des charges récurrentes élevées ne figureront pas, par nécessité, dans la série des solutions proprosées.

- En ce qui concerne la diversité biologique et la conservation de l'héritage écologique commun, il faudrait reconnaître que les populations rurales vivant en marge de la subsistance ne leur donnent pas la priorité. Il faudra peut-être faire des investissements publics importants avant même d'entamer des actions spécifiques. Parmi les contributions les plus importantes à faire en la matière figure la solution de conflits en zone tampon, ce qui permettrait aux populations locales de gagner leur vie en harmonie avec le milieu, et non pas en contribuant à sa dégradation. Il existe des exemples de cas précis laissant à croire que cette approche a bien marché (voir le Volume IV portant sur la biodiversité). Nous n'avons constaté aucun cas où un gouvernement donné réussissait à protéger le milieu aux dépens des populations locales, même s'il aurait voulu le faire.

- Il y a des actions qu'il vaut mieux ne pas entreprendre, par exemple des boisements situés dans les zones d'une pluviométrie inférieure à 600 mm. Les populations rurales, qui sont engagées dans une lutte pour leur propre survie, font implicitement des choix d'actions de façon à ne pas perdre du temps. Il est donc possible que les gouvernements affectent, sans bien y réfléchir, des millions de dollars et des ressources institutionnelles précieuses à des solutions qu'ont rejeté ceux qui étaient censés en tirer avantage, sans que cela leur ait rien donné.

- La modération en matière de politique publique signifie la promotion utile des actions faisables. Seul un nombre limité d'actions, parmi toutes celles mises en oeuvre depuis vingt ans, répondent au critère affirmant qu'elles doivent s'avérer valables du point de vue technique, socio-économique et financier. Et pourtant, il existe beaucoup de possibilités de décupler les niveaux courants d'apports de fonds provenant de toutes les sources, sans pour autant s'écarter des critères assez rigoureux du succès. Aussi est-il plus probable que l'avenir de la gestion des ressources naturelles coïncide avec les occasions futures du développement, qu'il ne l'est qu'il coïncide avec des luttes qu'on aurait déjà probablement perdues.

6 PRIORITES

Le succès, que nous définissons comme produisant un impact soutenu et croissant sur la protection de la production rurale de base, sera toujours relatif. Les fonds qu'on y affecte ne feront qu'un facteur parmi tous ceux qui détermineront finalement le degré de succès qu'on aura réalisé. Sans tenir compte des sommes dépensées ni du degré du succès atteint, les conséquences combinées de la sécheresse, de la dégradation des ressources et du manque de débouchés économiques, finiront par déplacer des millions de personnes dans le Sahel dans les décennies à venir. La quantité d'investissements qui pourra être absorbée dépasse celle que n'importe quel donateur à lui seul serait en état d'affecter; elle dépasse même ce que tous les donateurs et les gouvernements-hôtes pourraient raisonnablement contribuer. S'il nous fallait estimer cette somme globale, nous dirions qu'elle atteindrait son apogée à un niveau de plus de cent millions de dollars par an au Mali, au Niger et au Sénégal, et à une somme légèrement inférieure en La Gambie. L'étendue de la coordination entre donateurs, ainsi que le degré d'intégration de la gestion des ressources naturelles dans d'autres programmes de développement rural, influeront, donc, de façon cruciale sur les chances du succès.

OPPORTUNITIES FOR SUSTAINED DEVELOPMENT

Successful Natural Resources Management in the Sahel

Asif Shaikh

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VOLUME II: CASE DESCRIPTIONS

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October 1988

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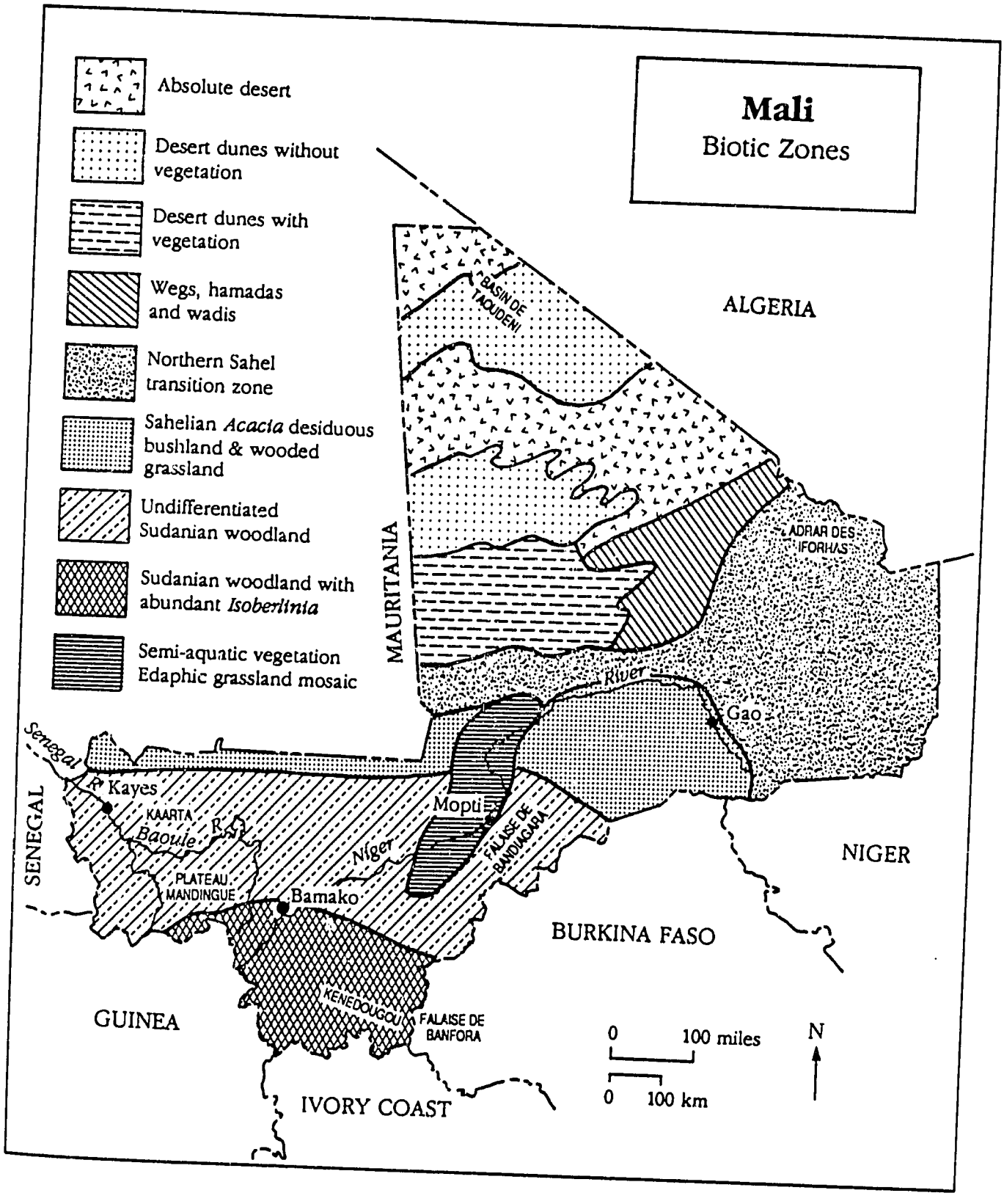
MALI


Mali
Biotic Zones
Absolute desert
Desert dunes without vegetation
Desert dunes with vegetation
Wegs, hamadas and wadis
Northern Sahel transition zone
Sahelian Acacia desiduous bushland & wooded grassland
Undifferentiated Sudanian woodland
Sudanian woodland with abundant Isoberlinia
Semi-aquatic vegetation Edaphic grassland mosaic
ALGERIA
MAURITANIA
BASIN DE TAOUDENI
ADRAR DES IFORHAS
River
Gao
Senegal
Kayes
KAARTA
Baoule
Mopti
Niger
FALAISE DE BANDIAGARA
SENEGAL
PLATEAU MANDINGUE
Bamako
NIGER
BURKINA FASO
KENEDOUGOU
FALAISE DE BANFORA
GUINEA
IVORY COAST
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0 100 km
N

WATER CONSERVATION

Village Initiated Small Cement-Rock-Earth Dam

The village of Kaban initiated the construction of two water retention dams. The water is used for human and animal consumption, washing clothes, and, to a minor degree, for gardening.

The water table as viewed from open wells in the village has noticeably risen since the construction of the dams. The dams retain storm flows and reduce the chance of channel erosion down stream. Surface water is available for longer periods of time which attracts domesticated animals as well as wildlife. The increased grazing around the dam could lead to reduced surface cover and increased erosion. The two dams directly affect approximately 15 hectares.

Background Information

Kaban is located in south central Mali, 15 km northwest of Banamba and 130 km northwest of Bamako, Mali. Kaban has received an average of around 730 mm of rainfall. The area has a renewable groundwater resource of 25,000-50,000 m3-km2/year. Water is generally unfavorable for crop irrigation but favorable for village and livestock supplies. Tube wells can yield 0.5-2.0 m3/h (TAMS, 1983).

Approximately 50% of the area is flat to very gently sloping, silty plains with deep, moderately well-drained, silty soils (Aridic Haplustalfs). These soils support a moderately dense cover of small trees and large shrubs, predominantly Acacia seyal and Ziziphus mauritania. Approximately 20% of the area is composed of gently sloping, shallow to moderately deep, well drained soils over iron stone (Aridic Cuirustalf). These soils support patchy vegetation with moderately dense thickets of large shrubs, notably Pterocarpus lucens and Combretum spp. Approximately 15% of the area is composed of level to gently sloping alluvial plains with moderately fine textured, deep, well drained soils (Aridic Haplustalfs). These soils support a moderately dense cover of trees, notably Bombax costatum. Approximately 70% of the area is suitable for non-irrigated field cropping and has a land capability class of IVc. The remaining 30% of the area has low field cropping potential with a land class of VIsc (TAMS, 1983).

Kaban's population is between 2,000 and 5,000. The land use for the area is predominantly rainfed, plain cultivation with some denuded zones to regular zone pasture. Over 60% of the land is cultivated continuously with millet, sorghum, and peanuts being the predominant crops. Other crops grown include cowpeas, bambara peas, orchards, corn, foxglove, vegetable gardening, cotton, Jamaica sorrel, and tobacco. Cattle, sheep, and goats are the major livestock animals listed in the order of importance (TAMS, 1983).

Description of Initiative

The village coordinated and funded the construction of two small dams, one 100 meter long, across a small drainageway which provides surface water for longer periods of time and is used for livestock and gardening. The dam has caused a noticeable increase in the water table as viewed from the wells. The dams could have been constructed with less expensive materials and could have been better designed with a larger protected spillway.

Catholic Mission Initiated Small Rock Dams

The Catholic Mission initiated the construction of small flood retention dams in the villages of Fakobougou and Dialacoro Ditoumou. The dams increase water infiltration into the soil which allows increased

rice production at some sites while allowing rice cultivation on land previously used for sorghum cultivation at other sites. The brief impoundment of flood water allows women to wash clothes behind the dams after storms.

The dams have caused a noticeable rise in the water table as viewed from the village wells. The dams retain the flood water for a longer period of time, reducing peak flows down stream. This reduces the chance of erosion down stream and increases the period of storm flow which results greater aquifer recharge from the stream channel. In areas were the storm water is held for longer periods of time, livestock as well as wildlife are attracted to the area. Also fish have appeared in the semi-permanent pond that has formed behind one dam. The increased water availability has reduced some of the risks of agricultural production and allowed an intensification of agriculture which utilizes human energy more efficiently. The three dams that the Team observed affect approximately 5 hectares.

Background Information

Fakobougou and Diaiacoro Ditoumou are located 50 km south-southwest of Bamako in south central Mali. The area has received an average yearly rainfall of around 1100 mm. The area has a renewable ground-water resource of 25,000-50,000 m3-km2/year. Water is generally unfavorable for crop irrigation but favorable for village and livestock supplies. Tube wells can yield 0.5-2.0 m3/h (TAMS, 1983).

Approximately 50% of the area consists of almost flat to moderately steep, gravelly, moderately deep, reddish soils over iron stone (Typic Cuirustults). These soils support a dense cover of medium trees, large shrubs, and perennial grasses, especially Isoberlinia doka and Andropogon gayanus. Approximately 20% of the area consists of gently sloping, well drained, gravelly, shallow soils over ironstone (Mollic Cuirorthents). These soils support moderately dense patches of small trees and large shrubs, such as Pterocarpus erinaceus and Lannea microcarpa (TAMS, 1983). Butyrospermum parkii (karite) trees are dying in the area.

Approximately 75% of the area is usable for field crops. Fifteen percent of the area has a land capability class of I/Ii, 10 percent with class IIse, 50% with class IIIse, and 20% with class VIIse. Local floodplain soils are called Falla with Ganga and Bele soils occurring on the uplands (TAMS, 1983).

Fakobougou's population is less than 200 (17 extended families). The land use for the area is predominantly rainfed agriculture on valley pediments with some natural submersion irrigation on floodplains and depressions. Cultivation is dispersed with 11-30% of the area cleared for cultivation. Sorghum, millet, and peanuts are the predominant crops. Other crops grown include corn, foxglove, rice, orchards, cotton, bambara peas, vegetable gardening, cowpeas, Jamaica sorrel, and tubers. Cattle, sheep, and goats are the major livestock animals listed in the order of importance (TAMS, 1983).

Description of Initiative

Fakobougou

These porous flood retention dams, initiated by the Catholic Mission, cause larger areas to be flooded for longer periods of time as occurred naturally before the general decrease in annual rainfall. The increased flooding has allowed large areas of sorghum cultivation to revert back to the more productive rice cultivation. The increased flooding has also increased the amount of water infiltrating into the soil and recharging the local aquifer. The increased aquifer recharge has increased the water level in the village well from a 6 to 9 meter yearly variation to 5 to 6 meters variation.

One of the three dams has collapsed due to poor design but their beneficial effects of these dams have captured the interest of the village and they are interested in rebuilding the broken dam and also building new ones. The broken dam was constructed in a gullied drainageway (five meters wide, two meters deep) that had existed since the villagers could remember. The dam caused floods from smaller storms to leave the incised channel and spread over the floodplain. The increased flooding was frequent enough for the farmers to, once again, grow rice. The dam, which was not constructed with a clayey core, failed due to piping which under-mined the dam and caused its collapse. One of the functioning dams crossed the drainageway where it was not gullied. This four year old flood retention dam was 70 meters long, two meters wide and one to two meters high.

It was constructed with rock gabion and earth. The village provided the labor and hauled the rock using bicycles and carts. Sixty to seventy people worked for 17 days to construct the dam and the Catholic Mission supplied the wire for the gabion baskets. The flood water flows around the ends of the dam which act as spillways and nonerosively flows back into the channel. Some of the flood water is retained and charges the soil and aquifer with water. There are no villages immediately down stream so water rights are not an issue. However, one problematic side effect of the existence of the dam is that Peul herders also water their cattle there during the dry season. This causes trampling damage to the crops and speeds up the depletion of the stored water.

Dialacoro Ditoumou

The gabion dam in this village was also initiated by the Catholic Mission. It is approximately 50 meters long, one meter high and one meter wide. This porous rock dam was constructed in the center of a relatively flat drainageway and impounds the flood water and result in it spreading over a wider area during the floods. The most popular result of the dam is the pond that is created during flooding which allows women to wash clothes. The dam also increases water infiltration into the soil which recharges the aquifer. As a result the level of the water table in the village's well has noticeably risen since the construction of the dam. The flood water is not impounded long enough to allow for expanded rice production which was widely cultivated when the annual rainfall was higher. The farmers are very much interested in constructing small dams that will allow them to increase their rice production. The design of the dam is such that during larger flood the water flows over the top of the dam which threatens to erode the soil at its base and will eventually result in the collapse and failure of the dam.

The villagers from Fakobougou and Dialacoro Ditoumou constructed the dams with technical assistance and wire for the gabion baskets provided by the Catholic Mission. The resulting rise in the water table and increased rice production has maintained the villages interests and provides them with incentive to construct more dams should technical support be provided.

Discussion of Initiative

The villagers are very interested in constructing new dams and repairing the broken one but are prevented because they do not know how to design the dams. The existing dams are not efficiently designed and reflects a general lack of technical skills available to small voluntary and non-governmental organizations trying to help the people. Proper site selection and appropriate dam design will result in more efficient use of labor, materials, and greatly decrease the chance of failure.

Operation Haute Vallee Check Dams

Background Information

Location: The Third Region of Mali.

Major Characteristics of the Location: Gently accented, forested savannah terrain cross-cut with seasonal watercourses. Most soils are thin with a high sand and/or lateritic gravel content. Receives some 800-1000 mm of rainfall annually.

Area Affected: Several thousand hectares.

Special Characteristics: In some places, check dams are already familiar to villagers, having been initiated by the White Fathers years ago.

Traditional Resource Use Pattern: Primarily rainfed agriculture on piedmonts with some natural submersion irrigation.

Nature of the Initiative: Systems of rock and earth dams in a number of areas crossed by shallow water courses.

Description of Initiative

Technical Measures Taken: In the village of Fadjibougou, 60-70 people organized themselves for 17 days to build a 70 m long, two meter high dam in accordance with technical advice from project staff. Villagers hauled the rock and earth on carts and bicycles. Construction techniques are relatively simple and all materials are local.

Social Organization of the Initiative: The large AID-financed OHV (Operation Haute Vallee) project has begun developing these dams in response to local demand. Project staff, having adopted a more interactive extension after some eight years of experience, have sought to use dam development as a point of departure for other natural resources management activities. Labor is deployed through the traditional town or age grade work organization. The work was directed by a leader of the senior town in whom villagers expressed confidence.

Economic Incentive System: Small dams provide immediate benefits, but additional dams can be added as resources and energy permit. Farmers recognize multiple benefits: improved water levels in village wells (5-6 meters, up from 6-9 meters), reduction in water lifting and hauling outlays; restoration of rice production; more reliable fruit tree production; improved animal access to water; increased fish harvests.

Socioeconomic Data: Benefits are broadly distributed to upstream landholders, women, and leaders. Effects are long lasting with proper maintenance. Demonstration has increased local awareness of dams' effectiveness, and reinforced the credibility of OHV extension workers and technicians. Success with check dams, along with other project benefits such as rural feeder roads, encourages farmers to experiment with contour bunds, composting, village woodlots and other project activities.

General Discussion of the Initiative: This case illustrates the importance of mixing short and long-term benefits in technical interventions, and project responsiveness to local needs.

SOIL CONSERVATION

DRSPR Initiated Diversion Bunds and Vegetative Bands

Division de Recherches sur les Systems de Production Rurale (DRSPR) in Fonsébougou has shown farmers how to construct diversion bunds which reduce gully erosion in their fields. Also the project is extending, with limited success, the use of vegetative bands along field boundaries in order to help reduce erosion.

These interventions help reduce soil erosion and help maintain soil fertility and productivity. The vegetative bands, in addition to providing pasture, improve water infiltration into the soil and help conserve water. Approximately 20 affected hectares were observed.

Background Information

Fonsébougou is located 40 km north west of Sikasso in southeastern Mali. The rainfall in this area has averaged around 1150 mm per year but more recently the area has received around 700 mm. The area has a renewable groundwater resource of 50,000-100,000 m3-km2/year. Water is generally unfavorable for crop irrigation for units larger than 10 hectares and moderately favorable for units less 10 hectares using hand-dug wells. The possibility for using tube wells for village and livestock supplies is favorable. Tube wells can yield over 2.0 m3/h. The depth to groundwater from the surface is under 20 meters and mostly under 10 meters (TAMS, 1983).

Approximately 45% of the area is composed of flat to gently sloping, very gravelly, very shallow, well drained soils over ironstone (Mollic Cuirorthents). These soils support thinly scattered moderately dense patches of small trees and large shrubs, especially Pterocarpus erinaceus and Lannea microcarpa. Approximately 25% of the area is composed of almost flat to moderately steep, gravelly, moderately deep, reddish soils over ironstone (Typic Cuirustults). These soils support a dense cover of medium trees, large shrubs and perennial grasses, especially Isoberlinia doka and Andropogon gayanus. Approximately 15% of the area is composed of gently sloping, deep, moderately fine textured soils (Oxic Haplustults). These soils are generally under continuous or short rotation cultivation (TAMS, 1983). A soil pit in the area exposed a 80-100 cm silt loam surface over ironstone. This silty cap is possibly a loess deposits over an old laterized soil.

Approximately 50% of the area has land adequate for field cropping. There is approximately 15 percent land with a capability class of I/II, 10% of class IIw/Id, 25% of class IIIse, and 45% of class VIIse (TAMS, 1983).

The population of Fonsébougou is between 500-1000 and is predominantly of the Fanufu ethic group. The land use for the area is predominantly rainfed agriculture on valley pediments with some natural submersion irrigation on floodplains and depressions. Cultivation is continuous with 31-60 percent of the area cleared for cultivation. Sorghum, millet, and corn are the predominant crops. Other crops grown include peanuts, foxglove, cowpeas, Bambara peas, tubers, cotton, Jamaica sorrel, rice, and orchards.

Around 45% of the farmed area is cotton and 25% is sorghum. The fallow periods of crop land are decreasing and the soils are not completely recovered by the time it is put back into production. This in addition to naturally low phosphate fertility of the soil and the decrease in rainfall has resulted in poor crop yields. Cotton yields of 1500 kg/ha have been achieved by following the fertilizer recommendations and applying 150 kg/ha of "cotton complex" (7000 F CFA) and 50 kg/ha of urea.

Cattle, sheep, and goats are the major livestock animals and are listed in the order of importance (TAMS, 1983). Peul herders are not that common in the area. The farmers have enough labor to herd their own animals.

Description of Initiative

The project was started in 1977 as a socio-economic farming systems project. Extension methods are focused to help the farmers identify problems and then choose methods to solve them.

Rock diversions are used to reduce the noticeable problem of gully erosion in the fields. They divert excess runoff from the rocky plateau and reduce water erosion in the farmers fields that occur below the plateau. Even with this success, the farmers still noticed that runoff within their fields was causing erosion problems. Diversion bunds within the field and along field boundaries were then constructed. Fifty meter spacings between diversions were used on 1-2 percent slopes. The farmers do not accept diversion bunds in their field at closer spacings. The diversions are laid out when possible on a 0.4 percent grade. The farmer dig some of the 30-50 cm tall bunds before the rains but the ground is dry and it is very hard to dig. Therefore after the first rains, but before the ground is wet enough to plant a crop, the farmer do most of their bund construction during this narrow period of time. After the crops are planted there is a large labor demand for cultivation and little bund construction is done even thought the ground is easily dug.

Grassed strips are also grown, usually at the boundary of the fields, these tend to be 2-3 meters wide. The farmers do not accept wider strips.

Discussion of Initiative

The project has good participation in the constructing of diversion bunds above the fields since the runoff from the shallow plateau soils and the resulting gully erosion in their fields is a perceived problem. However the farmers are not as eager to construct diversions and vegetative bands within their fields so most of them are constructed along field boundaries. This results in an inefficient layout and can result in erosion problems when using diversion bunds. The CMDT Erosion Control Project in the area is having similar problems with farmers not wanting the bunds to crowd their fields.

REFORESTATION

Natural Forest Management

Operation Amenagement Reboisement De Sikasso (Swiss)

Local tree species that are desired by the villagers living near the forest are planted and/or protected from weed competition in order to increase the production and value of the natural forest. Fire control measures are also initiated and supported by the project.

These interventions change the composition of the vegetative cover and produce biomass with a higher value. The vegetative cover at the site is relatively dense so that if there is increased protection of the soil from erosion it will be minimal. Less than 100 hectares of the national forest have been treated.

Background Information

Farako National Forest located in southeastern Mali near Finkolo, 10 km east of Sikasso, Mali. The rainfall in this area has averaged 1200 mm per year. The area has a renewable groundwater resource of 50,000-100,000 m3-km2/year. Water is generally unfavorable for crop irrigation for units larger than 10 hectares and moderately favorable for units less 10 hectares using hand-dug wells. The possibility for using tube wells for village and livestock supplies is favorable. Tube wells can yield over 2.0 m3/h. The depth to groundwater from the surface is under 20 meters and mostly under 10 meters (TAMS, 1983).

Approximately 30% of the area is composed of almost flat to moderately steep, gravelly, moderately deep, reddish soils over ironstone (Typic Cuirustults). These soils support a dense cover of medium trees, large shrubs and perennial grasses, especially Isoberlinia doka and Andropogon gayanus. Approximately 20% of the area is composed of steeply sloping, gravelly, shallow to moderately deep soils over sandstone with rocky and stony surfaces (Lithic Ustropepts). These soils support a moderately dense cover of large shrubs, small trees, annual and perennial grasses, especially Terminalia macroptera and Diheteropogon hagerupii. Approximately 20 percent of the area is composed of gently sloping, deep, moderately fine textured soils (Oxic Haplustults). These soils are generally under continuous or short rotation cultivation. Approximately 15% of the area is composed of flat to gently sloping, very gravelly, very shallow, well drained soils over ironstone (Mollic Cuirorthents). These soils support thinly scattered moderately dense patches of small trees and large shrubs, especially Pterocarpus erinaceus and Lannea microcarpa (TAMS, 1983).

Fifty percent of the area has soils that are appropriate for rainfed field crops. Twenty percent of the soils are of land capability class I/Ii, 30% of class IIIse, and 35% of class VIIse (TAMS, 1983).

The population of nearby Finkolo is between 1000-2000. The land use for the area is predominantly rainfed agriculture on valley pediments with some natural submersion irrigation on floodplains and depressions. Cultivation is dispersed with 11-60% of the area cleared for cultivation. Sorghum, millet, peanuts, and corn are the predominant crops. Other crops grown include cotton, cowpeas, rice, foxglove, tubers, Bambara peas, orchards, and Jamaica sorrel. Cattle, sheep, and goats are the major livestock animals and are listed in the order of importance (TAMS, 1983).

The Farako National Forest is a 15,500 hectare forest established in 1951. The forest contains most of the Swiss-funded industrial forest plantations. One thousand hectares of this classified forest are planted in the exotic species of teak, eucalyptus, and gmelina for the purpose of providing a wood reserve for Sikasso. The natural forest contains approximately 50 m3/ha of standing volume. The Swiss project in the Farako National Forest is intensively managed and is functioning well according to the workplan, but most of the activities have a research orientation and seem too intensive, costly, and complex for large scale implementation by villagers.

Description of Initiative

To determine what areas of the forest are put under natural forest management, the project uses the Natural Resource Inventory (PERT) maps of Mali to separate the soils by depth to the lateritic layer. The soils greater than one meter deep are put into plantations while soils less than one meter deep are managed as natural forest. The inventory maps are also used to design management practices and experiment in the forest.

In 1987 the project started a study in natural forest management. Within the zone designated for natural forest management (due to soil depth less than one meter) strips are cleared of competing grass cover and preferred local tree species are planted. Also, where existing preferred local species occur within these strips and if they are less than one meter tall, a 300 m2 area around these saplings is cleared to encourage their growth. The project has difficulties in germinating some of the local species.

The project discourages burning by paying villages an award if there is little burned brush around the village at the end of the dry season. The more area that has been burned the less the award is. The forest is divided into "responsibility" regions between adjacent villages. Each village is equipped with basic fire fighting equipment and is responsible for fighting fires in their region of the forest, under the direction of a project salaried and village designated leader (19,500 F CFA/month during the dry season). At the end of the season, the village receives payment for the surface areas in their responsibility region not burned, according to the following schedule:

% of surface area not burned	F CFA Payment
100 %	50,000
90 %	40,000
80 %	30,000
70 %	20,000
60 %	10,000
50 %	- 0 -

Source: Amadou Diallo, Swiss Forestry Project

Other than the project using local labor, the villagers are excluded from the management of the forest. The villagers, however, can obtain permits to cut and harvest forest products in the National Forest.

The project pays village laborers 650 F CFA per day or per 600 m2 for weeding. One person can weed 600 m2 in three hours. Some weed as many as three 600 m2 parcels in one day and receive nearly 2,000 F CFA per day for his work. Clearing firebreaks takes approximately 17 person days per hectare and costs 650 F CFA per person day.

Discussion of Initiative

This project originally started with a main focus to develop plantations of exotic species but as it became apparent that this approach was not economical the project switched more of its efforts to community forestry, research, and natural forest management. Large scale replication in the field of the projects activities would be difficult, if not impossible. The Swiss project is well managed and is functioning well according to the workplan, but none of the activities are developed and undertaken with the ultimate objective of achieving replication in the field on a large scale. The activities are far too intensive, too costly, and too complex to be implemented in the field by the villagers. Its natural forest management efforts are just starting but in time should provide information for developing management techniques that are appropriate to this vegetation and climatic zone.

Collective Village Nurseries in the Sikasso Region

The Forest Service and the Swiss project based in Sikasso advises villagers to establish nurseries and furnish free seedlings for the village reforestation efforts. All of the work carried on in the nursery is done subject to the advice and approval of the Forest Service agents. Seeds are given to the nurseries by the Forest Service. The seeds are germinated directly in beds, from where the seedlings will be transplanted, bare-rooted.

Village of Natie

The population of Natie is between 500-1000. The land use for the area is predominantly rainfed agriculture on valley pediments with some natural submersion irrigation on floodplains and depressions. Cultivation is dispersed with 1-10% of the area cleared for cultivation. Sorghum, millet, and corn are the predominant crops. Other crops grown include peanuts, cowpeas, cotton, Jamaica sorrel, rice, tubers, and orchards. Cattle, sheep, and goats are the major livestock animals and are listed in the order of importance (TAMS, 1983).

The people in this area have a land classification system with Ley soil occurring in the floodplains and Bele soils occurring on the lateritic slopes next to the floodplain.

One older village member was made responsible for the operation and maintenance of this nursery. He is not compensated for his work other than through being released from working on other communal projects. The farmer said that the Forest Service gave him the idea for the nursery. The trees are given free to the people of the village to plant where ever they want. Trees would be sold to others outside the village if the demand is there.

The site the farmer selected for the nursery is on the edge of his rice and dry-season garden field. The lower half of the 20-30 m2 nursery floods for 4-5 hours during storms. The water table is one meter deep and boys were using both surface water from the small stream and water collected in shallow pits. The farmer was growing unpotted gmelina (10-15 cm tall), neem (40-80 cm tall), and teak (30-50 cm tall) in raised beds which is the method the farmers in Mali use in growing garden crops.

This private village nursery operation illustrates a typical villager response to outside authority. Even though this authority comes in the form of government advice it is authority nevertheless and very little dialogue between the advisor and the farmer occurs. Based on several conversations with villagers, the communication between the forestry agent and the villagers is one way only. The agent has all the technical knowledge and he tells what to do, when and how to do it.

Also refer to Case Example, the Swiss Forestry Project in the Third Region for additional discussion.

Village Tree Plantations in the Sikasso Region

Village tree plantations in the region around Sikasso are supported by the Forest Service and the Swiss project. Gmelina, teak, and eucalyptus are the species planted.

Village of Ifola

The rainfall in this area has averaged 1200 mm per year. The population of Ifola is between 500-1000. The land-use for the area is predominantly rainfed agriculture on valley pediments with some natural submersion irrigation on floodplains and depressions. Cultivation is dispersed with 1-10% of the area cleared for cultivation.

Sorghum, millet, and corn are the predominant crops. Other crops grown include peanuts, cowpeas, cotton, Jamaica sorrel, rice, tubers, and orchards. Cattle, sheep, and goats are the major livestock animals and are listed in the order of importance (TAMS, 1983).

The two hectare tree plantation consisted of 3 to 4 year old gmelina, teak, and eucalyptus trees. The tree spacings is 3 by 3 meters. Plowing is done between the trees as well as around the plantation in order to form a 10 meter wide fire break. Plowing was done in the direction of the slope and the resulting gully erosion occurred where furrows intercepted runoff from the road and small drainageways.

At another site one individual in Ifola had approached the Forest Service for technical advice on how to plant trees, which species to plant, and at what density. He was advised to plant gmelina, eucalyptus, teak and mango trees. He planted all of these species in the recommended spacing density four years ago and is now waiting for advice on what to do next. The trees have reached merchantable pole size long ago.

Ziworodougou

The rainfall in this area has averaged 1200 mm per year. The population of Ziworodougou is between 200-500. The land use for the area is predominantly rainfed agriculture on valley pediments with some natural submersion irrigation on floodplains and depressions. Cultivation is dispersed with 1-10% of the area cleared for cultivation. Sorghum, millet, and corn are the predominant crops. Other crops grown include peanuts, cowpeas, cotton, Jamaica sorrel, rice, tubers, and orchards. Cattle, sheep, and goats are the major livestock animals and are listed in the order of importance (TAMS, 1983).

The village collectively decided to plant gmelina, eucalyptus and cashew trees on the persuasive advice of a wealthy member of the village now living in Dakar. Farmers are growing plantations of gmelina for poles and wood for matches. One farmer interviewed was not interested in planting and growing local species since a sufficient supply existed in the area. Contour plowing or other soil and water conservation practice are not used. The cultivated soils in this area form a weak crust and could result in sheet and gully erosion on all but the mild slopes if soil conservation methods are not used.

The villagers in the project area are in need of more technical advice and better management techniques, however, the enforcement role that Forest Agents fill does not lead to a successful extension programs. Also, the lack of total control that the farmer has over the management of his tree crop as he or she would have over agricultural crops greatly impedes the development of village and individual plantations in Mali. Refer to Case Example, the Swiss Forestry Project in the Third Region for further discussion.

Angel Togo
Private Initiative for Intensified Resource Management

Location: Village of Pelesoko, four hectare fields of Angel Togo located in the flood plains (Yame) between Mopti and Bandiagara.

Problem Addressed

Most farmers in the zone grow millet on average plots of 4-6 hectares per family. In recent years, rainfall has declined, with some years of severe drought. This is a major transhumance area. Land is scarce, as is competition for resources between farmers and herders. Fallow periods have decreased and in some cases agricultural land is kept in continuous production.

Land degradation is widely evident. Millet yields have been so low in recent years that most farmers are unable to meet subsistence needs through rainfall agriculture.

Background

Angel Togo is a 55 year old veteran of the French Army, for whom he served in Indochina, and travelled widely as a soldier. He speaks French but is not literate. He has a wife and two older sons, both of whom are in school. Through military pay and retirement benefits, he has had some cash income for much of his later life.

He says that through his travels he noted that other places had more trees than in his region and decided he should have more. When he retired in 1982, he obtained eucalyptus seedlings from the Service des Eaux et Forets and planted them. His motivation appears to have been a combination of cultural (via his travels), esthetic and economic. He specifically mentioned the desire to break out of the cycle of diminishing millet yields, to lower the workload in his old age and to have something more than barren fields to pass on to his sons.

Specific Interventions

Since 1982, Angel Togo has planted 3000 eucalyptus trees on his four hectares. He began with a few dozen seedlings obtained free from Eaux et Forets, and has increased plantings every year since. The trees are planted in windbreaks, as borders around the fields and in other locations at his pleasure. He uses nearby streams to water seedlings during establishment, and has recently dug a well. In addition to eucalyptus, he has planted guava, tamarind and other species for products which can be marketed. He has a variety of garden crops and also grows millet to meet the needs of this small family. For new species and initiatives, he receives both advice and free seedlings from forestry agents.

In areas used for millet, he has both planted and protected the natural regeneration of Acacia albida. His millet yields appeared substantially better than surrounding fields, and several of his neighbors present commented that his yields were better than most. Mr. Togo has planted live fencing around many of his garden crops, which he said were for protection and to hold the soil. When asked about the Tamaring tree, which will not bear fruit for twenty years, he replied that it was for his sons.

He lives in the village (a few hundred meters from his land) and maintains a small nursery on his roof. Except for new species, he produces his own seedlings. Seedlings are gown in plastic (from Eaux et Forets), in calabashes and in earthen pots.

Sociopolitical Considerations

By tradition, the land is his, but he has no legal title. His improvements to the site have increased his sense of property ownership. By law, in order to harvest wood from the trees, he still requires a "free permit" from Eaux et Forets, which he has always been able to obtain. He does not require one for each cutting, but either seasonally or on a one time basis.

Mr. Togo's land has attracted a great deal of attention from neighbors and from visitors, the interest of each tending to reinforce that of the others. His fields stand apart from the relatively barren surrounding landscape. He, his neighbors and the local agents say that herders seldom move across his land, thinking of it as "private property" different from surrounding fields. He says he is very vigilant on this point.

He is now well known in the village, and in surrounding ones. His immediate neighbor, Abdulahi Traore, was present at the interview and said after seeing the eucalyptus growing he obtained seedlings from Angel Togo and planted them three years ago. He pointed to his fields where several hundred trees of about 7-10 meters each were visible.

Word of his success seems to have spread quickly. In the last three years, farmers from four villages have come to ask him for eucalyptus seedlings. When he has them, he gives them for free. He has provided

approximately one hundred farmers with 5-15 seedlings each to date. The idea of establishing commercial nursery operations was discussed, but was of little interest to him. He appeared pleased with the respect that his free distribution of seedlings had brought from his neighbors, and didn't think they could afford to pay.

Mr. Togo has made a transition from subsistence farming into production for cash. While he has participated in the cash economy for years (military service), other subsistence farmers appear to be attracted by the cash benefits and "counter cyclical" nature of his operations (as evidenced by the strong demand for eucalyptus, which produces poles which can be marketed even when subsistence crops do poorly). At present, Mr. Togo is the only farmer to actually have marketed large numbers of poles. Others are either using the poles themselves (saving cash outlays), are not yet ready for harvesting, or operate on a smaller scale.

Economic Considerations

Mr. Togo is in his late fifties. His school-age sons do not now work on the land. He employs, seasonally, up to four workers at 400 CFA francs per day, plus food, each.

After three years, a eucalyptus can be harvested and the pole sold for 1000 francs. After the first harvest, one year's regeneration yields a smaller pole with a market value of 500 francs. Poles are shipped to market in a hand-drawn cart (which he owns) in about one-and-a-half hours (one way). One to two workers can take four or five poles per trip.

Approximately thirty seedlings can be planted in one person-day of effort. Mr. Togo does not use any of the trees he plants for firewood, which he appears to obtain either traditionally or for cash.

Within the next few years, he plans to build plantings to a total of 5000 eucalyptus, and to increase his already substantial Acacia albida, live fencing, garden crops and other tree species. In discussion, he cited the following benefits he expects:

- Poles provide a stream of cash income independent of rainfall. He expects prices to rise in the long run, and is already a factor in local market supply.
- Increased yields for millet from windbreaks and Acacia albida plantings, with sufficient production in most years to meet all or most of his family's food needs.
- Marketable garden crops, fruit, fodder and other by-products, which can also serve as a supplement to his own needs.
- Capital formation. He was very sanguine on this point: He and his wife are both getting old, and he wants to be able to live without have to work degrading land. He wants his sons to have benefits from the land without being at its mercy.

It is noteworthy that through his eucalyptus plantings to date, he has created a standing volume of poles with a market value of 3,000,000 CFA francs (3,000 trees @ 1,000 francs each). If he achieves his goal of 5,000 eucalyptus, and with expected increases in the real price of poles, he will have formed new capital in the order of 5 to 7 million francs ($16,000 to $23,000) from the eucalyptus alone. The value of windbreaks, garden crops, a well, in-field plantings of Acacia albida and other improvements, could well increase that figure by 50%.

Economy Summary

Three points are to be noted:

- Rainfed agriculture in the zone is increasingly difficult. The water table, however, is relatively high. Mastery of water resources (la maitrise de l'eau) is a key ingredient in this particular case. Necessity, exposure to new ideas, willingness to innovate, an appreciation of the role of capital investment plus a web of unique individual characteristics have accounted for Angel Togo's success. That success has created a model which one hundred farmers, most of whom do not share his background, have followed in some measure.

- Counter-cyclical production (marketable products not directly dependent on rainfall), diversification (garden crops, poles, fruit, millet, forage) and cash income appear to (a) be useful farmer strategies for risk management in the zone and (b) have appeal to a large number of farmers, amongst whom there is a widely held perception that millet farming may no longer be sustainable.

- The economic concept of capital formation is directly linked, in this case, to soil protection and enhancement of the productive capacity of the land. In this instance, neither can be separated from counter-cyclicality, diversification and cash incomes.

Sustainability and Replicability

Based on a very brief visit and interviews, and given the background knowledge on the soils and environment, the team believes that this example has increased sustainability of productive land-use and water management, nutrient cycling, biological diversity and economic activity. Soil protection, erosion control, financial viability have all clearly been enhanced. Continued access to water and access to commercial markets may both limit sustainability if others pursue the same strategy in large numbers. The "strategy", however, is not limited to a specific package of technical interventions, and may itself evolve with changing physical and economic circumstances.

If Angel Togo can serve as a "model", it is only on a localized basis. Critical is the access to water, and the soil conditions under which the first trees took root and flourished. That he is a local model is already established. The team estimates that between 5,000-10,000 farmers may reasonably draw from his specific technical interventions. The socio-economic ground he has broken has wider applicability, and innovative farmers in other zones are already breaking similar ground with wholly different technical approaches more suited to their environment. Few farmers are likely to duplicate that absolute level of success he has achieved, however.

SOIL FERTILITY IMPROVEMENT

Compost Pits

The construction of compost pits for demonstration and research purposes have been initiated by several organizations throughout Mali. USAID's Operation Haute Vallée (OHV) project in Dialacoro-Djitoumou, the Dutch Division de Recherches sur les Système de Production Rurale (DRSPR) in Fonsébougou, and the Cinzana Research Station near Segou are examples of compost pit sites.

The composting pits located next to corrals provide a means of collecting and processing animal and crop wastes which can be used as fertilizer and to increase the soil organic matter. Each pit, roughly 2 x 5 x 1 meters, can supply up to 10 tons of excellent organic fertilizer per year. Villagers in Dialacoro-Djitoumou constructed fourteen isolated pits and ten pits located next to corrals were dug and are used as demonstrations in the area. OHV advise the farmers to apply 5-10 tons/ha-yr of the composted material to millet and sorghum and 10-20 ton/ha-yr to corn and cotton.

DRSPR also promotes the use of organic fertilizer through the use of compost pits. The project has established one six-ton capacity demonstration pit in Fonsébougou. The result from one test on a cotton field in the area indicated that approximately four tons per hectare of compost produced a slightly higher cotton yield than the yields obtained using chemical fertilizer.

On a regional level the impact of compost pits at this time is minimal, however, it provides an excellent source of fertilizer and organic matter for farmers that own livestock. This intervention is more likely to have an impact on cash crop production than cereal crops. The Cinzana Research Station near Segou is beginning research on the fertilizer value of the compost from several pit systems. Research and field trial results are forthcoming and will provide better information on which to evaluate the value of composting.

Risk Avoidance in Crop/Fertilizer Association

Ziworodougou, Mali

The farmer interviewed in this village said that the reason he uses credit to purchase fertilizer for his cotton crop but not for his millet and sorghum is that the millet and sorghum crops are more risky. This is due to their determinant growth which results in the seasons production being largely dependent on the one brief period of flowering and grain filling. Cotton on the other hand is indeterminate and flowers and produces cotton throughout the growing season. This reduces the risk that any one drought period during the growing season will threaten the season's crop.

Bere Younou, Private Gardener

Location: Immediately across river from Djene. One hectare commercial garden of Bere Younou, plus adjacent lowland of same size being brought under cultivation.

Problems Addressed

The site of Bere Younou's garden was a highly degraded area which had been abandoned as unusable for agriculture. In some places only mottled clay is left. Other areas are dominated by clayey silt. The structure is blocky and given to water-logging as seen in the mottled soil.

There is a strong demand for garden cops in Djene, and the ready access to above ground water and the high water table (1 meter) make the site appropriate to the opportunities Younou is hoping to seize.

Background

Younou is a traditional mason of low to middle income, approximately 45 years old and with a large family. As a mason, he is involved in the cash economy, and is described as having "travelled widely." He is the one contracted by the VRP to produce well linings, and access to both the skills and income from this appear to have contributed to his strategy for improving this degraded plot.

Through an administrative permit, he obtained rights to use the plot from its "customary owners" in 1985. Neither those owners nor the administration saw any potential value in the land at that time.

When he began work, he was described as "crazy" by his neighbors.

Specific Interventions

The small plot sits next to the river and is less than 70 meters across the water from the heart of Djene town. The cultivated plot is enclosed by chicken wire and some live fencing (sisal). The second plot is not enclosed.

There are three hand-dug wells on the plot, each with a lining of his own manufacture.

Since 1985, he has established orchard trees (grenadinier, mango, citrus, papaya, banana, cashew, vitex, tamarind and guava), market annuals (melons, peppers, hibiscus, peanuts, sweet potato), and sorghum.

He brought in grafted mangoes from Koutiala and first saw the use of sisal for living hedges in Sikasso. On the same plot, he operates a mini-nursery. He raises both guava seedlings and sisal, which he gives away free. His workers collect manure from surrounding areas and transport it in by cart. There are two "diguettes" which run the length of the field.

He has asked the forestry service for assistance on soil conservation and living hedges. He has received these, plus other technical advice, seedlings and frequent visits, which have added to the "prestige" and visibility of his efforts.

Socio-Political Considerations

Younou employs three to four workers for his garden on a seasonal basis, plus one "gardien" who lives there. They are drifters -- young men who have come to Djene with no means of livelihood -- and get food and housing in return for their labor.

The forestry agents said he had little trouble obtaining rights to the land because it was degraded. One of his neighbors is copying his garden on a plot immediately behind his. The agents felt that it might be difficult to get land rights in the future if Younou is successful because the perception of the land's potential may change. They did not, however, feel that land tenure (he only has usufruct rights) would be a problem for him because of the improvements he has made. The garden has high visibility, being very close to town, and has attracted attention from residents.

Economic Considerations

Virtually all of his crops have strong cash demand. Whether by accident of design, they are distributed so as to generate cash income throughout the year. Except for the annuals, he has not yet harvested from most of his plantings. The cash income potential appears to be high.

Labor is housed on site at no cost. Food costs are probably 200 francs a day. Hand dug wells are estimated to cost four to six days labor (at 400-500 francs/day). Lining costs were estimated by agents at 200,000 CFA, but others estimated them at half that. Both because of the very high water table (1 meter) and because Younou makes the linings himself, his cost is probably much lower.

The clear economic motivation is cash, and economics appear to be the driving force behind the garden. While restoring the soil and bringing it into production, Younous has also added substantial capital value through his improvements (we estimate between 300,000 and 600,000 CFA). His second plot, now being brought into production, suggests a desire to expand operations once initial gains are consolidated.

BIODIVERSITY IMPROVEMENT

Sacred Woods

Sacred woods occur throughout the savanna region of southern Mali. These groves of trees are protected by the neighboring villages from any type of human exploitation, however, villagers as well as livestock are free to enter the area. In addition to the religious significance, sacred woods are also storehouses of environmental and ecological information. It functions as an arboretum that contains tree and other vegetation that are rare or extinct in the area.

In Fonsébougou, a village composed of the Fanufu ethic group, there are several sacred thicket in the area. One has a gallery forest and tree species that are rare for the area.

In Dialacoro Djitoumou, a half hectare area has been protected at least as far back as 1817. This particular sacred woods contains at least one species of tree (Miegon) that has become rare in the region around the village. This village appoints a person that is responsible for the protection of the wooded thicket although this seems more for status than the actual need to prevent villagers from exploiting the wooded area.

ORGANIZATIONAL IMPROVEMENT

USAID's Operation Haute Vallee (OHV)

The OHV project is a $20 million, 10-year effort designed to promote integrated rural development primarily in the 2nd region of Mali. The current USAID intent is to design an $11.5 million Phase II of the project including an expansion of the project impact area. The present impact area has a population of approximately 450,000 people and 939 villages. The region is divided into six large sectors which are subdivided into 27 Rural Expansion Zones which are further subdivided into 130 Sectors. Each of the 130 Sectors have field extension and training agents.

The major activities of the project are:

- Credit system to village associations (55%) and individuals (45%) for cash crop farming--loans given for fertilizer and agricultural equipment.
- Provision of animal traction systems.
- Rural roads and roadside tree planting.
- Extension and training of village farmers.

Activities planned for the future include:

- Diffusion of improved clay wood stoves.
- Reforestation and enrichment planting in the natural forests.
- Improved bush fire control.
- Green belts.

The OHV project appears to be doing all the "right things" (diversion bunds, contour line plowing, windbreaks, small water catchment dams, and grass roots extension and training) as far as reducing deforestation, increasing biological diversity and fighting desertification. The activities of the project focus on reducing the pressure on the fragile natural resource base and are carried out for the local people with their solicited and welcomed participation. The project addresses natural resource problems and concerns, not through preventing people from exploiting the resources in order to conserve them, but through local participation in promoting better stewardship over scarce natural resources. The evident success of this pragmatic approach, with which the team concurs, demonstrates that natural resource concerns, problems and solutions cannot be divorced from the people whose literal survival depends directly on the right to exploit these resources.

The environmental protection activities observed in the OHV impact area were not farmer or self initiated. The ideas always first came from some external source such as the OHV project, the Catholic Mission, and/or from non-governmental organizations in the area. However, once the farmers are exposed to an idea and have received some training, the interventions spread among the people. The villagers mobilize collectively or individually to carry out work, often with little or no additional external support.

The project offers extension and training in the forms of: mass media (radio, TV, etc.); groups (small groups of 6 - 15 villagers trained by extension agents); individual contacts between the project extension agents and the farmers in the field; and demonstration (model site) plots. Several technical "how-to" course modules have been developed according to the needs observed in the field. All of the courses have been taught in the field and, according to OHV representatives, the spread effect has been quite substantial. The following are course modules:

- Soil conservation techniques such as diversion bunds, micro-catchments, dams, contour planting, etc.
- Preparation and use of chemical and organic fertilizer.
- Improved planting density for agricultural crops.
- Chemical pest control.
- Seed and crop storage and preservation.
- Seed production and the introduction of improved seeds and crop varieties.
- Improved wood stoves.

The training programs occur at three levels: the training of field agents; training of selected villagers; and retraining of the selected villagers. The field agents are salaried government employees and are trained at the Poly-Technical Institute in Katibougou. Groups of 6 to 15 farmers are selected by the village and receive one full day of field training by the field agents. The training is optimally timed to minimize the time between the training and the techniques application in the field. The follow-up visit by the field agents ensures that the techniques are properly applied and appears to have the most durable impact. The ultimate goal is to have selected groups of farmers provide examples of improved techniques which will eventually spread among the rest of the villagers.

The most important aspect of the OHV training and extension program is the recognition of the importance of grass-roots level training. There may be problems with how the training is conducted and whether the techniques offered are the most appropriate, but they are resolvable and of secondary importance to recognizing that extension training is vital.

The interventions extended to the farmers do not require investments of any significant magnitude. The focus of the project is to use local resources and labor as much as possible. The economic and financial implications of practicing improved soil conservation techniques on the cost side, for example, are practically nil whereas the direct benefits may be very attractive.

An example of OHV activities is the introduction of improved varieties of sorghum and cotton. Improved cotton varieties can be obtained through the project credit system, however, the improved sorghum varieties cannot. Farmers take advantage of the guaranteed market and credit system for cash crop by using the credit for fertilizer and equipment. The lower risk of total crop failure associated with the indeterminate growth of cotton, the increased yield obtained through fertilization, and the guaranteed market provides the farmer enough incentive to purchase fertilizer on credit. The residual effect of the fertilizers also benefit their grain crops. Millet yields, for example, have doubled in many areas (from 750 to 1,500 kg per hectare) because of the projects extension efforts and the residual fertilizer from the previous year's cotton crop.

Government of Mali Decree to Use Improved Wood Stoves

Partly as a result of the governmental decree that everyone must use improved wood stoves and because the stove design used has been accepted by the women, there has been a mass diffusion of clay stoves in the rural areas throughout Mali. The women and men indicated they are very satisfied with the stoves because of the time they save when collecting wood. Some claimed that wood consumption had been reduced by as much as 50%.

This apparent mass diffusion of improved wood stoves can be considered a major breakthrough in view of the enormous difficulties improved wood stove proponents have had in diffusing their stoves on any significant scale. Over the years there have been large investments made in stove designs and attempts at mass distribution, but with little immediate success. People have previously rejected the stoves because of a multitude of reasons: They do not perform to expectations, they are too costly, they would break and erode, or when they need replacement the people forgot how to correctly build them. The improved stoves used throughout Mali are the clay version. The stoves can be made by the women themselves in less that one day, using only clay, water, stones, and labor.

An apparent combination of persistent extension, community oriented social structure, and finally the government decree has finally resulted in wide scale acceptance of the improved stoves in Mali, which are preferred over the traditional 3-stone stove even where fuelwood supplies are relatively abundant. This is in contrast to many other improved wood stove programs throughout the Sahel which have yet to succeed in areas where fuelwood supplies are critically scarce.

Swiss Forestry Project in the Third Region

The project began in 1981 and will continue until 1989. The second phase began in 1987. The project has four components: forest classification and forest management; industrial plantation forestry; forestry education at Tabakoro Centre de Formation Pratique Forestier (CFPF); and support to the regional Forest Service in Sikasso, primarily on village reforestation efforts. Approximately 10 Peace Corps volunteers work with the project.

Forest Classification and Management

The project has identified through the collaboration of the villagers 360,000 hectares of forested land that will be reclassified to protected forest. The project used the soil, vegetation, population, cultural, and hydrology maps produced by the USAID supported PIRT project to identify potential areas within the third region that should receive protected status. Approximately 40,000 hectares in the region are already protected. The project anticipates little negative reaction from the local population about the reclassification of the forest land because few villages are located inside the soon to be protected areas. The next step for the project is to begin the management of the forest. This entails constructing a network of firebreaks, improving growing conditions in the forest, and planting selected species.

Operation Amenagement et Reboisement a Sikasso (OARS)

This industrial forest management component started in 1982 in the Farako National Forest which was given to the project to manage. The emphasis was placed on establishing a viable forestry industry including economical and financial forest production and a sawmill in Sikasso. Approximately 200 hectares of exotic species plantations (Eucalyptus camaldulensis and gmelina) were established in 3 x 3 meter spacing using mechanical techniques per year until 1986. When it was determined that growth and yield performance in the plantations was far below the levels anticipated, the project decided not to continue with the plantation component. However, intensive management of the existing 800 hectares of plantations continues. This includes mechanical and manual weeding twice a year, every year, and firebreak maintenance around the plantations. Villagers are hired and paid a daily rate (650 F CFA/day) for their work as weeders in the plantations and for other work in the forest. The project's lack of economic success in plantation forestry has resulted in placing a larger focus on natural forest management as described in Case Example, Natural Forest Management, Operation Amenagement Reboisement de Sikasso.

Forestry Education at Tabakoro
Centre de Formation Pratique Forestier (CFPF)

The project gives financial support to the school and helps with curriculum development. The objective is to train 25 agents techniques each year. Since the beginning of the project for three years, three groups of 25 students have graduated as scheduled. Now, however, 25 students graduate only every other year because the Malian government does not have the means to guarantee employment for all of the forestry agents. To make up for the reduced number of students, the project sponsors seminars for forestry agents using school facilities.

Support of the Regional Forest Service in the Sikasso Region

This village reforestation program of the project is implemented through the regional Forest Service in Sikasso. The main components are village tree nurseries and plantations. The overall objective of the program is to sensitize villagers to the importance of tree plantations and to teach people how to plant and maintain trees. The villagers choose the site, prepare the site, and plant the trees. Both during this process and afterwards they receive continuous advice from the forestry agent. The exotic species (eucalyptus, gmelina, neem, and teak) have been the only trees planted, however, the forestry agents recently have promoted the planting of several local species in the same plantation. Although the trees all belong to the villagers and are planted in their farm fields, they must still obtain permits from the Forest Service before they can harvest.

To date approximately 1,000 hectares have been reforested through this program in about 350 villages. Up until fairly recently, seedlings were produced in seven government nurseries and given away. Now seedlings are also produced in several village nurseries or are sold at subsidized prices to villages where nurseries have not been established.

A subcomponent of the village reforestation program is for the Forest Service to promote the establishment of protected village forest, 5 - 30 hectares in size, on village land. Villagers choose the sites and they work with the Forest Service agents to develop management plans. To date, nearly 30 villages have indicated an interest in participating in this program. For further description of these programs refer to Case Example on the Collective Village Nurseries in the Sikasso Region and Case Example on the Village Tree Plantations in the Sikasso Region.

There appears to be very little emphasis placed on training at the grass roots level -- i.e., in and/or for the villages. The training given to the forestry agents at the Tabakoro school is in forestry, not in extension and integrated development techniques. The advice given by the forestry agents in the field, particularly in the village reforestation component, appears to be of the top-down variety. Villagers are in essence told what to do, when, and how to do it. There have yet been no cases where villagers have said they wanted to harvest the trees (most of the planted stands now have grown beyond the ideal size for fuelwood, some trees are even beyond the ideal polewood size), and they all wait for the advice from the forestry agent. Few of the villagers have any definite idea of why they chose the exotic species they planted nor what to do with the wood once harvested. Cashew trees (Anacardium occidentale) were planted in one village because villagers had been told that the oil from the nuts could be used as a lubricant for airplane engines. What the villagers eventually plant is based more on the advice given by the forestry agents and the availability of species in the nurseries at the time, than a function of their freedom of choice.

Despite the apparent top-down approach to giving advice, there has been a spreading effect in many of the project's villages as a result of the Village Reforestation Program. As mentioned above, approximately 30 villages in the region participate in the reforestation program and a total of 1,000 hectares have been planted to date. In addition to the collective reforestation efforts, many individuals farmers have also approached the Forest Service to receive advice on how to reforest portions of their land. They want to plant trees when they see others in their village do so successfully.

Research Division of Rural Production Systems (DRSPR)

DRSPR conducts research over a wide variety of topics, several of which are similar to the topics addressed more directly in the field by the OHV project. A strong emphasis is placed on agricultural and rural development. The project has identified soil and water conservation as the major focus in its rural development and has concentrated its research efforts on improving techniques and testing their acceptance by the farmers. Research topics include soil conservation techniques, crop associations, fertilizer trials, agroforestry trials, live fences, livestock vaccinations, forage production on fallow land, and compost pits.

DRSPR is an applied research organization financed by the Dutch under the Ministry of Plan umbrella. The project began in 1977. The present funding level is eight million guilders for a period of three years. The project employs nine expatriate and several Malian professionals in several disciplines.

DRSPR works in approximately 30 villages conducting research and demonstrating new techniques. The project representatives claim that the rate of adoption of the new techniques (particularly soil conservation techniques) has been excellent. Several villages have organized themselves into associations to collectively adopt the new technologies.

Their extension and training program is different than the OHV program in that DRSPR's approach is focused on identifying appropriate research topics while the OHV extends existing packages that are appropriate to the farmers situation.

One of the objectives of the DRSPR training and extension program is to build and improve on traditional soil conservation, anti-desertification, and erosion control methods.

Very little emphasis has been placed on the economic and financial aspects of the research carried out by the project. However, an agricultural economist was only recently added to the project staff. The following are some rough estimates of time a farmer must invest in soil and water conservation techniques:

Techniques	Meters/Person Day
Diversion bunds (earth)	1.0
Diversion bunds (rocks)	1.0
Runoff channels (rocks)	1.5
Living hedges (1 m wide)	10.0
Shrub planting	20 - 25

Source: DRSPR, Oct. 1985

Cinzana Research Station (SRCVO/DRA/IER)

The research station carries out basic and applied research aimed at creating new varieties of millet and sorghum and testing their adaptability to the difficult soil and environmental growing conditions in Mali. In addition the station carries out research on crop associations, the chemical composition of organic fertilizer from compost pits under different methods of operation, and windbreaks. The station has a fully equipped soils analysis laboratory.

The research on millet and sorghum focuses on finding varieties that give stability rather than high yields. After considerable dialogue with village farmers, researchers learned that the important factor is not to get the highest yield possible, but to be assured that a crop will be available for harvest after the growing season. With the traditional varieties, there is always the risk that disease will set in, pests will attack the crop, drought sets in, or any combination of these and other factors. When any of these events occur, a large percentage of the crop, if not all, is lost. Farmers have little to fall back on if the staple crop fails. In response, the research

station has focused on developing varieties such as the 65 days "petit" millet variety that have a shorter growing season and avoid droughts that frequently occur late in the rainy season.

MISCELLANEOUS

Traditional Method to Reduce Crop Losses From Birds

Some farmers in the area around the Cinzana Research Station near Segou plant the same varieties of millet at the same time as their neighbors to reduce their crop losses from bird damage. This method of planting limits the period that an area of millet fields provide food for birds. This apparently results in the fields attracting and supporting fewer birds during harvest time. Also the crop loss that any one farmer experiences is reduced since a limited number of birds feed briefly on all the field that ripen at the same time. Coordinated plantings and harvests are becoming more difficult, especially in the more marginal rainfall zones due to the reduced rainfall and increased variability of rainfall.

Traditional Fruit Tree Management in the Sikasso Region

Some of the large native trees surrounding one of the plantations near Ifola, Mali are girdled with a machete. This is done once every few years to increase the fruit harvest. The 0.5 to 1 cm wide cut around the trunk of the tree eventually heal but a permanent swelling occurs around the trunk at the cut.

DRSPR Livestock Vaccination

The project constructed a livestock vaccination pen in 1987 and invited villagers of Fonsébougou to bring their herds in for February vaccinations of Bovis Pestis. The subsidized cost to the farmer/herders for the vaccine is 15 F CFA per head. The vaccinations are popular because they help keep the animals healthy for animal traction use. The project has 100 percent participation from the farmer/herders for all their livestock. The project hopes that vaccination pens will be replicated in other villages.

The population of Fonsébougou is between 500-1000. The rainfall in this area has averaged around 1150 mm per year however the rainfall during the previous season was around 700 mm. The land use for the area is predominantly rainfed agriculture on valley pediments with some natural submersion irrigation on floodplains and depressions. Cultivation is continuous with 31-60 percent of the area cleared for cultivation. Sorghum, millet, and corn are the predominant crops. Other crops grown include peanuts, foxglove, cowpeas, Bambara peas, tubers, cotton, Jamaica sorrel, rice, and orchards. Cattle, sheep, and goats are the major livestock animals and are listed in the order of importance (TAMS, 1983). Peul herders are not that common in the area. The farmers have enough labor to herd their own animals.

Walia Magazine

Environmental Education in Mali's Fifth Region

Background Information

Location: Mali's Fifth Region.

Major Characteristics of the Location: Walia's headquarters are in Mopti. The Fifth region has the most complex ecology in Mali because of the seasonal flooding of the Niger River into a series of vast plains and lakes. Over nine ethnic and/or linguistic groups share the area practicing distinctive economies and exploiting discrete econiches historically. In a context of environmental deterioration and economic crisis, wildlife and habitats diversity has decreased catastrophically through over-exploitation, open access rules, and/or unenforceable limited access rules.

Area Affected: Some 78,000 square kilometers.

Special Characteristics of the Initiative: Walia aims to teach improved resources management, reconciling long-term and short-term gains, as well as harmonizing rural development goals with conservation.

Nature of the Initiative: Walia is a mimeographed, illustrated magazine distributed to 25 schools in the Fifth region of Mali.

Description of Initiative

Technical Measures Taken: IUCN, Centre Canadien d'Etudes et de Cooperation (CECI), CARE-Mali, and the regional branch of the Forest Service cosponsor the magazine. Walia is published three times yearly. IUCN mimeographs and delivers the magazine to the schools since the postal system is unreliable. Its articles cover geography, wildlife, Malian environmental and health concerns, traditional stories, ecology, and natural resources issues.

Social Organization of the Initiative: Individual issues are passed around so that the 4000 copies produced for each issue and destined for a school age target group are most probably read by over 10,000 Malians. In fact, its popularity is so great that Walia is now read throughout Mali. Each issue is followed up by two day teaching visits to each school by the head of the IUCN project and her Malian counterpart/translator. Each round of visits takes three months to complete.

Socioeconomic Data: IUCN spends $40,000 annually on the project.

General Discussion of the Initiative: Walia has brought natural resources issues to the fore in the Delta region. Children often talk to their parents about ecological change. Teachers incorporate Walia into their curricula. Contests, games and projects based on the Walia material raise consciousness about natural resources matters. Similar efforts have been critical to the improved climate for preserving biodiversity in East Africa.

The "Bouna Agreement"

Background Information

Location: Mali's Inner Delta Region.

Major Characteristics of the Location: One of the few inland deltas in Africa. Rainfall averages 200-400 mm. Populations of animals, plants, and people are seasonally dense. Highly diverse ecosystem and economy traditionally.

Area Affected: Several hundred square kilometers on the Niger River.

Traditional Resource Use Practices: Complex, overlapping systems of herding, fishing, agriculture, and hunting. The rules that prevented overuse of forests and range have become clouded by rapid historical and climatic change.

Nature of the Initiative: Through several years of negotiation, employing conflict resolution techniques, the interested parties have signed an agreement on common resource use.

Description of Initiative

Technical Measures Taken: The Bouna Agreement will create a new series of common property laws to replace the current contradictory mix of local village lineage claims, rules promulgated by the Fulani Dina in the nineteenth century, French colonial law, and more recent national common property access rules.

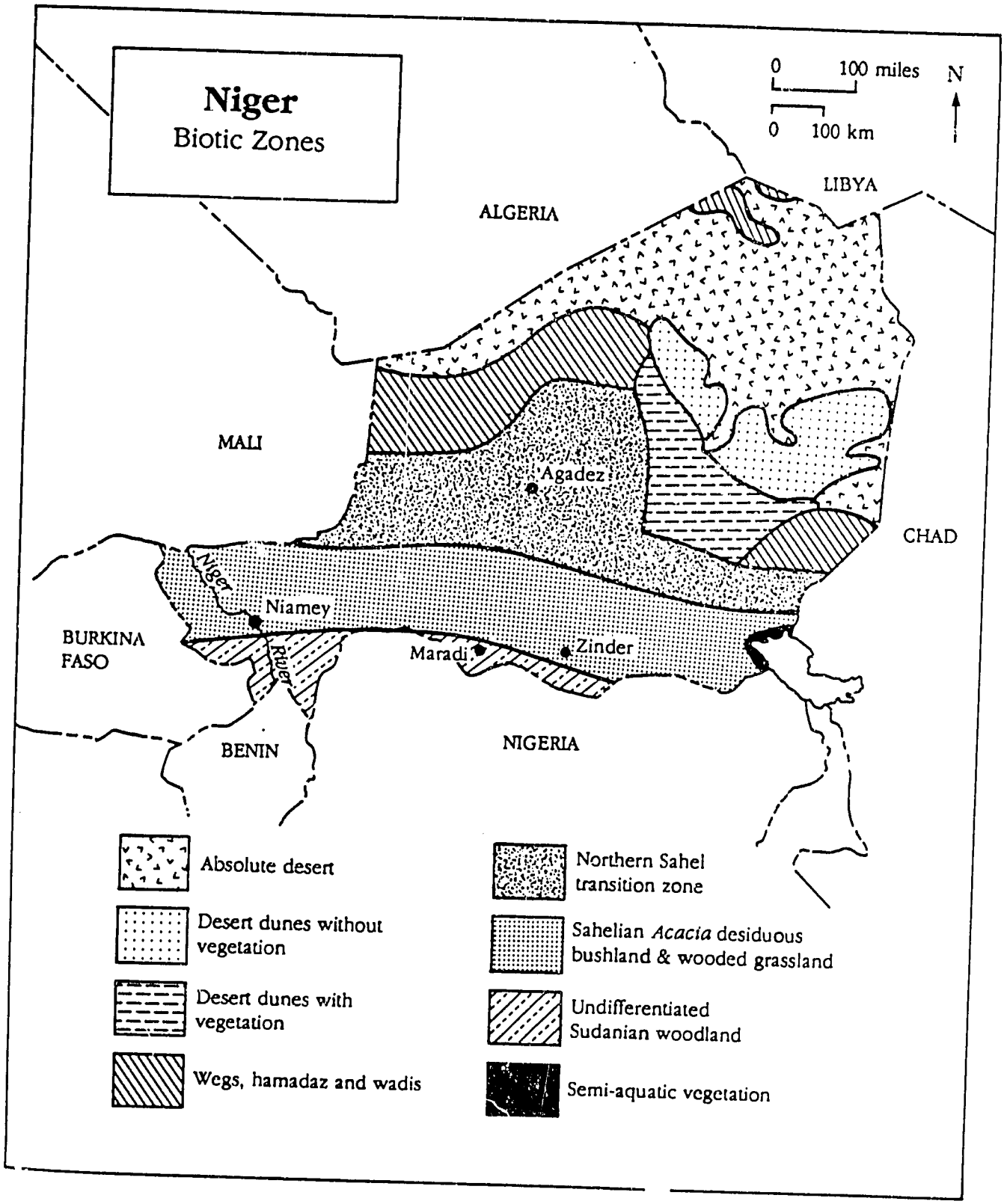
Social Organization of the Initiative: In essence, IUCN is helping goat herders, fishers, local traditional authorities, and national authorities who use a series of small, seasonally flooded forests in the Inner Delta of the Niger. The agreement: 1) vests rights of forest ownership to local villages; 2) places power of local management into the hands of the dioros and village chiefs who are the managers historically; 3) formalizes fishing rights that already exist; 4) enforces a no cutting policy of trees for enclosures or browse; 5) forbids harvesting of heron nestlings for two years; 6) restricts entry of goat herds (destructive overgrazing of the bourgou grass and trees); and 7) obtains backing for the agreement from the appropriate administrative entities of the Malian government.

Economic Incentive System: The interested parties have been shown that through proper management bird guano will increase algal growth and fish production for fisher folk; goat herders will be assured better forage and assured access to the bourgou grass in exchange for ceasing to cut Acacia tortillis, (var. kirkii) branches for enclosures and forage; farmers will have more reliable flocks of storks to help with locust control; the Mali government will fulfill its RAMSAR agreements to protect wetlands. Finally, local control will be more effective because of constant monitoring by the controllers. In January 1988, this multi-dimensional agreement still needed approval of local administrators and the Forestry Service to become fully binding.

Socioeconomic Data: The total cost of this initiative, the related Walia publication, and other Inner Delta projects is only $712,000 spread over four years.

General Discussion of the Initiative: The "Bouna Agreement" exemplifies a non-technological intervention to improve common property management, including biodiversity, through conflict resolution. It also shows how a disinterested NGO can serve as a neutral facilitator in a negotiation process. This approach to common property management is unique in the Sahel.

NIGER


Niger
Biotic Zones
0 100 miles
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N
LIBYA
ALGERIA
MALI
Agadez
CHAD
Niger
Niamey
BURKINA FASO
River
Maradi
Zinder
BENIN
NIGERIA
Absolute desert
Desert dunes without vegetation
Desert dunes with vegetation
Wegs, hamadaz and wadis
Northern Sahel transition zone
Sahelian *Acacia* desiduous bushland & wooded grassland
Undifferentiated Sudanian woodland
Semi-aquatic vegetation

WATER CONSERVATION

Swissaid Water Retention Dams for Humans and Livestock

Swissaid supported the construction of two earthen water retention dams to provide surface water for villagers and livestock throughout the rainy season and up until November or December.

The dams collect runoff from small watersheds which reduces storm flows and erosion. The dams provide surface water for livestock as well as wildlife. The dams reduce the human and animal energy need to walk long distances to obtain water. Also, livestock can be watered without having to pass through agricultural areas. Some of the impounded water infiltrates into the soil and recharges the aquifer, although the village has yet to notice a change in the village wells. These dams impound an area of 200 to 600 m2.

Background Information

Ouirihamija is located 50 km north-northeast of Tahoua in central Niger. The area is within a 250-300 mm average yearly rainfall zone with characteristically high variability in rainfall. The area has been severely degraded during the past 20 years. The plateaus and hillsides have lost nearly all vegetation and productivity. Many of the drainageways in the valley have cut deep ravines. The sites are located on the footslopes and side slopes of an escarpment capped with laterite. These soils are derived from phosphate rich limestone and have high levels of available phosphate and potassium. They are neutral to basic (pH ranges from 7 to 9) and have free carbonates present. They have silty clay to silt clay loam subsurfaces, strong structure, and a relatively high cation exchange capacity and water holding capacity. These soils are generally bare of vegetation. The slight crust formed on the surface creates a large amount of runoff water during rain storms which has caused a large degree of gully erosion in the area. The soils have strong structure.

Ouirihamija is a recently settled village of less than 200 people, with around 90% consisting of the Bouzu ethnic group and the remaining 10% consisting of Hausa, Toureg, and Peul. Twenty years ago there were no villages in the area. The people, through lack of available farm land in the south, have moved north into this region. Plentiful Calotropis procera provides fuel and construction wood for the area. The area has been used for pasture although the area is severely degraded with little tree, shrub, or perennial grass cover.

This project was initiated in 1976 by Father Roget Desbos who has been working in the village since 1967. Father Desbos took four villagers to see similar water retention dams that had been constructed in the Agadez region to the north.

Description of Initiative

In 1980, fifty villagers constructed an earth and rock dam near the village. Approximately 35 person-months of volunteer work was require to complete this dam. Water stored behind the dam provides for human and animals needs throughout the rainy season and up until November or December. The dam reduces the time needed to carry water from the wells that are located some distance from the village. Also the dam provides water for livestock and reduces the time needed by herders in the village to water their animals. Water up to three meters deep is stored in the reservoir. A earth bund diverts water from a nearby drainage way into the reservoir to supplement runoff water collected from the dams natural watershed. Another earth bund diverts excess water nonerosively from the dam's spillway to the natural drainageway. Siltation of the reservoir is a problem from the eroding bare slopes above. Immediately above the reservoir the people have constructed a series of contour rock bunds to trap the sediment. These have already completely filled with sediment. The villagers have cleaned sediment from the reservoir twice since it was constructed. The removed sediment is used to increase the size of the dam.

At another site approximately 10 km south of the village, fifteen herders over a 2 month period (approximately 300 person-days of work) constructed a rock and earth dam across a small drainageway in order to provide water for their livestock. Father Desbos initiated the dam construction and the villagers and herders provided the labor. Food-aid (approximately 500 F CFA worth of millet and dry milk per day of work) was given to them for the work they did. As in the previous case, Swissaid provided shovels and picks for construction of the dam. The herders constructed the dam in order to provide their animals water on the plateau during the rainy season. Before the dam was constructed the herders, in order to water their livestock, had to herd them several kilometer down from the plateau and into the valley. Besides taking a long time to herd their animals from the plateau to the valley, the herders risked having their animals damage farmer's fields.

This dam, although successfully collecting and storing water, has no spillway to allow excess water to escape nonerosively. Should an exceptionally large storm occur the dam could be breached and the dam destroyed by eroding flood water. A series of rock bunds were constructed across the drainageway above the dam in order to reduce sedimentation within the reservoir.

Discussion of Initiative

The demand for a water retention dam can be huge as in this case where the villagers voluntarily constructed a relatively large dam. However, the villagers and herders in Ouirihamija are not interested in constructing another one near the village since their needs for water have sufficiently been met. Water retention dams for human and animal use have much different requirements than those constructed to increase agricultural production as in the cases described in the Mali, Senegal, and the Gambia sections.

Siltation of the dams is a major problem. The watersheds in this case are completely denuded and each year eroded sediments accumulate in the reservoirs. Persuading villagers to control erosion by treating the upper watershed before the dam is constructed will require excellent extension and/or subsidies. After eight years the villagers in Ouirihamija are now well aware of the problems of siltation and know that they must do something to reduce it. The villagers have constructed sediment traps immediately above the dam but have not yet protected the entire watershed from erosion.

FLUP Initiated Water-Harvesting for Trees and Crops

Small water-harvesting catchments are constructed to increase tree seedling survival and growth on degraded shrubland in Guesselbodi National Forest. The Forest Land Use Planning Project pays laborers from nearby villages minimum wages to build the structures.

The rain that falls on the crusty soil is captured behind small bunds which allow a larger percentage of the water to infiltrate into the soil. This allows increased vegetative growth and aquifer recharge. Also the captured and impeded runoff reduces erosion on slopes and drainageways down stream from the catchments. Each water-harvesting catchment concentrates water to 5 to 25% of the catchment area.

Background Information

Guesselbodi National Forest is located 20 km east of Niamey in southwestern Niger. The site is a 10,000 ha National Forest on eroded degraded shrubland. The present annual rainfall is around 450 mm. The predominant soils of the forest occur on the nearly flat to moderately sloping plateaus and are shallow, gravelly, and occur over ironstone. These soils support thinly spaced, moderately dense thickets of small trees and large shrub, primarily of Combretum spp. Moderately deep to deep, sandy soils are of minor extent but highly productive. These soils occur at the base of the plateaus and are easily eroded.

Zarma is the predominant ethic group in the area. Some sedentary Peul also live in the area. The forest provides pasture for nearby sedentary populations as well as for the transhumant population. The forest is especially grazed during the rainy season when the surrounding fields are in crops.

The project pays laborers, usually from nearby villages, the governmental minimum wage to dig erosion control and water conservation bunds, build channel protection dams, and plant tree seedlings.

Description of Initiative

Numerous types of soil and water conservation efforts are being evaluated on the forest. These include small V-shaped water-harvesting catchments, contour bunds, and grids of earthen bunds. The V-shaped water-harvesting catchments are approximately 2 meters on an edge. Workers can dig four of these V catchments per day (approximately 2 to 3 cubic meters of earth per day) which brings the cost of each catchment to around 200 F CFA each. Contour bunds of earth and/or stone when constructed on the flat landscapes are primarily used for water retention. When they are constructed on the steeper slopes their primary purpose is for erosion control. Continuous square grids of earthen bunds, which are used capture and hold all the rainfall, were tried but considered too expensive.

Each tree that is planted behind these water conservation structures is fertilized with 40 grams of super simple phosphate at a cost of around 5 to 10 F CFA per tree. The water conservation and fertilization measures have greatly increased tree seedling survival and growth.

Experiments on the yield and spacing of sorghum and millet grown in water-harvesting catchments were conducted at the forest by a Peace Corps volunteer. They showed that during a 320 mm rain fall year yields up to 0.6 kg/m2 could be achieved on degraded, abandoned soils by using fertilizer and water-harvesting catchments. Spacing of plants seem less of a factor than site conditions. A financial analysis, based on this research, was conducted on an agroforestry system that grows Acacia senegal trees, sorghum, and cowpeas in water-harvesting catchments and it indicated that a 42% internal rate of return could be achieved on degraded abandoned soils (Sève and Tabor, 1985).

Discussion of Initiative

Water-harvesting has a bright future in agriculture and forestry for selected areas throughout the Sahel. Construction techniques for water-harvesting structures can be simple and easy to learn, they can be applied to all but the most sandy of soils, and they are most effective on crusty soils that have usually been abandoned. Water-harvesting increases the amount of water available to the plant. It reduces the period of stress on a plant due to drought by allowing small rains to saturate the soil. And it increases the length of the growing season by allowing the planting of seeds after the first rain.

Base on the FLUP experiments, millet and sorghum yields of 600 kg/ha can be expected on moderately fertile, deep soils with only 20 percent of the area planted. This agrees with 600 to 700 kg/ha yields reported by the Swissaid water-harvesting project which is in a 300 mm per year rainfall zone. The high yields achieved in the FLUP experiments also suggest that the 600 kg/ha yields can be doubled through improved site selection and preparation. Also, the research suggests that denser spacing of collection areas, where supplemental water is supplied through diversion of runoff, could provide per hectare yields approaching 3 to 4 tons.

The increased tree seedling survival and growth that results from forming water-harvesting bunds around them makes the additional cost in labor seem small compared to the cost of producing and planting the seedlings. Also, the increased growth rates caused by water-harvesting and fertilization reduces the period of time that protection from livestock is needed.

Swissaid Initiated Water-Harvesting for Crops and Trees

Swissaid helps villager in the region north of Tahoua construct water-harvesting catchments for growing crops and trees. Swissaid pays the villagers food aid for building the catchments.

The rain that falls on crusty abandoned land is captured behind the small bunds of the water-harvesting catchments. These catchments allow a larger percentage of the water to enter and be stored in the soil. This increased water storage allows increased vegetative growth and aquifer recharge. Also, the captured water and impeded runoff reduces erosion on slope and drainageway down stream. The increased vegetative cover as a result of these water-harvesting catchments helps protect the soil from splash and wind erosion. The Swissaid design concentrates the runoff from approximately 18 m2 onto 6 m2. Several hundred hectares have been treated in the area.

Background Information

Ouirihamija and Enadoujoum are Swissaid project sites located 50 km north-northeast of Tahoua in central Niger. The average annual rainfall in the area is around 300 mm. The sites chosen for water-harvesting are located on footslope soils that are derived form phosphate rich limestone and have high levels of available phosphate and potassium. These soils have silty clay to silt clay loam subsurfaces and have a relatively high cation exchange capacity and water holding capacity. They are neutral to basic (pH ranges from 7 to 9) with free carbonates present, and are generally bare of vegetation. The slight crust formed on the surface creates a large amount of runoff water during rain storms which has caused a large amount of gully erosion in the area. The soils have strong structure. The type of clay occurring in these soils expands when wet. The large cracks formed in these soils after they dry threaten to cause failure of bunds through erosion from piping if the catchment are not maintained. These areas have not been used for cultivation and are available to anyone willing to cultivate them.

Ouirihamija is a relatively recently settled village of less than 200 people, with around 90% Bouzu and the remaining 10% consisting of Hausa, Toureg, and Peul. Twenty years ago there were no villages in the area. The people through lack of available farm land in the south have moved north into the area. Plentiful Calotropis procera provides fuel and construction wood for the area.

This project was initiated in 1976 by Father Roget Desbos and financed by Swissaid. Father Desbos has been working in the village since 1967. The project started after Father Desbos took four villagers to see water-harvesting catchment work being done in the Agadez region to the north.

Description of Initiative

In 1980, Father Desbos helped the villager of Ouirihamija build their first water-harvesting catchments. They made the catchments within a half hectare fenced garden area and planted millet, cowpeas, and okra, at approximately 30 by 30 cm spacings. The water catchments are constructed by excavating an area the shape of a half circle with a radius of 2 meters. Earthen bunds are formed on the edge of the circle. These bunds have settled somewhat over the past seven years but yearly maintenance keeps them functional.

More recently Swissaid, over a two year period, has supported through food-for-work the construction of 250 hectares of half-moon shaped water catchments near the village of Enadoujoum. These catchments are constructed on unclaimed eroded barren land at the base of hills and escarpments in the area. The catchments are constructed in areas with 1-3% slopes. The villagers constructed the catchments at a density of 400 per hectare. At this density around 75% of the area is used to collect runoff and 25% of the area is cultivated in sorghum and millet. Sorghum is planted at a density of 3 pockets/m2. Millet is planted less densely, 2 pockets/m2, because of its ability to tiller. The farmers report yields of 600 to 700 kg/ha or around 0.2 to 0.3 kg/m2 of actual area planted. The farmers are extremely happy with their harvest and the edge of the village is bordered with hundreds of newly constructed graineries. Swissaid reported that a farmer in a nearby village around 20 km from Enadoujoum has constructed, on his own, a hectare of water-harvesting catchments for millet and sorghum cultivation. This was the only example in the area where construction was self-initiated.

In one area around 50% of the catchment bunds had been breached and eroded due to the large amount of runoff from an exceptionally large storm. This large percentage of failure was due to a badly designed "protective" diversion bund and failure of the farmers to properly maintain their catchments. In one area a diversion bund/ditch was dug at the base of the hill and just above the catchments in order to intercept the runoff from the completely denuded hill. The improperly designed diversion ditch has resulted in the formation

of a large gully. Also, at a point where the diversion bund intersects a small drainage channel, the storm flows have eroded a break in the bund. The flood that resulted destroyed numerous catchment bunds. The water impounded behind water-harvesting catchments was released when water from the broken diversion and the broken catchments flooded over them and resulted in massive erosion in the catchment area. Also, the laying out of catchments in straight lines on non-uniform topography resulted in poor orientation of some catchments. The failure of these catchments to hold their portion of runoff creates excessive runoff for the catchment below and often results in erosion and failure of the catchment bund.

Swissaid has supported through food aid the establishment of several village woodlots. The village of Ouirihamija has constructed several 10 ha plot of water catchments, encircled the plots with chain-linked fence made by the Swissaid supported village cooperative, and planted the catchments with trees that are provided by the Forest Service, mostly Prosopis juliflora but some local tree species as well. The survival rates of these plantations are 90 to 95%. Within 18 months these trees grow between 2 and 2.5 meters tall and provides a sharp contrast to the adjacent bare eroded slopes next to the plantation.

Swissaid helps organize the villagers so they can work communally on building the catchments and, for the village wood lots, the planting of trees. The participating villagers then divide the catchments among themselves as property. They harvest for themselves all that is produced in their catchment, trees and crops, but they are also responsible for the maintenance of the catchment.

Food-for-work is provided by Swissaid for the construction of the catchments because the families need a means of support if their able-bodied members are to forgo income that they could make by working elsewhere during the dry season.

Discussion of Initiative

The layout of the catchments at both sites are perpendicular to the predominate slope of the parcel. For areas with smooth even slopes as at the Ouirihamija site this is relatively effective. However, this method has been transferred to areas of more complex slopes and the straight line orientation of catchments result in many of them pointing the wrong direction to efficiently capture runoff. Also natural drainageways within the parcels are not often respected and results in many of the catchment bunds being eroded away. In many areas the accumulated pulse of water created by a series of bunds breaking causes massive destruction of the catchments. These cases are aggravated by improperly constructed bunds, poor maintenance, and failure to adequately protect the catchments from excessive runoff with diversion bunds.

This project illustrates how a small organization can identify a local problem, inspire a high level of local participation, and provide a means to help the farmers. However, it also shows that lack of sufficient technical skills in an organization can limit the full potential of technical interventions.

The fact that Rural Works (Genie Rural) badly designed a diversion bund indicates that this service also needs some technical upgrading. Rural Works should learn and use simple techniques when possible and teach these techniques to villagers so that they will not be dependant on outside technicians to continue the construction of water-harvesting catchments or other structures.

Keita Water-Harvesting Catchments

The Projet de Developpement Rural Integré de Keita (PDRIK) is encouraging people in the Keita Arrondissement to constructed two types of water-harvesting catchments by providing food-for-work. A contour bund type of catchment is used on the sandy plains and lateritic plateaus, and a trench type is used on the steeper sloping areas with deep soils.

Rainfall runoff is captured behind small bunds which allow a larger percentage of the rainfall to infiltrate into the soil. This allows increased vegetative growth and aquifer recharge. Also the captured and impeded runoff reduces erosion on slope and drainageway down stream. The trees provide protective cover against splash and wind erosion. The trees enrich the soil with organic matter and nutrients and provide wood products to the villagers. Spacing of the catchments are such that runoff is concentrated in a quarter to a tenth of the catchment area. Collection areas are 1.5 m2 for the trenches and 700-900 m2 for the contour bunds.

Background Information

Keita is located 100 km south-east of Tahoua in central Niger. The project area is in a 350-400 mm rainfall zone which is characterized by highly variable rainfall throughout the year and between years. The area consist of plateau soils, sideslope and footslope soils, sandy plain soils, and alluvial soils. Plateau soils which range from shallow to deep are mostly used for pasturage and forestry. Agricultural soils in the plateau areas often occur in depression and sinkholes which have accumulated deeper soils and receive supplemental water through runoff. Sideslope and footslope soils are the predominate soil in the Keita area and occur on the steep to moderate slopes below the plateau escarpment or on the outlying hills. These clayey soils have formed from phosphatic limestone and are some of the most fertile soils in Niger. Over grazing and deforestation on these soils has resulted in them appearing as barren wastelands. The valley also contains sandy plain and stable dune soils which are the predominate agricultural soils of Niger. These sandy soils are drought, and low in phosphate. The alluvial soils that occur in the area are extremely variable and can range from sandy to clayey in texture. The area has been severely degraded due to the general reduction of rainfall, overgrazing, deforestation, and expansive agriculture. The selection of this severely degraded area for the project provides a stark background to accentuate the positive results that occur.

This intervention is one aspect of a 34.8 million dollar, seven year, Italian based project which is concerned with integrated rural development of a portion of the Keita arrondissement. This project is described in more detail in Case Example, Projet de Developpement Rural Integré de Keita.

Description of Initiative

Trench types of water-harvesting catchments are dug on the hills and side slopes between the plateaus and the sandy plains in the valley. These hills and sideslopes have deep limestone derived soils with high water holding capacities, high fertility, and high pH. Using water-harvesting on these soils results in an impressive 90 to 95% tree survival rate and an amazing rate of growth especially considering that they are growing in a 300 to 350 mm rainfall zone. Local and exotic species of trees have grown 2 to 2.5 meters in only 18 months.

The trench catchments are designed and spaced so as to catch and hold all of the rainfall runoff. This results in deep percolation and the formation of moist columns for the roots to tap the water table. These trenches are approximately 3 meters long, 0.6 meters wide and 0.6 meters deep, and lines of them are spaced along the contour one meter apart at intervals of three to four meters. Between 600 to 800 are dug per hectare. These trenches are dug at an average rate of one per person-day. Men and women share this work equally.

The project uses trench water catchments as the main upper watershed treatment. They require participating villages to construct these catchments on the hills before the project helps with other conservation structures in the farmers fields.

The contour catchments are used on agricultural soils of the sandy plain and on the gently sloping soils on the plateaus. They are constructed along contour lines which are surveyed by teams using builder's levels and rods. A surveying team can layout around six hectares of contour lines per day. Three types of tractor implement are used to construct the contour bunds; ripping chisels, berm plows, and compacting rollers. Hand labor is used to remove and place rocks on the bund. The mechanically formed bunds follow the contour a distance of 60 meter. The ends of the bunds are turned up-hill from the contour for about 15 meters on the nearly flat plateaus and less on the more sloping land in the valleys. The contours catchments are spaced 30 meters apart. The bund is 40 cm high and 70 cm wide at its base.

The farmers are given super simple phosphate fertilizer for the first year after the catchment is constructed (enough for one match box per pocket of sorghum or millet) with the hope that they will purchase fertilizer for the following years. However, the farmers generally have not followed the project's wish. A reason for this may be that the rains are so variable that the farmer is only willing to put minimal inputs on these marginal soils. The 1986 harvest on the plateau was good (good rainfall year) but the 1987 harvest was poor (poor rainfall year). The less fertile, drought soils of the plateau are much more dependent on good rainfall than the deep soils in the valley.

PDRIK uses the indigenous village land control system, "le terrior villageois", when planning land rehabilitation efforts around each village. The project and the villages together decide on contiguous areas of land to be treated each year. This allows easier protection of the young trees from grazing animals, and establishes a system for rotation management where the land is protected from animals until the tree and grasses become established.

PDRIK gives food aid (approximate value of 800-1000 F CFA per person-day) to the laborers for constructing these water-harvesting catchments. Trench catchments are dug at a rate of one per person-day. The contour catchments constructed by this project cost around 250,000 to 300,000 F CFA/ha to build. The high expense is due to the use of heavy equipment and skilled labor in addition to village labor.

Discussion of Initiative

Although PDRIK's interventions are dependent on paid labor and heavy equipment other aspects of their approach is extendible to other areas of the Sahel. For example, the project requires the village to treat the upper watershed with soil and water conservation structures before structures are built in the lower watershed. Also, the project and the villages work together to agree on what rehabilitation efforts will be applied to the land. Catchments are dug and trees are planted in protectable blocks of land. The following years adjacent blocks of land are treated and protected. The trees and catchments are divided among the participants which retain harvest rights on the trees but are also responsible for the maintenance of the catchments.

PDRIK selected an area for the project that has many elements that encourage success. The people in this drought stressed region are more interested in new management techniques. The project chose an area with some of the most fertile soils in Niger. The degraded conditions of the area provides a sharp contrast to the successes that the project produces. Also, reforestation and agricultural development of the denuded landscapes pose few land use tenure problems. Protecting a previously denuded area from livestock is much easier for the herders to accept.

Malbalza Water-Harvesting for Trees

Small water-harvesting catchments are constructed by villagers in order to reforest bare eroding slopes. A Forest Service agent organized this activity by following a technical paper issued by the Department of Tahoua and providing food-for-work to pay for village labor.

The rainfall runoff is captured behind these small bunds and causes a larger percentage of the water to infiltrate into the soil. This reduces erosion, increases vegetative growth and aquifer recharge. The planted trees provide protective cover against splash and wind erosion. The trees enrich the soil with organic matter and nutrients and provide wood products to the villagers. The project constructed water-harvesting catchment on 20 hectares. Each catchment concentrates runoff from 19 m2 onto 6 m2.

Background Information

Malbalza is located 130 km south of Tahoua in south central Niger. Malbalza is a moderately large village that has Niger's only cement factory. The project area is in a 450-500 mm rainfall zone which is

characterized by highly variable rainfall throughout the year and between years. The site is located on moderate sloping hills. The clayey soils are formed from phosphatic limestone and are some of the most fertile soils in Niger. Over-grazing and deforestation on these soils has resulted in them appearing as barren wastelands. The region is composed predominantly with Hausa farmers who grow mainly field crops of millet and cowpeas during the rainy season.

Description of Initiative

The Forest Service agent in Malbalza followed a technical sheet that was sent to all forestry agents in the department. The sheet describes a method of designing, constructing, and using food-for-work labor to build water-harvesting catchments for growing trees and crops. The agent that organized this project has two years of forestry training (Agent Technique). Using food-for-work labor, he organized the planting of 2O hectares of denuded land near the village with Prosopis juliflora and Acacia senegal. The villagers who participated received approximately 800 F CFA worth of food aid per person-day. Seven thousand two-meter diameter half-circle catchments were constructed and trees were planted in each one. By November of the same year tree survival was 89%. The trees are protected from livestock by guards and will be protected from cutting for 3 years.

Discussion of Initiative

This project which is replicated at other villages within the Tahoua Department is relatively easy to implement and is a good method to disperse food aid. Land that is degraded and abandoned is put back into a high level of production using relatively simple techniques that the villagers can easily use themselves. These methods, however, need refinement in that the catchments are laid-out along straight lines running perpendicular to the general slope of the land. This method result in the misalignment and failure of many catchments, especially in areas with uneven slopes. This intervention provides immediate, often spectacular results but needs some modification to achieve its full potential.

SOIL CONSERVATION

Swissaid Large Channel Protection Dams

Swissaid provides financial and technical support to villagers in Ouirihamija and Enadoujoum for the construction of channel protection dams. Swissaid uses food aid to pay the unskilled labor.

Channel protection dams reduce or stop channel erosion and gully erosion that spreads over the floodplain from the main channel. The constriction of storm flows by the dams cause increased flooding and sedimentation on the floodplain which allows much greater infiltration of water into the soil for agricultural production and aquifer recharge. The increased water availability reduces some of the risks in agricultural production which allows an intensification of agriculture and more efficient use of human energy. Several hundred hectares are directly affected by the construction of nine channel protection dams.

Ground Information

Ouirihamija and Enadoujoum are located 50 km north-northeast of Tahoua in central Niger. The area is in a 300 mm average annual rainfall zone. The channel protection dams are constructed in the gullied channels of relatively large drainageways. These drainageways are the most densely vegetated areas within the region. Due to the general devegetation of their watersheds the storm flows have become larger and more intense. This has caused gullying along sections where the stream channel gradient is large, and deposition of sediments, mostly sterile sand, along sections were the stream channel gradient is small.

The villages in the area have been established relatively recently. Twenty years ago there were no villages in the area. The people through lack of available farm land in the south have moved north into the region. Bouzu is the major ethnic group in the area.

Some areas along the floodplain of these drainageways have been planted in sorghum during the past 25 years that this region has been settled. Plentiful Calotropis procera provides fuel and construction wood for the villagers.

Description of Initiative

Swissaid's channel protection efforts began near Ouirihamija in 1985 through the efforts of Father Roget Desbos. Father Desbos has been working in the region since 1967. Five channel protection dams were constructed near the village along a one kilometer long gullied section of the valley's major drainageway. The dams were spaced along a 800 meter section of the gullied drainageway. Three dams were constructed in 1985 and the other two in 1986. The dam were positioned so that the impounded water of the lower dam reaches to the base of the next one up stream and thereby protects the dam from undermining by tumbling flood water and eventual collapse. The gullied channel was 3 meters deep in spots.

The upstream end of the gully had an advancing head wall which each year dissected more agricultural land. Swissaid contracted an agent of Rural Works to design and help supervise construction of a series of dams to stabilize the gully. Besides the gabion dam constricting the flow within the gully, earth bunds which extend across the flood plain further restricted the flow of the flood water. Both the dam and the earth bunds increase flooding on the floodplain. The dams and bunds stopped the advance of the gullies and increased sedimentation and water infiltration in the channel and on the floodplain. The increased soil fertility and water availability greatly improved crop production on the floodplain and in the channel. The soils on the up stream side of the bund and dam are able to store sufficient water that even in November, two months after the last rain, sorghum was still growing. Also, dry season gardens are now grown in the stabilized channel which is filling with silt and clay sediments.

Swissaid also initiated the construction of a series of four channel protection dams along a section of a large drainageway near the village of Enadoujoum. Although the gully is much deeper and wider than the gully which was stabilized near Ouirihamija, the same design and construction methods were used. These dams, just like those near Ouirihamija, restricted the flow in the gully and caused more frequent flooding of the floodplain. Due to the increased flooding, large areas of the floodplain were planted in sorghum and produced a large harvest for the village of Enadoujoum. One major difference between the two sites is that the series of dams near Enadoujoum did not extend the full length of the gully. This resulted in the undermining and partial collapse of the last dam down stream from the others. Sand has completely filled the gullied channel behind the dams near Enadoujoum. The lateral gullies that were forming from the channel are now stable. The Prefet on viewing these dams was greatly impressed, especially from the last dam in the series which provided a striking contrast of a large 3-4 meter deep gully below the dam and a completely sand filled channel above the dam.

Laterite rock was mined from nearby areas and used to fill the gabion. Unskilled labor used to mine the rock and construct the dam was paid by Swissaid through food-for-work. Swissaid also subsidized the construction of the gabion wire baskets through the village cooperatives and provided transportation for the materials.

Food-for-work provides the incentive for the people to construct the dams and bunds. Otherwise many villagers would, out of necessity, have to leave the area in search for income during the dry season. The food income generated during the construction of the dams provided an equivalent income of 15,000 F CFA per person-month. The greatly increased sorghum production on the flood plain now offers an example and incentive to villager for construction of other dams.

Discussion of Initiative

Channel protection dams are usually too large for an individual or even a village to construct without technical and financial support. Without this support to stabilize the large gullies the land is at risk from extensive lateral gully erosion and permanent loss of productive agricultural land. The dams cause increased flooding of the floodplain which provides supplemental irrigation for crops. This is especially important in the dryer rainfall zones.

It is important that the entire length of the gullied drainageway be treated with a series of channel protection dams. As demonstrated at one of the dam near Enadoujoum, if the gully continues from the last dam, the last dam will be left unprotected from undermining and will eventually collapse.

Also, dam construction projects can be community projects which offer opportunities for villages to organize or reinforce those organizations that exist. These as well as other projects can be a catalyst for increasing organizational and management skills of villagers and for the formation of new enterprises.

FLUP Gully Erosion Control Checkdams

Small channel protection dams are constructed through paid labor that is hired by the Forest Land Use Planning Project (FLUP) in order to stop gully erosion. This is one of several interventions used by the project to rehabilitate the forest and brushland.

The soils surrounding the stabilized channel are protected from lateral gullies forming. The flood water retained behind the dam reduces storm flows and helps reduce erosion down stream. The retained water infiltrates into the channel and helps recharge the local aquifer. Also, the improved habitat result in increased vegetative cover around the stabilized gully.

Background Information

Guesselbodi National Forest is located 20 km east of Niamey in south western Niger. The site is a 10,000 ha National Forest on eroded degraded shrubland. The present annual rainfall is around 450 mm. The predominant soils of the forest occur on the nearly flat to moderately sloping plateaus and are shallow, gravelly,

and occur over ironstone. These soils support thinly spaced, moderately dense thickets of small trees and large shrub, primarily of Combretum spp. Moderately deep to deep, sandy soils are of minor extent but highly productive. These soils occur at the base of the plateaus and are easily eroded.

Zarma is the predominant ethic group in the area. Some sedentary Peul also live in the area. The forest provides pasture for nearby sedentary populations as well as for the transhumant populations. The forest is especially grazed during the rainy season when the surrounding fields are in crops.

The project pays laborers, usually from nearby villages, the governmental minimum wage of around 900 F CFA to dig erosion control and water conservation bunds, build channel protection dams, and plant tree seedlings.

Description of Initiative

Small check dams are constructed in gullied drainageways. They are constructed from hand placed lateritic rock that are collected from the surface or, when not available, from that ripped from the ground using a bulldozer with a ripping chisel. The spacing of the dams is such that the water from the lower dam will be ponded to the base of the upper dam. This spacing is estimated without using surveying equipment. After the rains, sediment and vegetation collect above the dams and grow on the previously scoured and bare gullies.

Discussion of Initiative

Gully erosion is expensive to control and usually does not provide benefits that are as immediate and tangible as other conservation structures. However, if the gullies are not controlled their spread can be rapid, exponentially increasing the expense of stabilizing them. Frequently gullies occur where rocks are not readily available, thus the added transport cost makes the expensive repairs even more expensive. In cases where rocks are not available, gully erosion control is much more complicated and requires a community effort to revegetate the gullies and control excess runoff from the upper watersheds.

CARE Maggia Valley Windbreaks

CARE, working with Peace Corps volunteers and area farmers, planted lines of windbreaks to protect the agricultural soils within the Maggia Valley from wind erosion.

The windbreaks protect the soil from erosion and provide a microenvironment which allows more efficient transpiration of the crops. Wood harvested for the windbreaks relieves the demand for wood that is on the surrounding brush land. The reduced wind erosion improves the air quality for people living near the windbreaks. The effect windbreak on the aquifer is not yet known.

Windbreaks protect bare soils from wind erosion for a distance down wind of 10 to 20 times the height of the windbreak. This distance depends on soil and wind conditions. The 400 km of Maggia Valley windbreaks protect 4,000 hectares.

Background Information

Maggia Valley is located 110 km south-southeast of Tahoua in central Niger. The valley is in a 400 to 450 mm per year rainfall zone and is surrounded by lateritic plateaus. The windbreaks are located on the terrace and floodplain soils which are grown are flat, deep, well drained, and loamy sand to sandy clay loam in texture. The water table is generally 5 to 15 meters deep.

The predominate ethnic groups in the area are Hausa, usually farmers, and Fulani, usually herders. Agriculture is restricted to the sandy plains, terraces, and flood plains in the valley. Millet, cowpeas, and

sorghum are the major field crops. Occasionally, once every 10 years or so when floods provide supplemental water to the fields, cotton is intercropped with millet and sorghum.

Description of Initiative

The CARE project established the first windbreak in the Maggia Valley in 1975. CARE foresters, Peace Corps volunteers, and Forest Service agents have worked with the farmers in planning and planting the windbreaks. Since 1975 over 400 km of windbreaks have been established to protect fields in the valley. The cost of establishing and protecting one kilometer of windbreak for the first four years is between 270,000 to 300,000 F CFA or about $1000. The windbreak lines are spaced 100 meters apart with each line consisting of two lines of neem or one line of neem and one line of Acacia nilotica. The lines of trees are spaced 5 meters apart and the trees within the lines are spaced 4 meters apart. The line are oriented perpendicular to the prevailing winds.

The neem trees that are trimmed grow back very rapidly. Fifteen year old trees that were pollard cut at a height of 2 to 2.5 m in May-June 1985 are now, 2.5 years later, nearly the same height as the trees that were not trimmed. The crowns of trimmed trees grow lower to the ground which makes them more effective windbreaks.

The project hopes to undertake a pollard cut of up to 35 km of the oldest windbreaks at the end of this dry season. However, the ownership of the trees in the windbreaks, and the method of distribution of the wood products to be harvested has still not been decided. CARE is striving to have the wood products divided between the field owner, woodcutter, and village or valley wide cooperatives but some of the forestry agents in the area feel that the windbreaks are for the Forest Service.

Windbreaks, besides producing wood products, increase the production of crops between the windbreaks by protecting the crop from winds that cause sand blasting of young plant and from storm wind that can cause lodging. Yields are also increased, especially during low rainfall years, because the windbreaks allow the crop to more efficiently use water. Studies conducted on the effects of the Maggia Valley windbreaks of crop yields indicate that one can expect a 17% increase in overall millet yields when the crop is grown between windbreaks. That is, 1000 hectares of millet fields with windbreaks will yield about 17% greater yields than 1000 hectares without windbreaks. The increase in biomass production of the crops is even more substantial.

The effect of wood products from the Maggia windbreaks on local markets will be interesting to follows. Four meter neem poles currently sell for 500 to 750 F CFA in the area. The effect on the pole wood market of maintenance harvesting of 35 km of windbreaks per year is unknown. This is especially important since private woodlot production of poles has become very popular.

Discussion of Initiative

The Maggia Valley windbreaks are a widely recognized success in stopping wind erosion, increasing agricultural production, and providing wood products to a deforested area. However, the valley has relatively high water tables compared to much of Niger and the Sahel so the extension of neem windbreaks will not be appropriate for all sites in the Sahel. Determining ownership of the trees is still a burning question in the valley and may pose problems in other areas as well. Difficulties may also be encountered in designing windbreaks so all farmers bear an equal burden of having a portion of their fields out of production. The loss of grazing land for four years during the establishment of the windbreaks is also a problem that should be addressed with the herders. Also, the water balance between aquifer recharge and the transpiration of the ground water by the windbreaks is unknown for Maggia Valley and other areas in the Sahel. There is a danger that inappropriate windbreaks may put too large of a demand on the water table and result in a lowering of the water table.

SOIL FERTILITY IMPROVEMENT

Gao Project (UNSO)

Background Information

Location: Boboye, Loga, Dosso Arrondissements, Dosso Department, Niger

Major Characteristics of the Location: Plateaux with sandy soils fall away to several fossil affluents (dallol) of the Niger River. Naturally dense stands of Acacia albida are found in some of the latter areas. Upland vegetation is open tree savannah with Combretum micanthrum, and Guiera senegalensis with scattered larger trees including Ficus, sp., and tamarind. From north to south, annual rainfall is in the 300-600 mm range.

Number of Hectares Affected: Several thousand. Ninety villages affected by project activities.

Special Characteristics of the Case: Project is working with individualistic Zarma farmers and Fulani farmer-pastoralists. Project utilizes direct payments for tree planting and protection.

Seasonal cultivation of millet, sorghum, and cowpeas accompanied by cash crops of peanuts and cotton, especially in the better watered areas. Around Dosso, some big merchants have begun to use mechanization. Around Boboye, a traditional agro-sylvo-pastoral system involving protection of Acacia albida, or Gao trees, existed. Under higher rainfall conditions, historically, maize and sorghum were commonly planted at the feet of Gao trees.

Protection and regeneration of field trees, especially Acacia albida through direct payments to farmers and through ongoing extension efforts. Current applied research activities concern development of living fences, alley cropping, contour bunds, direct seeding, etc.

Description of Initiative

Technical Measures Taken: Farmers were paid 30 CFA francs per protected seedling. Initially, project tried to get farmers to picket the seedlings with color coded pickets in order to examine year-by-year progress. Women were paid 200 CFA francs for woven protective baskets made from local materials: Combretum and Guiera. Project aims for 100 trees/ha, but suggests 50 trees/ha would be as reasonable goal.

A number of small village nurseries producing seedlings (Baobob, Neem, Nere, Prosopis, Gao, etc.) for reforestation have been established. These are dependent upon the good will of local village heads. The population does not seem especially enthusiastic about continuing this activity.

The project overcame difficulties of transplanting Gao by using direct seeding with protection, earthen pots, and early replanting. The key issue in artificial regeneration is protection to allow roots to develop. Two weeks of protection during the wet season is enough to get plants established. Thereafter the main problem is protecting young plants from destruction during weeding and from deracination by cattle.

There is some interest in construction of contour dikes and reseeding with Andropogon gayanus. The bundle of seco, or cut Andropogon goes for 1000 francs on local markets. As was discovered at Guesselbodi, this grass regenerates will behind bunds.

Summary of Project Activity

Years Action	1983/84	1984/85	1985/86	Total
Villages	22	33	46	47
Farmers	394	1085	1648	1700
Total plants produced	25,828	38,215	54,455	118,495
Gao produced	20,443	31,762	45,099	97,304
Total trees planted	18,682	25,337	40.687	84,706
Gaos planted	15,942	23,050	36,313	73,305
Gao/farmer	37	20	22	44
Protective baskets produced	7,709	26,674	5,377	37,760

Social Organization of the initiative: The project began with traditional extension methods, i.e., top down methods. In the second year of the project, the GRAP interactive extension method, devised in Burkina Faso, was implemented. Villages are visited twice monthly during the rainy season. Farmer recognition of the agronomic advantages of Gao facilitate implementation of project goals. Progress is greatest where village chiefs support these goals. Since payments are made through the chiefs, the latter have an interest in promoting protection activities. For a variety of reasons, project staff note a change in farmers' attitudes towards the environment towards a more proactive stance. There has been something of a spread effect from the project, with farmers in some non-project villages protecting Gao on their own.

Results of Extension Efforts

Years	1983/84	1984/85	1985/86	Total
Project Villages	52	67	84	90
Farmers Participating	1,566	1,555	1,675	2,500
Gaos Protected	35,435	101,571	177,854	314,860
Gaos/Farmer	2,365	105	126	

Economic Incentive System: The essence of the system is the cash payment received by farmers for each seedling protected and/or planted and protected. Project staff say that they would like to move away from this system, but the system was inherited from the precursor FAC/CCCE project and villagers favor it.

General Discussion of the Initiative: Staff claim that trees belong to the population. Farmers may, under Forest Service control, thin trees in their fields. A sociological survey discovered that only 10% of the population would continue planting activities in the absence of project support, mainly because of the sacrifice in time and effort involved in planting and protecting trees. The same evaluation complained that a regular extension effort had not been established due to the lack of extension personnel.

Project documents note that Gao alone is insufficient to cope with the effects of drought, lack of following, and erosion on departmental soils. For this reason, the project has broadened its efforts to experiment with contour diking and establishment of windbreaks cum living hedges, and adding Acacia senegal to Acacia albida plantings. No method of rapid windbreak establishment has yet been found, although the project is experimenting with a number of species, especially Australian acacias.

REFORESTATION

FLUP Management of Guesselbodi National Forest

The Forest Land-Use Planning Project is developing and using natural forest management techniques on Guesselbodi National Forest to rehabilitate the degraded forest and greatly increase the production of wood and other products from the forest. Central to the management techniques is control over land-use and involvement of the surrounding communities in the management of the forest. Reforestation, soil and water conservation, controlled cutting of live trees, and controlled grazing of the forest are techniques used by FLUP in natural forest management.

Reforestation and natural forest management, beside providing wood, forage, and a better wildlife habitat, protects the soil from splash and wind erosion and increases its fertility and productivity. The soil and water conservation structures also increase vegetative production and increases aquifer recharge. Due to both reforestation and conservation structures the rainfall runoff from the area, although less, carries less sediments and is of better quality. The reduction in wind erosion improves the air quality for the surrounding villages. Approximately 4,000 hectares have been treated at Guesselbodi National Forest in the past four years.

Background Information

Guesselbodi National Forest is located 20 km east of Niamey in south western Niger. The site is a 10,000 ha National Forest on eroded degraded shrubland. The present annual rainfall is around 450 mm. The predominant soils of the forest occur on the nearly flat to moderately sloping plateaus and are shallow, gravelly, and occur over ironstone. These soils support thinly spaced, moderately dense thickets of small trees and large shrub, primarily of Combretum spp. Moderately deep to deep, sandy soils are of minor extent but highly productive. These soils occur at the base of the plateaus and are easily eroded.

Zarma is the predominant ethic group in the area. Some sedentary Peul also live in the area. The forest provides pasture for nearby sedentary populations as well as for the transhumant population. The forest is especially grazed during the rainy season when the surrounding fields are in crops.

The project pays laborers, usually from nearby villages, the governmental minimum wage of around 900 FCFA to dig erosion control and water conservation bunds, build channel protection dams, and plant tree seedlings.

Description of Initiative

The management of this forest began with a soils and vegetation inventory of the forest. The forest was divided into 10 parcels, approximately 1,000 hectares each. The size of the parcel was determined on the projects capability to planting trees and construct water conservation structures over the area within a one year period. The parcels are treated and protected from livestock for four to five years until the planted trees grow above grazing height. Guards are hired who are not from the area and thus are unlikely to have any social obligations to any of the users of the forest. The guards for this project are Touregs which have a tradition of being guards. Livestock caught in the protected area are put in stockades and the owner is fined when he claims the animals. During the beginning of the project there were numerous violations but now there are relatively few.

Planting of indigenous species is an integral part of natural forest management. Planting trees and grasses provides an opportunity to change the species composition of a degraded forest and achieve much higher and more valuable levels of production. By planting indigenous species the people are provided trees that have known uses and products (e.g. food, fodder, firewood, building poles, fiber for cordage, tannins, dyes, stains and inks, gums, resins and waxes, poisons, antidotes, and drugs).

The FLUP project promoted, to a reluctant Forest Service, the cutting of live trees followed by a period of protection, usually one to two years. Cutting old, slowly growing trees allows these trees to be replaced by very rapidly growing sprouts. Protection from livestock allows the sprouts to grow above grazing height. Otherwise the sprouts are likely to be killed through overgrazing. Studies are being conducted to determine the level of increased production. Current conservative estimates of regrowth is 1.5 m3/ha-yr. The immediately exploitable wood that exist in a forest provides sufficient incentive for this type of management.

Another major management technique used under appropriate site conditions is the construction of small water-harvesting catchments around each tree planted and around selected existing trees. Phosphate fertilizer is applied to all the trees planted. Water conservation and soil fertilization increases tree survival and growth rates at minimal extra cost compared to that of producing and planting seedlings. Tree production costs are around 35 to 200 F CFA, not to mention transportation and planting cost, while the cost of fertilizer for each tree is 5 to 10 F CFA. The labor cost of a water-harvesting catchment can range from essentially zero to very expensive. Two types of water-harvesting catchments are mainly used by this project. One type, which cost essential nothing to build, is where a portion of the earth removed from the planting hole is shape into a small bund orientated so that it intercepts runoff and diverts it into the hole. The other type consists of two bunds, each two meters long, formed in a shape of a "V". This type cost approximately 200 F CFA each in labor.

The project conducts applied research on different conservation and planting techniques. Much of the research is initiated and conducted by Peace Corps and German volunteers who also oversee the construction of soil and water conservation structures, the management of the tree nursery, and the planting of the trees. Nigerian forestry agents assigned to the project receive on the job training while conducting assign tasks. The project frequently gives field courses in natural forest management to forestry students.

The project is involving neighboring villages in the management of the forest by allowing them to exploit its natural resources. The cooperative structure which was organized by the Cooperative League of the United States of America (CLUSA) is extremely viable and works to the mutual benefit of the project, the villages, the villagers, and the cooperative. The cooperative organization consists of representatives from the neighboring villages. It provides an organization through which the project can work with the villagers in achieving sustainable and increased production from the forest. The villagers who are cooperative members have the privilege of exploiting the forest resources at the direction of the project. The members must in turn sell the forest products, usually wood, to the cooperative. The cooperative then sells the wood at a higher price usually to traders who in turn sell them in Niamey. Often the villagers will by-pass the traders by buying from the cooperative the wood that they collected and then selling it at nearby markets. The cooperative makes its percentage of the wood and the villager makes more from the wood. Cooperative members are discouraged from by passing the cooperative because they would be stealing from the cooperative and the villages who collectively benefit form the cooperative's revenues. Also it is in the cooperative and villages interest to protect the forest from illegal harvesting from the forest.

The neighboring villages also benefit from the forest by being allowed to cultivate on the sites that are ideal for agriculture. The project requires the farmers using the national forest land to protect the trees planted for windbreak. Hopefully, over time, the farmers will become aware of the benefit of agroforestry as have the farmers that have fields within the CARE Maggia Valley windbreaks.

Discussion of Initiative

The deforestation around urban centers is a serious environmental and economic problem facing Sahelian countries. For example, an estimated 3 million metric tons of wood will be harvested from one million hectares of forest and shrubland during the next 12 years in Niger. The forest and shrubland around urban centers is experiencing severe pressure from lower annual rainfall, wood harvesting, livestock grazing, and expansion of agricultural. Unless the present land management is changed regeneration of trees and grasses in these area will remain low and desertification will continue to claim more and more productive land.

As a result of the project's activities, donor groups and the government are considering adopting the Guesselbodi approach and extending it throughout the country. In order to extend this natural forest management approach, land tenure, especially for herders, must be resolved since most of the forest land that

should be managed is not within the boundaries of national forests. This approach will remove a large area of land from grazing. Even though the managed tracts of land will provide greatly improved pastures the initial loss of limited pasture land will place disproportionately the burden on the herders.

This approach will require the training of "new" techniques in forestry management to a large number of forestry agents. An estimated 60 additional forest agents plus administrators will be needed to manage the one million hectares that will be required to supply Niger's wood requirements for the next 12 years.

The change in attitude for the Forest Service from one of total protection to that of sustainable exploitation may be difficult for the government and its agents to accept, but examples like the Guesselbodi Forest can provide convincing evidence to speed their adoption.

Swissaid Initiated Village/Private Wood Lots

Swissaid organized and supported through food aid the construction of water-harvesting catchments and the planting of trees for village woodlots. Once the trees are planted individuals are given ownership of the trees and catchments.

The village of Ouirihamija is reforesting abandoned, degraded areas that are devoid of vegetation. The rain that falls on the crusty soil is captured behind small bunds which allow a larger percentage of the water to infiltrate into the soil. This allows increased vegetative growth and aquifer recharge. Also the captured water and impeded runoff reduces erosion. The increased vegetative cover as a result of these water-harvesting catchments helps protect the soil from splash and wind erosion.

The Swissaid design concentrates the runoff from approximately 18 m2 onto 6 m2. The village has constructed water-harvesting catchments and planted trees in three 10 hectare woodlots during the past three years.

Background Information

Ouirihamija is located 50 km north-northeast of Tahoua in central Niger. The area is located at the base of an escarpment capped with laterite on the footslope soils derived form phosphate rich limestone and have high levels of available phosphate and potassium. The soils on these foot slopes have silty clay to silt clay loam subsurfaces and have a relatively high cation exchange capacity and water holding capacity. They are neutral to basic (pH ranges from 7 to 9) with free carbonates present, and are generally bare of vegetation. The slight crust formed on the surface creates a large amount of runoff water during rain storms which has caused a large amount of gully erosion in the area. The soils have strong structure. The type of clay occurring in these soils expands when wet. The large cracks formed in these soils after they dry threaten to cause failure of bunds through erosion from piping if the bunds are not maintained. The areas where water-harvesting catchments are constructed have not been used for cultivation and are available to anyone willing to cultivate them. Plentiful Calotropis procera provides fuel and construction wood for the area.

The village of Ouirihamija is a relatively recently settled village of less than 200 people, with around 90% Bouzu and the remaining 10% consisting of Hausa, Toureg, and Peul. Twenty years ago there were no villages in the area. The people through lack of available farm land in the south have moved north into the region.

This project was initiated in 1976 by Father Roget Desbos and financed by Swissaid. Father Desbos has been working in the village since 1967. The project started after Father Desbos took four villagers to see water-harvesting catchment work that was being done in the Agadez region to the north.

Description of Initiative

In 1985 the villagers of Ouirihamija began woodlots that are communally constructed and planted but privately owned. The villagers begin during the dry season by constructing water catchment in the shape of 2 meter radius half circles. Each catchment concentrates runoff onto 25 percent of the area which nearly quadruples the water that is normally available. Each participating villager construct four catchment per day at a density of around 400 catchment per hectare. See Case Example, Swissaid Initiated Water-harvesting for Crops and Trees, for further discussion on the water-harvesting catchments.

Swissaid helps organize the villagers where they communally construct the water-harvesting catchments and plant the trees. Swissaid provides food aid to the villages for their labor and subsidizes the making of chain-linked fence through the village cooperative. Villagers that build and plant the village woodlot are compensated for their labor through payment in food-aid. Each person receives 2.5 kg of sorghum and a variable amount of dry milk per day (800-1000 F CFA in value) for each day of work. The project pays for chain-link fencing that the village cooperative makes in order to protect the woodlot from livestock. Once the trees grow above grazing height the project plans to use the fences at other sites. After the trees are planted the villagers divide the catchments among themselves for cropping and/or tree management.

For each 10 hectare woodlot each family receives approximately 50 catchments with trees. Each family is responsible for the maintenance of their trees and catchments. They trim and harvest their trees with the guidance of the Forest Service. The villagers also plant millet, cowpeas, and okra, at approximately 30 by 30 cm spacings, in the same catchments as the trees. This allows the farmer to take advantage of the full productive potential of the catchment until the trees grow large and create too much shade for the crops.

The trees that are planted during the rainy season are provided by the Forest Service. They are mostly Prosopis juliflora but numerous local species are provided as well. Survival rates of trees planted in these woodlots are around 95% when planted on the clayey footslope soils and around 80% when planted on the sandy plain soils in the valley. Trees in these woodlots have grown 2 to 2.5 meters in the 18 months from planting and provide a sharp contrast to the adjacent bare eroded slopes next to the plantation.

Discussion of Initiative

This project combines the positive aspects of communal work in a common area with those created through private ownership. A technician that is monitoring and directing a project can more efficiently use his or her time if a large number of individuals are concentrating their work on a common area. Working in groups is often much more enjoyable than working individually. Also, protecting one large communal woodlot is much easier than protecting many individual woodlots.

When the villagers know that they will directly receive benefits from their communal labor, the work tends to be of better quality. Giving private ownership over the trees decentralizes the operation and maintenance of the woodlot to a family or individual level. The villagers then can use their trees and catchments in ways that best suits their needs. This system offers more incentive for the villagers to maintain the catchments and trees. Also communal peer pressure will ensure maintenance because a poorly maintained catchment can threaten the others down hill from it.

The water-harvesting techniques used are simple and easily replicated by villagers on their own. Their are no opportunity costs or tenure problems in using these degraded, abandoned lands which are often ideal for water-harvesting.

It is doubtful that the people in this severely degraded area with no immediately exploitable resources could forego income, that they could earn elsewhere, in order to construct water-harvesting catchments for the woodlots. Using food-aid allows the villager to construct catchments and to plant trees which can provide them with a source of income in the near future. As soon as the people situation improves and they are assured adequate food, clothing, and shelter, then they will be more willing to invest in the future on their own.

Private Woodlots in the Tahoua Department

Farmers are using short rotational forestry techniques to grow trees on prime agricultural land. The trees grown in the woodlots provide a denser, more protective cover than the agricultural fields that they replace. The denser cover provides better protection against wind and water erosion. It also provide a better wildlife habitat. The increased production of polewood through private woodlots relieves the natural forest and brush-lands from exploitation. Private woodlot are usually 100 to 3,000 m2 in size.

Background Information

The Maggia Valley and Bouza are located 110 km south-southeast of Tahoua in south central Niger. The recent annual rainfall in this area is 350-400 mm. Herding and rainfed field cropping is the major land uses of the area. Millet, cowpeas, sorghum, cotton, and peanuts are grown in the area. The Forest Service has allowed unrestricted harvesting of trees by the individual that plants them which has lead to the spread of woodlots. The woodlots are located in depressional areas of the sandy plains where the trees receive supplemental water from flooding or high water tables.

Description of Initiative

Tama Area Woodlots

The farmer interviewed near the village of Tama in the Maggia Valley started his woodlot in 1979. He has been to Mecca for the Hadj and was one of the first in the village to start his own woodlot. He now has a total of three woodlots. Two of his woodlots are on the best soils in a drainageway which frequently floods. This provides supplemental irrigation to what rain that falls. The water table at this site is 20 meters deep. His first harvest was in 1984, five years after planting. Neem trees are predominantly grown because there are few eucalyptus seedling available to plant. The initial tree spacing is often irregular, generally 1 tree per 1 to 7 m2. Seed and stump sprouts often densely cover the ground under the canopy of the older trees.

Bouza Area Woodlots

Fifteen out of 100 families in a small village near Bouza have woodlots. The growing of private woodlots started 15 years ago when the Forest Service allowed the cutting of neem. The farmers said that an area with a high water table or an area that frequently floods is needed in order to grow a woodlot. Tree spacing is variable and is similar to the spacing observed in Tama.

The Forest Service decision to allow uncontrolled harvesting of trees that a villager plants permitted the culture of trees as a crop. The Forest Service in the Tahoua Department gives Tree Farmer of the Year Awards for each arrondissements.

The need for more wood keeps up the demand for more woodlots. Approximately 20% the families in Tama have woodlots and the number is increasing each year. In a village near Bouza the villagers sells most of the wood that they grow, obtaining an income of 50,000 F CFA/year from an average size woodlot. Poles are sold for 500 F CFA each in the villages around Bouza, 700-750 F CFA each in Bouza, 600 to 700 F CFA each in small villages around Malbalza, 800 F CFA each in Malbalza and approximately 1,500 F CFA each in Tahoua. The people are not afraid of the local markets being saturated because they feel the market in Tahoua and in other areas where polewood is scarce will take-up the slack.

Discussion of Initiative

Using prime agricultural land to grow an assured polewood crop makes economic sense in zone where drought and crop failure is likely, especially when one considers that growing trees has a small labor requirement and few storage problems.

The market for wood produced from private woodlots has not yet stabilized. Each year more and more people are starting woodlots. Crucial to their development is a good relationship with the Forest Service and the ability of farmers to freely harvest the trees that they grow.

Bouza Area Live Fence

A four meter high Prosopis juliflora live fence has grown around the seasonal pond that the villagers use for dry season gardens, orchards, and woodlots. The villagers planted the live fence with the help of LWR in 1983. The live fence is discontinuous and the empty gaps are filled with thorny, dead branches when the farmers needs to use a section to partition and protect their garden plots. The farmers are afraid to allow cutting and trimming of the fence for fear that they, themselves, will cut too much from the trees and kill them. The Forest Service has assured the villagers that it is alright to cut the trees. Presently the fence is acting as an effective wind break where the line of trees are oriented perpendicular to the wind. These live fences still have potential to provide good protection for the gardens from animals and provide a large amount of wood and leaf fertilizer for the gardens.

The site is located 20 km south of Bouza in south central Niger. The recent annual rainfall in this area is 350-400 mm. The site is in an interdunal depression with sandy soil around the edge of the depression and clayey soils in the depression. The water table is 5 meters deep.

ORGANIZATIONAL IMPROVEMENT

Project de Developpement Rural Integre de Keita

This $34.8 million, seven year Italian based project is concerned with the integrated rural development of a portion (53 percent) of the Keita arrondissement, located 100 km south-east of Tahoua. The population of the arrondissement is around 150,000 people.

The project is truly integrated with activities in agriculture, forestry, livestock, road construction, soil conservation, cooperative development, commercialization, credit development, education, and health. Of the total invested, the Italian government is donating $29.0 million for payment of equipment, materials, and expatriate salaries. FAO is donating $3.8 million in food aid, and the Government of Niger is donating $2.0 million in government worker salaries. The area immediately affected by project is 2,570 km2 around the town of Keita, of which 153 km2 are plateaus, 2,165 km2 are valley slopes, and 252 km2 are alluvial plains. This investment averages $135/hectare, obviously an amount that is not widely extendible throughout the country or the Sahel.

The project is designed to be flexible and pragmatic. It started with a survey of successful natural resource management and community development techniques used in Niger. From this the projects team of specialists further developed the project plan. This included a variety of interventions, such as: soil and water conservation, tree planting, tree nurseries, crop variety improvement, crop culture improvement, livestock improvement, crop storage facilities, wells, clinics, schools, clinics, and cooperative establishment. Through village participation, the people decide what actions they need and should implement. Among these project-supported interventions many have immediate and tangible results. Once cooperation, results, and trust have been established other less tangible interventions are initiated.

The project area is in a 350-400 mm rainfall zone which is characterized by highly variable rainfall throughout the year and between years. The area consist of plateau soils, sideslope and footslope soils of the valley, sandy plain soils, and alluvial soils. Plateau soils, which range from shallow to deep, are mostly used for pasturage and forestry. The agricultural soils on the plateaus often occur in depressions and sinkholes which have accumulated deeper soils and receive supplemental water through runoff. Sideslope and footslope soils are the predominate soil in the Keita area and occur on the steep to moderate slopes below the plateau escarpment and on the outlying hills. These clayey soils have formed from phosphatic limestone and are some of the most fertile soils in Niger. Over-grazing and deforestation on these soils has resulted in them appearing as barren wastelands. The valley also contains sandy plain and stable dune soils which are the predominate agricultural soils of Niger. These sandy soils are drought, and low in phosphate. Alluvial soils are extremely variable and can range from sandy to clayey in texture. The area has been severely degraded due to the general reduction of rainfall, overgrazing, deforestation, and expansive agriculture. The selection of this severely degraded area provides a stark background to accentuate any positive results.

Among the interventions the soil and water conservation ones have the most visual and immediate impact. Three simple techniques were chosen by the project that can be used throughout the project area. They consist of a water-harvesting trenches for growing trees, water-harvesting contour dikes for growing both crops and trees, and checkdams to stop gully erosion. These interventions which are labor and equipment intensive, account for a large part of the project's budget. However, its result is a spectacular transformation of a barren wasteland into land that is producing food, forage, and wood.

The project uses a watershed management approach in treating the land. In order for people to receive the benefits of the project treating their agricultural land that occurs in the valley, they must first treat the upper watershed, the plateaus, hills, and footslopes. This prevents excessive runoff of the upper watershed from eroding away the work done in the lower watershed. Also, the control of runoff in the upper watershed allows the use of smaller less expensive structures in the treatment of the lower watershed.

The project uses the indigenous village land control system, "le terrior villageois", when planning land rehabilitation efforts with each village. The project and the villages together decide on contiguous areas of land to be treated each year. This allows easier protection of the young tree from grazing animals. It also establishes a system for rotation management where the land is protected from animals until the tree and grasses become established, then is opened to controlled grazing. This then could be followed by tree harvesting, replanting, and animal protection, etc.

The project's activities provide means for dry season "income" to people and allows many of the men to stay in the area instead of traveling to other towns in search for work. The high level of participation should be expected since the people are in need of something to improve their rapidly declining standard of living. Also they have been sensitized to the benefits of soil and water conservation through previous conservation projects.

The government of Niger at all levels can not take lightly this concentrated amount of aid. Food-for-Work which has produced the most noticeable results of the project, infrastructure development, extension, and education that are provided by the project have encouraged strong governmental backing.

Many of the less expensive aspects of the project are used elsewhere with equal success. The seven year time constraint, the use of expensive heavy equipment, and the use of soil and water techniques that may have been more labor intensive than necessary contributed to high cost of the project. Three aspects that may allow similar projects to be as effective while using less money are: (1) a longer project time frame; (2) less dependence on machinery and more on local labor which may be slower and less cost effective, but has more social and economic impact to the area; and (3) the utilization of soil and water conservation techniques that are better designed, more sight specific, and less expensive to build.

Prefet de Tahoua Initiated Interventions

The Prefet (departmental governor) of Tahoua, located in central Niger, had a technical sheet on water-harvesting developed and dispersed throughout his department. The sheet describes the use of water-harvesting for tree and crop production and is based on the design used by the Swissaid project (Case Example, Swissaid Initiated Water-harvesting for Crops and Trees). The Prefet encourage the forestry agents to use food for work to initiate tree planting in the area and also suggested that millet and other crops could be grown within the catchments.

Case Example, Malbalza Water-harvesting for Trees, describes a project initiated by a forestry agent in Malbalza as a result of the Prefet's technical sheet. This demonstrates how a bottom-up development project can develop regionally adaptable natural resource interventions which can then be rapidly and widely dispersed using the top-down approach.

Niger River Fisherman's Association

Another example of policy reform leading to improved resources management is provided by fisherman's associations in Niger River fisheries in Niger.

Niger River fisheries have declined from an annual capture of 45000 metric tons in 1960 to only 900 metric tons in 1985 due to lower annual river flows, less variety in seasonal flows, and the exploitation of the river basin floodplains for irrigated rice culture. Over the same period, daily catch per fisher has dropped from 13 kgs to 3.3 kgs. Some species have virtually disappeared. Conditions are dramatic in the southern zone shared by Benin and Niger, where over 80% of the capture is immature. Furthermore, lack or organic matter, limited sources of feed, periodic drought and competition with other activities for water resources limits future acquaculture development. However, research results from the UNDP and U.S.A.I.D. financed FAO Niger Fisheries Development Project suggest that proper resource management can double reverine production within three to five years to 2000 metric tons annually.

The policies of Niger's "Development Society", created in 1979, are based on revitalization of local authority and participation. The recently adopted national charter now makes the "Development Society" responsible for regional and sectoral development. The FAO-sponsored Fisheries Development Project exploited this policy opportunity in order to start forging a new relationship between the Niger Fisheries Direction and the Fishing communities. In 1985, fishers started creating their own professional associations in consultation with project staff. They selected senior leaders, balancing regional, ethnic and "national" representation. Senior officers in each community are also the successors to ancient, still-respected traditional senior offices for each regional fishery.

Proposals for a fisheries management plan are the fruit of two years of frequent debate between FAO project staff, Niger Fisheries Direction personnel, and the fishers. Management proposal include legal measures to be institutionalized nationally and local measures identified by the associations. Legal measures prohibit specific gear and restrict seasonal uses of certain areas and species. They were, however, designed for gradual implementation in order to minimize further disruption of the local economy. Local measures cover implementation and monitoring, limiting "stranger" fishers participation, education of fishers for an ecologically sound catch, and the identification of fish sanctuaries reserved for growth and reproduction. Further progress and institutionalization of reforms depends upon the fruit of further dialogue to be carried out under a planned second project phase.

IDA Forestry Project, Damana

Background Information

Location: Damana Canton, Filingue Arrondissement, Niger.

Major Characteristics of the Location: The zone consists of lateritic plateau cross-cut with fossil river beds (dallol) covered with recent sandy soils. Dallol zones are characterized by Acacia albida (Gao), Balanites aegyptica, Hyphanae thebaica, Zizpyhus mauritania and other Acacias. Plateaux vegetation is dominated by Combretum nigricans, Combretum micranthum, and Guiera senegalensis. Annual rainfall now rarely exceeds 400 mm. Population pressure has forced inhabitants to establish villages on the plateau tops within the last 70 years.

Number of Hectares Affected: Three villages are chosen for intensive work; numerous villages have obtained seedlings through project activity. Twenty hectares in one village protected by check dams.

Special Characteristics of the Case: Since June 1986, the team has been experimenting with a new extension methodology for integrated agroforestry approaches to antidesertification.

Traditional Land Use Practices: Rainy season cultivation of millet and sorghum in association with extension livestock rearing.

Nature of the Initiative: Developing interactive extension methods to cope with major environmental problems experienced by villagers, including serious erosion and lack of means to exploit numerous small ponds.

Description of the Initiative

The main focus of work has been damming a gulley which threatens one village. A well has been dug. Mini-nurseries have also been established in the three villages. The project has experiment with tin-field planting and protection of field trees. Fencing and kiking of a small pond for gardening is underway. A program to extend improved mud stoves employing AFN (Association des Femmes du Niger) extension agents has been financed.

Social Organization of the Initiative

The World Bank provides funding through its umbrella forestry project. The Fonds d'Aide et de Cooperation (FAC) and the Association Francaise des Volontaires de Proress (AFVP) provide personnel.

Organizing village self-help in the zone is difficult. According to the technical assistance, villagers do not have many interests in common. Village authorities do not have much power. Local administration has never been very favorable to local initiative. Villagers have few resources. Cross-cutting land tenure claim complicate reclamation programs. While the project is working towards a plan for village territory management. for these reasons progress will be slow, incremental. Technical assistance is feeling its way along. Where possible each activity is based on expressed needs at the village level, then, a retrospective study of resource use is made, and joint plans for development elaborated. Project insists that villagers resolve internal discord themselves before assistance is rendered.

For construction of check dams on the fully, 10 persons received some special technical training. Thirty person work groups were called in turn to labor. Men did worked with the stones, while one carried water to the sites. The project provided some compensation during the two and one-half months of work. The chief and certain other vigorous individuals provided leadership. An evaluation of the results was made after the rainy season so that people understood the causes of success and failure. Apparently, villagers have determined to continue the work.

AFN extension agents trained five people in 4-5 villages in the construction and use of improved stoves. Animators were chosen by the AFN. In three weeks, 95% of the compounds had improved stoves. A brief follow-up visit was organized a week later. Apparently among the women, a collective decision to try the stove led to rapid adoption. Women claimed later that most could repair them, but that they relied on the five trainees for new construction. Technical assistance felt that a more significant follow up effort was needed.

Economic Incentive System: An OFEDES-dug well was provided the village by the project as a proof of the project's serious intent and as a source of motivation. Self-interest has played a role in motivating people for the collective work involved in preparing the pond for the collective work involved in preparing the pond for gardening and for the gully control program. Technical assistance notes a certain enthusiasm for Eucalyptus for poles, Neem for shade, Baobob for leaves and for fruit trees. A consumption study of improved stoves revealed savings which varied from 30-40% for some to 10% or less for others.

Socio-economic Data: The well cost 8 million CFA francs, the pond will cost 30 million CFA francs.

General Discussion of the Initiative

World Bank financing ends in 1988 although the FAC would like to continue funding for another five years. A long time horizon characterizes project activities according to technical assistance.

Establishing a climate of confidence is itself a lengthy, iterative process. Technical assistance opts for a flexible site specific approach to activities under a broad antidesertification/soil conservation rubric. They have hit on a basic extension message which they feel can be carried into new villages and their elaborated. The themes of the message are: produce trees which do not exist; protect trees which do exist; economize scarce natural resources.

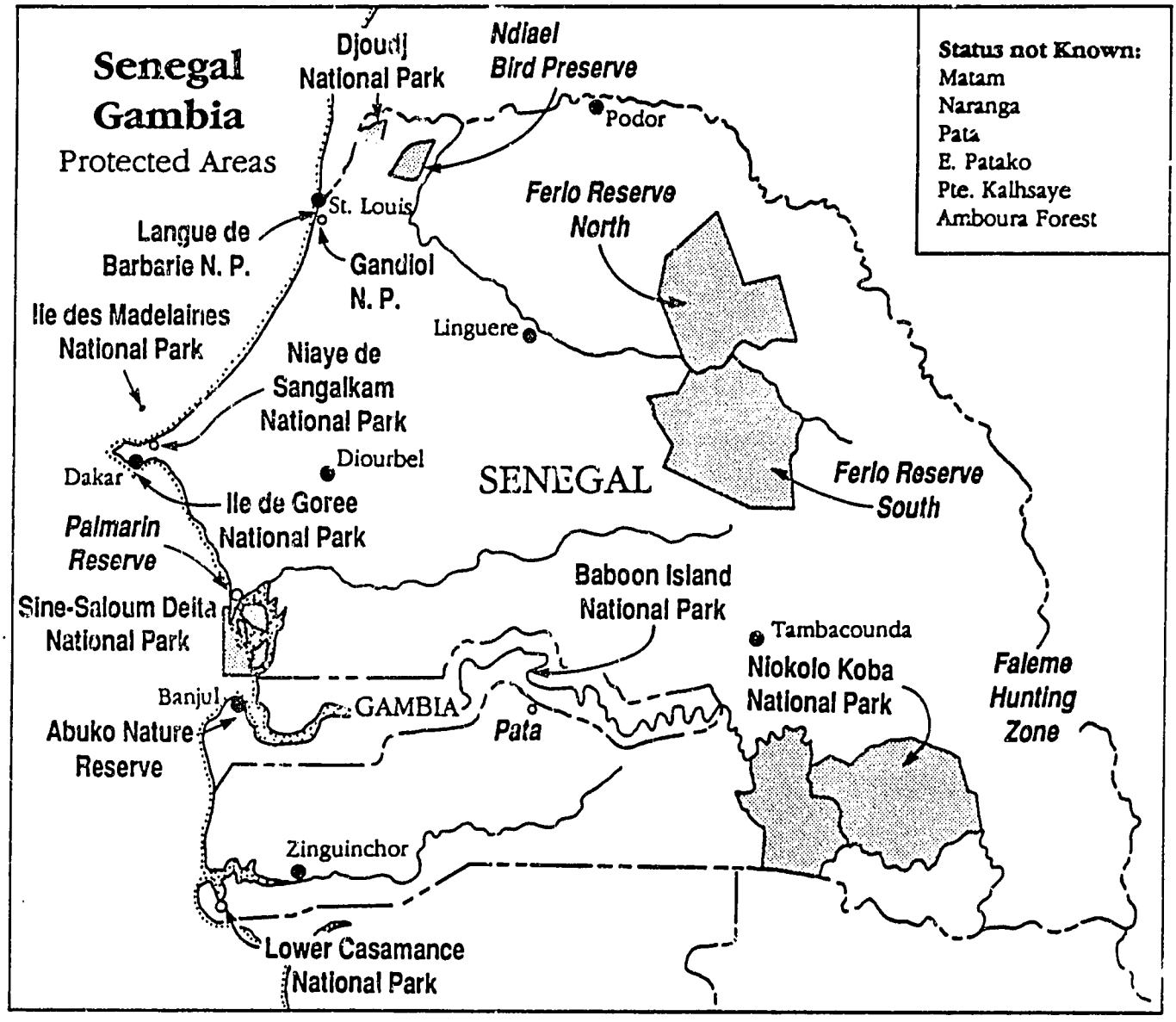
Over the long run, and assuming a broad-based heightened level of environmental awareness can be achieved, the project sees village territory management at several different levels. These include: overall watershed management, through gully control and field level protection; windbreaks at the level of the entire village territory; pond development for individual villages; demarcation of grazing zones between villages.

The project has tried a lot of different, currently popular forestry extension ideas. They tried to identify young regeneration with pickets, but found it difficult to picket in sandy soils. They also found protection from animals very difficult. They have used protective baskets, but the latter are expensive, and people are somewhat

reticent to deprive animals of pasture. It appears that buying and planting trees grown in the nurseries implies customer intentions to protect as well. Unfortunately, certain popular trees, such as mangoes and baobobs require more water than is conveniently available.

Technical assistance indicates it might be interesting to expand activities into nearby plateau forests. Some 10 hamlets depend on the forests for income form woodcutting. These forests are just on the edge of the zone from which Niamey draws firewood. Villagers there feel exploited by urban wood haulers given that a bundle of wood is sold for just $0.10 in the bush, while a stacked cubic meter retails for $15.00 in Niamey.

SENEGAL


Senegal
Gambia
Protected Areas
Djoudj National Park
Ndiael Bird Preserve
Podor
Status not Known:
Matam
Naranga
Pata
E. Patako
Pte. Kalhsaye
Amboura Forest
St. Louis
Langue de Barbarie N. P.
Gandiol N. P.
Ferlo Reserve North
Ile des Madelaines National Park
Linguere
Niaye de Sangalkam National Park
Diourbel
Dakar
SENEGAL
Ferlo Reserve South
Ile de Goree National Park
Palmarin Reserve
Baboon Island National Park
Sine-Saloum Delta National Park
Tambacounda
Niokolo Koba National Park
Faleme Hunting Zone
Banjul
GAMBIA
Pata
Abuko Nature Reserve
Zinguinchor
Lower Casamance National Park

WATER CONSERVATION

Bougoutouts Salt Barrier and Water Retention Dam

Dam construction was initiated by Comité d'Action pour le Developpement du Fogny (CADEF). The funding for the dam construction was provided by OXFAM Canada, however, CADEF also receives funding from Church World Service, Centre International d'Education Permanent et d'Amenagment Concerté, USAID, ISRA, and ENEA Dakar.

Soil and water are conserved and productivity of the soil is increased through these interventions. The fresh water retained behind the dam attracts livestock and wildlife. Fish have appeared in the semi-permanent pond that has formed behind the dam. The increased water availability has reduced some of the risks of agricultural production and allowed an intensification of agriculture which utilizes human energy more efficiently.

The dam affects approximately 20 hectares upstream by impounding water for a longer period of time. Also, it affects approximately 50 hectares down stream by providing a flush of water after the tidal flooding and thereby reduces the amount of accumulated salts. Four villages directly benefit from the dam and seven villages indirectly benefit.

Background Information

Bougoutouts is 10 km east of Sindian and 45 km northeast of Ziguinchor in southwestern Senegal. The vegetation cover is a mixture of dense tropical (Soudanean-Guinean) forest, derived savanna through burning, and cleared fields. The area had a pre-1961 yearly rainfall average of 1400 mm and a 1967-1983 average of around 1150 mm, as reported from nearby Ziguinchor. The largest recorded rainfall year in the area was 1750 mm.

The site is within a seasonal drainageway that is used for rice culture. The drainageway is flooded seven months of the year. The first four months only rainfall runoff flows through the drainage, however, during last three months flooding is affected by the tide. The floodplain along the drainageway is becoming more salty and the salt affected areas are spreading up the drainageway. The soils are dark, clayey soils and only formed minor cracks when dry.

Rice is grown when the drainageway is flooded and after the harvest animals graze the residues and drink from surface water left in the depressions. The reduce amount of rainfall and flooding has resulted in reduced rice yields through shorter growing season and increased the amount of salt accumulation from tidal flooding.

Description of Initiative

A 440 meter long earthen dam, 1 to 1.6 meters high, was constructed across a drainageway in order to retain water and improve rice culture and act as a barrier to saline water from tidal flooding. The dam was constructed between February and May 1986. CADEF associations from nearby villages provided and organized the labor used in constructing the dam. CADEF provided the technical support, materials, and equipment used in the construction of the dam. The villagers dug a core for the dam, then filled the trench with layers of compacted clay and lateritic graves. The gravel was used in order to reduce the amount of hard clay that the villager had to dig to form the dam. The gravel was hauled to the site by a project truck. Two concrete and wooden gates were constructed so that the water level could be controlled upstream and stored water could be released in order to flush the fields down stream after the tidal flood recede.

Although a spillway was constructed, CADEF personnel believe the dam will be breached by flooding if the rains of 10 years past returns to the area. The dam is maintained by a committee from the association

which this past year had to dig clay from the down stream side of the dam in order to fill holes and cracks along a section of the dam which were caused by burrowing animals.

CADEF organizes village associations headed by a male and a female president which are selected by the villagers. Village gardens are the projects incentive for the village to start an association. Initially the association is given 25,000 F CFA in order to purchase seeds, fertilizer, and pay for the transport of materials, such as dead wood in order to build a fence.

For the construction of the dam, one family donated their land on which it was built. The others farmers in the area retained their inherited land. The association, on their own initiative, organized a committee in charge of maintaining the dam.

Some of the villages down stream are unhappy about the dam although the down stream yields of rice are larger now than just before dam was constructed. CADEF is planning to construct a second dam down stream from the existing one in order to stop the conflict.

CADEF financed the purchase and transport of materials and supplied skilled labor and technical support. The total cost of the dam was 6.9 million F CFA. The increased yields which resulted from the dam, both up stream and down stream, insure that the villagers will maintain the dam. Also surface water remains behind the dam several months longer and provide a convenient watering hole for animals.

Discussion of the Initiative

The construction of the dams, although often expensive and beyond the means of villagers to organize and construct themselves, offers immediate benefits to a large number of people for long period of time. A well designed and positioned dam can greatly reduce construction cost so experienced, well trained people should be involved in its construction. Water rights, as in this case, are often a point of conflict between neighboring villages so an agreement from all people directly affected should be attained before construction begins.

SOIL CONSERVATION

Border Plantings for Windbreaks and Live Fences

The Sous-Prefet suggested that the people plant dense lines of Euphorbia balsamifera along field boundaries. This use of euphorbia is very similar to its traditional use of marking field boundaries. The dense lines when properly oriented against the wind act as an effective wind break. Some of the border plantings are used as live fencing and are reinforced with thorny branches. These lines of euphorbia greatly reduce the demand for wood and branches that would otherwise be harvested from surrounding trees.

Background Information

These plantings occur around the Keur Momar Sarr area, 60 km east of St. Louis. The area received a pre-1961 average 400 mm of rain per year but only received an average of 233 mm per year between 1968 and 1983. The region is predominantly nearly level sandy plain underlaid by an old residual soil. The soils are loamy sand to sandy loam in texture, are generally low in organic matter, and have high infiltration rates.

Description of Initiative

The Sous-Prefet suggested in 1970 that the people delimit their fields with border plantings of Euphorbia balsamifera for protection against wind erosion, fencing from animals, and to identify field boundaries. Over the past 18 years a large portion of the administrative district (arrondissement) has been treated by the farmers.

The farmers collect cuttings of euphorbia and plant them in rows along field boundaries. Some farmers plant the cuttings more densely than others. As a result, the more densely planted lines act as effective windbreaks and animal barriers, while others only identify field boundaries.

Discussion of Initiative

In areas where wind erosion has occurred, the border plantings capture windblown sand and forming continuous sand ridges. These ridges, when oriented along the contour of the slope, act as water conservation structures to hold runoff and increase water infiltration for the crops. A similar, more deliberate, method of forming these sand dikes, is used in the southern part of Mauritania. There, some the farmers construct brush fences across small drainageways and around their fields in order to keep animals out of their fields and to collect wind blown sand during the dry season. The sand dikes that form retain some or all of the runoff and create water harvesting catchments.

Alone, euphorbia rarely forms a fence that is impenetrable to animals but it does provide an effective barrier when a relatively few thorny branches, cut from nearby trees, are woven among its flexible stems. Where fences are needed, these lines of euphorbia greatly reduce the amount of thorny branches needed to make a fence. Otherwise, these border plantings of euphorbia that protect the fields from wind erosion do not interfere with traditional open grazing during the dry season.

Dune Stabilization Interventions: USAID, Canada, UNSO

The stabilization of the dunes along the coast between Dakar and St.Louis is funded by USAID, Canada and UNSO, and implemented through the government of Senegal with little local participation. All of the three dune stabilization interventions are similar in their approach and implementation.

The projects have resolved, at least for the near future, an acute environmental problem in the area. They help prevent sand blasting of inland plants, intercept salt sprays that reduce or prevent cropping near the shore, stop active dunes from filling inland niayes (agriculturally productive inter-dunal ponds), and increase agricultural production by stabilizing planted areas. All of the projects are, in part, restoration projects from previous human activities that destabilized some of the fixed dunes.

A total of 6,000 hectares of Casuarina equisetifolia trees have been planted since the beginning in 1980-1982 of the three maritime dune stabilization projects.

Background Information

The project areas are near the villages of Kayar, Fotou, and Lompoul, Senegal, along the coast between Dakar and St. Louis in Senegal. The coastal area between Dakar and St. Louis is characterized by a littoral landscape of active dunes adjacent to a marine beach. The beach area consists of active dunes, some of which are partially stabilized with pockets of rushes and succulent vegetation. Further inland, fixed dunes predominate, although blowouts are common and large areas (up to 4,000 ha) of active dunes occur. The dunal soils are loamy sand in texture, are low in organic matter and have high infiltration rates. The niayes (depressions between the dunes) have loamy to clayey soils high in organic matter. The water table is often just below the surface. Some of these niaye depressions were lakes before the Sahelian drought.

The original plant life of the active dunes is not known, however, Acacia tortillis and other species occur in some areas. The vegetative cover was destroyed through overgrazing and overharvesting of wood. This process of devegetation was aggravated by the droughts over the past 40 years, which has extended the number of active and reactivated dunes.

The present vegetation is a mix of planted Casuarina equisetifolia (predominantly between the marine beach and the inner dunes) with openings where Calotropis procera, Maytenus senegalensis, Cyperus maritimus, Cenchrus biflorus/Leptadenia hestata and Indigotera diphyla, and Ipomea sp., occur. Inland, there are eucalyptus and Prosopis juliflora (mesquite) plantations near vegetable gardens. Along roads near Lompoul were plantings of eucalyptus, Acacia holocericea and mesquite. Occasional live fences of Euphorbia balsamifera occur.

Various animals occur in the casuarina plantations. According to tracks, sightings and interviews, both green and patas monkeys use the forest for cover but feed from other trees and gardens. Rodents have made colonies in the stabilized dunes and snakes and jackals and probably raptorial birds are major predators. The plantations form a narrowly defined habitat because leaves and bark are not edible but do provide cover.

The pre-1986 average rainfall ranged from approximately 250 mm per year in the north to 500 mm in the south. Rainfall per year varies substantially. The 1968 to 1983 average annual rainfall was 233 mm to 329 mm. The water table is generally shallow (1.5 - 2.5 meters). Freshwater floats on saltwater and the depth of the freshwater layer is not known. Year around vegetable gardening has been made possible with dug wells. Vegetables include hot peppers, onions, tomatoes, lettuce, carrots, cabbage and others. The area is also characterized by the presence of numerous niayes, or highly productive depressions located between the stabilized dunes that can produce three or four harvests per year of onions and carrots. However, some of the depressional areas are saline which limits the agriculture potential.

Description of Initiative

In USAID's Kayar Project, two bands of trees were planted, approximately eight and 12 km long and between 300 and 400 meters wide. In the Gandiolais project, one band of trees, approximately 31 km long and 200 m wide, was planted. After 1983, a second 200 m wide band of trees was planted parallel to the first band, leaving an open area/distance between the two bands of 30 meters. In the UNSO project, one band, approximately 31 km long and 200 m wide, was successfully reforested. The UNSO project is also in the process of stabilizing interior dunes using other species such as Eucalyptus camaldulensis and mesquite and others. The interior dune is 4,000 hectares in size. Only 974 hectares have been stabilized so far.

In addition to the width of the bands of planted trees in the three projects, the direct impact zone should also include at least 100 m of land directly behind the planted trees, or 800 hectares for the projects. The 100 m wide strip is based on the rule-of-thumb that one meter of windbreak height protects 10 meters of land. The trees in the plantations are now approximately 10 m tall, thus a 100 m wide strip of land along the length of the plantations has been protected and made productive.

Along the maritime beaches Casuarina equisetifolia seedlings were planted in either 2 x 2 or 3 x 3 m spacing. The organic litter at the base of established trees is added to the soil around newly planted trees in order to inoculate the sterile soil with useful bacteria and fungi. Other species have been tried (mesquite in particular) but were rejected in favor of casuarina because the latter proved to be much more salt resistant. The trees appear to be vigorous and healthy but need silvicultural treatment, particularly thinning. Average diameter-breast-height is approximately 15 cm, the height of the trees is approximately 8 to 10 meters. The canopy is largely closed. No natural regeneration is taking place. Within some of the 200 to 400 m wide bands of casuarina there are cleared areas with productive gardens. Each plot is surrounded and well-protected by the trees. These garden plots also existed before the project but were then much less productive.

The only silvicultural treatment of the stands has been in the Kayar project--pruning to allow sunlight to reach the forest floor for the purpose of speeding the decomposition of the needles accumulated on the forest floor. Stands of untreated 33-year old casuarina trees established near Kayar, now have a high mortality rate. In addition, research in the Kayar project has discovered that the casuarina trees do not coppice well if the trees are older than 10 years. Selective harvesting (while maintaining stable dunes) on a rotation of less than 10 years could potentially extend the longevity of the plantations while producing valuable poles, charcoal and firewood. This is a strong argument for suggesting that stands younger that 10 years, which are in need of silvicultural treatment, be so treated to avoid having to replant if the older trees do not coppice.

The productive niayes depressions between the stabilized dunes have been protected by windbreaks. According to Mr. Abdourahmane Sarr, an obviously successful farmer who shares 7.5 hectares in one of the productive niayes, production has more than doubled since the establishment of the windbreaks.

The initiatives are managed by the Forest Service. No communal organization or cooperative has been established or created as a result of the interventions nor has the Forest Service actively promoted the creation of such groups. Local participation has been solicited in the form of paid labor and/or food-for-work, and more importantly, in the form of appealing to villagers to provide voluntary contribute their labor to guard and protect the trees (la nouvelle politique). The villagers are complying, in part, because they will become the woodcutters in the future. Illegal cutting appears to be negligible.

The Gandiolais and UNSO projects, however, are both moving into second phases. Exploitation of the trees has become prioritized and the GOS wants to solicit local participation; however, the formula for how this will work is uncertain. The villagers tacitly understand that the GOS owns the trees but also that the trees are planted for their benefit. Who should benefit how much from the harvest of the trees, is yet to be determined.

The dune stabilization efforts have been instrumental in creating a habitat in the casuarina areas providing shelter and cover needs for wildlife, but not food. The forests now provide shelter for monkeys, African hares, rats, the African wild cat, snakes and several bird species. The trees, once well established, are not damaged or hurt by the presence of the animals. Domesticated animals are forbidden within the planted zone. Some farmers complained about rats, rabbits and monkeys which can cause considerable damage in the gardens.

The interventions have not disturbed traditional land use practices. The farmers were there before the dunes were stabilized. There are more farmers there now because the productivity of the land in the impact zone behind the bands of trees has increased dramatically. Although there is potential for improved gardening practices (hand or motorized pumps etc.), particularly irrigation, none have been adopted, largely for lack of a credit system in the area and there has been no serious effort to establish cooperatives. All purchases of seed

and fertilizer are privatized. In addition, crop productivity has suffered from the use of eucalyptus on the borders of gardens. Eucalyptus roots compete with garden crops for water. All farmers interviewed accepted casuarina because it diminished the salt sprays, and preferred mesquite behind the casuarina because it supplied edible pods and increased soil fertility. The natural regeneration of eucalyptus is encroaching on a small part of one garden and poses a weed problem. Some farmers dig ditches between the eucalyptus trees and their gardens to cut the eucalyptus roots that rob water from the crops. These problems can pose recurrent labor costs.

There is no well-defined economic incentive system. The presence of the interventions have provided local employment opportunities to some degree. Local people from the villages have been hired to do the site preparation and planting work, and continue to work as guardians and, when required, as laborers for any work related to the forest. They are paid sometimes in cash, sometimes through the food-for-work program, and sometimes the labor is voluntary. The trees belong to the GOS and, at present, there is no plan to exploit the forests.

The following undocumented data was obtained during the field visits:

The cost of plantation establishment is approximately 250,000 - 300,000 F CFA per hectare.

The cost of labor is 161 F CFA per hour, or nearly 1,300 F CFA for an 8-hour day.

After six years of growth, the casuarina trees (planted in 2 x 2 m spacing) have reached a height of 10 m and a DIAMETER-BREAST-HEIGHT of 15 cm, on the average.

Opportunity cost of land is zero. If investments had not been made, most economic or productive use of the land would be forfeited. The more appropriate question to ask is whether alternative investments, with the same dune stabilization goal, might not have been more cost-effective.

Any cost/benefit analysis of this type of dune stabilization effort should take into account the increased agricultural productivity in the impact zone; i.e., the 100 m wide strip of protected land down wind of the trees, in addition to the value of the wood products.

Discussion of Initiative

It is now, after having made the investments to prevent a total disappearance of vegetable farming and future wood resources, that dialogue between the GOS and the villagers to define local participation programs in the management/exploitation of the resources, will be timely.

Boubacar Barry (Kayar intervention), voluntary tree nursery worker and farmer, is a retired Forest Service laborer who has lived and worked in the area since 1948. Since his retirement, he has worked for free in the nursery because of his "...love for the trees". Mr. Barry witnessed the process of degradation in the Kayar region over the years and is well aware of the beneficial impacts attributable to the project. He is frustrated, however, because nobody has listened to his ideas on how the forests should be managed, now that management is crucial for the continued vigor of the trees. He is adamant (and correct) that the stands need to be thinned and that the products (poles, fuelwood and charcoal) could be easily marketed. Portions of the proceeds could be used to manage the forests on a sustained yield basis and cover recurrent costs. If his formula were followed, any additional external support may no longer be required.

Mr. Barry has also experimented with additional species of plants (neem, Acacia holocericea, Terminalia, etc.) in order to diversify the inland forest. He stated that casuarina is toxic to other species (undergrowth) and would like to promote more multiples tree species. This activity to promote biodiversity will be discussed in a separate section.

In addition to the inoculation of the sterile, infertile, and sandy soil with litter from established trees, the application of fertilizer, at minimal cost during planting, may help increase growth, survival and reduce protection costs.

From the longer-term point of view, a question of sand balance along the maritime beaches should be investigated. In general, a balance between sand added from both the ocean currents and the dunes leads to a stable beach. It is possible that dune stabilization and the damming of the Senegal River may upset sand balance and eventually lead to erosion and loss of the beach. A geomorphologist might be hired to study the effect of the dune plantations on the equilibrium between the transport of sand by shore currents and the wind. The "worst case" scenario might lead to an undermining of the stabilized dunes.

The depth of freshwater above the saltwater is not quantified. In the bottom of one depression near Leona, salinization had begun to prevent cropping. The reforestation project has probably lowered groundwater tables by increased evapotranspiration and increased hand-watered irrigation. Any increase in irrigation and reforestation will increase usage of the freshwater layer and could lead to saline water entering the root zone and hurt crop production. Before supplying motor pumps or greatly expanding the dune stabilization project, the question of fresh water quantity in the niayes should be investigated.

REFORESTATION

PARCE: Rural Forestry Component

The PARCE (Projet Amenagement et Reboisement du Centre Est) project is a reforestation project supported by the World Bank, the Caisse Centrale (CCCE), FAC, UNDP/FAO and the government of Senegal (GOS). The project has three components, silviculture and management, forestry research, and training. The silviculture and management is composed of natural forest management, industrial plantations (discontinued), and rural forestry. Only the rural forestry component of the PARCE project will be discussed in this case study.

The rural forestry component of the PARCE project began with 95 (non-contiguous) hectares planted on village lands in 1983. Presently, a total of about 3000 hectares have been planted under the auspices of the rural forestry component. The project area (including the natural forest management and industrial plantation components) covers the two departments of Kaffrine and Tambacounda for a total of 25,000 square kilometers.

Background Information

Project is based in Kaffrine, 60 km east of Kaolack. Thoune and Kassas, located 10 km from Kaffrine, are example villages used in this discussion. The villages are small, Thoune has a population of 400. Average rainfall in the region between 1968 and 1983 was 600 to 700 mm per year. The water table in the village of Thoune is approximately 27 meters. The basis of the economy in the project area is rainfed agriculture with peanuts and millet as staple crops.

Description of Initiative

The technical interventions consist of the creation of a network of local nurseries throughout the project zone and the promotion of a number of tree planting and natural regeneration schemes by villagers to meet a variety of needs. The basic purpose of the local nurseries is to make communities largely independent of outside assistance (donor or GOS) in the production of seedlings of whatever species of trees that they desire to plant. In the past two years, some 157 private nurseries have been established in villages scattered throughout the Kaffrine Department and 30 have been established in the Tambacounda Department. All of the nurseries have been set up using existing wells. The project finances approximately 50% of the nursery establishment costs in the forms of seeds, screen protection for the seedlings (against insects), and some pesticides. Total establishment cost for a typical private village nursery (capacity 2,000 plants) is 20,000 F CFA including the cost of basic equipment such as rakes and shovels, etc.

Villagers are taught how to plant trees for woodlots, orchards, field border plantings, live fences, windbreaks, shade and as ornamental in their fields and yards. In short, trees are promoted in whatever niche where they can fill a useful role.

Although the project initially placed most of its emphasis on eucalyptus for woodlots, it has more recently begun to promote the planting of a much wider range of tree and shrub species. In 1987 a total of 37 forest species, most of them indigenous, were planted by participating villagers. The project's emphasis on local species has met with considerable resistance, however. None of the local species produce a straight bole as suited for pole and general construction purposes as eucalyptus. Even on upland sites where eucalyptus grows no more rapidly than native species, it is often the species of choice for the villagers.

The rural forestry component works with 245 and 30 villages in the Kaffrine and Tambacounda Departments respectively. The project offers technical assistance through its extension service. The project recruited former employees of SODEVA who had been trained as agricultural extension workers and gave them further training in forestry techniques including nursery practices, planting techniques, species selection for different sites and forestry extension techniques. These 14 agents have developed an excellent working relationship between the project and villagers, on both collective and individual bases, and with the Sous-Prefets in the impact region. It is probable, the Team was told, that this working relationship is attributable to the fact

that the 14 are not GOS employees. (GOS forestry agents are, more often than not, perceived to have a police enforcement mentality in their work). The extension agents travel on the average 1,500 km per month in their assigned territories on project furnished motorcycles. They are paid between 50,000 and 60,000 F CFA per month by the project, or a little less than a GOS Forest Service technician.

The PARCE rural forestry intervention consists of a highly successful approach in motivating people to participate either collectively with other villagers, or as individuals, without having to depend on project originated economic incentives to attract participants. As a result of day-to-day contact with villagers (both in groups and on an individual basis), the project personnel (particularly the 14 extension agents) has generated enthusiasm among the villagers for the nursery operations and the tree planting activities. Individuals have been trained by project extension agents in nursery techniques in participating villages. The nurserymen often establish the nurseries within their compounds and produce as many seedlings as ordered by the villagers. The project estimates that at least 10 percent of all families in the project area actively participate in the tree planting program. The villagers and project have organized themselves as follows:

At the beginning of the campaign, the extension agent holds village meetings for the purpose of getting orders for seedlings by participating individuals or groups. The extension agents does not impose the choice of species. However, a strong emphasis is placed on choosing appropriate species that will do well on the sites available. The extension agents visits as many of the proposed planting sites as he can. As mentioned above, despite these recommendations, the majority of villagers choose eucalyptus for woodlots even on upland sites not well suited. This is because of its economic value and desirable growth form. Other species such as Acacia albida and Acacia senegal are chosen more frequently for in-field plantings.

As the orders for seedlings are taken, the extension agent collects the sum of 5 F CFA per seedling ordered. This is the unsubsidized cost of the plastic sacks used to raise the seedlings.

The individuals or groups (who ordered the seedlings) often help with the preparation of the potting soil mix and the filling of the plastic sacks. In the same way, the routine work of watering the nursery is often done on a rotating basis.

Seedlings produced for members of the same village are generally not sold for cash. Seedlings ordered by outsiders or other villages, however, are sold for 35 F CFA each. The cost of production is approximately 15 F CFA per seedling.

Villagers are encouraged to use the taungya system of intercropping in newly planted woodlots. This system allow the cultivation of crops until the trees canopy make cropping impractical. This effectively eliminates the problem of weed control and the danger of wildfires during the period of intercropping and reduces the opportunity cost of the land planted in woodlots. The weeding of woodlots that are not intercropped often poses a serious problem to villagers because the weeding must be done during a period of labor shortage when they are fully occupied with their agricultural crops. Villagers generally follow the sylvicultural recommendations such as appropriate tree spacing.

When the trees have reached merchantable pole size and are ready to be harvested, the project sometimes provides a "brokering" service by finding buyers for the woodlot owners' products. Cutting permits from the Forest Service are not required.

Some of the local government bodies (les communautes rurales) have begun allocating 200,000 - 300,000 F CFA in their communal budgets each year for the purpose of tree planting.

The project does not offer any direct economic incentives to attract tree planting participants. This has not been necessary since villagers have learned that growing trees can be an economically competitive (with peanut production) land use activity. Based on a price of eucalyptus poles of 500 F CFA after five years of

growth, one hectare of eucalyptus plantation on a depressional site will typically earn a slightly higher net present value than the same hectare planted in peanuts at a discount rate of 10 percent. The project does, however, offer a direct incentive in the establishment of the several private nurseries in the project impact zone, as discussed above.

There have also been cases where eucalyptus poles were sold for as high as 1,000 F CFA each after a growing period of less than five years. Near the village of Kassas, for example, the Team observed a small 1984 eucalyptus plantation, situated on a slight slope in a depression area where, after only 30 months of growth, the owner sold 30 poles, approximately 8 cm in diameter-breast- height, eight meters tall, for 1,000 F CFA each. Furthermore, the stump sprouts from the trees harvested had already reaches five meters in height in less than a year.

The cost of establishing a typical private village nursery is 20,000 F CFA. The project furnishes approximately one-half in the forms of seeds and basic equipment.

Seedlings are sold to (outside) villagers and individuals for 35 F CFA each. This price is considerably lower than seedling prices in Dakar. Cost of production is approximately 15 F CFA per seedling. Fruit tree seedlings are sold for a higher price because production costs are higher.

Discussion of Initiative

Mr. Ka, the nurseryman met in the village of Thoune (one of three nurserymen in the village), has established his nursery in a corner of his compound. He has produced 2400 and 5000 seedlings in 1986 and 1987, respectively. (The total production of the three nurseries in 1987 was 9000 seedlings). Mr. Ka sold at least 2500 seedlings in 1987 to groups outside his village at 35 F CFA per seedling. He manages the nursery production for his own village on a voluntary basis but much of the routine work is shared by those villagers that have ordered seedlings. He is recognized as a leader in promoting tree planting in the area. For his work as a nurseryman and his leadership qualities, he was decorated by President Abdou Diouf in 1987.

Mr. Ka said he will continue to produce seedlings in the nursery when the project ends because he is certain that the villagers will continue to give him orders. Tree planting in this village is becoming an integral part of their production systems. He said he will continue to produce the seedlings for free for the village of Thoune, and sell them to outsiders for 35 F CFA each. He has his own eucalyptus woodlots established in 1984. He recently sold a few poles for 400 F CFA each.

Why the rural forestry component of the PARCE project is highly successful is attributable to the simple fact that the project has avoided the need to pay people to plant trees. The project sought, and found a simple formula for motivating villagers and individuals to plant trees in their compounds, as field border plantings, in the farm fields themselves, and in woodlots. The project has worked with participating villages on a day-to-day basis over several years, sensitizing them to the benefits that trees provide--economic, soil and water conservation, agricultural productivity, aesthetic, and many other benefits--to the point where the enthusiasm for forestry activities is now more self-generated than depending on outside prompting and cajoling.

The Team asked the PARCE project personnel whether they were aware of the new USAID reforestation project and how they perceived it would affect other forestry interventions in Senegal. Their response was that the USAID reforestation project will probably undermine the PARCE reforestation program because villagers will no longer be motivated to plant trees for free if someone is willing to pay for it, or match the costs they are incurring in their tree planting efforts. They cited an example of a nurseryman in one of project villages who immediately went to Dakar with his books showing his costs, to receive his matching grant money, after having listened to the radio announcement on the new USAID project. In their opinion it will be extremely difficult to continue with the same economic incentive-free formula of motivating people to plant trees if USAID's matching grant formula is implemented as presently intended.

In the team's judgment, based upon this and other experiences in Senegal, the PARCE criticism of the new AID program may be justified. AID would do well to rethink its strategy. Money could easily be reprogrammed to 1) split capital start-up costs with nurserymen; 2) provide loans to functioning nurseries to

grove infrastructure such as wells, holding basins, pipe, hose, fencing and even transport facilities; 3) purchase d for communal, urban woodlots; 4) provide appropriate fire control equipment for urban and rural fire gades; 5) PL480 for firebreak establishment in the heavily forested regions of Tambacounda, Kolda; 6) finance stical supplies (e.g., motor scooters, vehicles, and radios) and infrastructure (e.g., permanent water sources animals and wells for agents) in the national parks. The Team strongly encourages AID to reexamine its rent matching grant strategy, and above all, to coordinate its activities with those of the other forestry donors.

Bamba Thiallance Reforestation

This Catholic Relief Service (CRS) reforestation project is helping the villagers of Diam produce ketable timber on a communal woodlot, restore natural vegetation, and protect the environment. CRS vides technical assistance, tools, and nursery supplies for reforestation efforts. They also provided the fencing ugh a small, private firm located in Rufisque.

The village forestry project has been allocated 250 hectares by the village (before the creation of the munaute Rural). Paperwork was still being processed by the sous-prefecture to legitimatize this allocation e satisfaction of the administration.

Of the 250 ha, eight have been enclosed in a wire fence and seven of the hectares have been reforested dy with eucalyptus and Acacia holocericea. Trees are mature enough for harvesting.

ground Information

Diam is located 18 km south of Koumpentoum, in the Tambacounda region of Senegal. The rainfall 87 was 865 mm. The water table is 50 to 55 meters deep. Rainfed and animal powered mechanized altural production is the traditional land-use pattern. The main crops are millet, corn, sorghum and peanuts. egetative cover is good. Villagers claim that it has been subjected to pressure from the population and the climate. The immediate environment of the village is degraded; surrounding fields are subject to uous cropping. Soils are subject to wind erosion and there are signs of increasing water erosion.

The initiative is a local one, developed with the support of local administrative structures, but strictly ing parallel to official channels. Details of organizational structure are included in the Koumpentoum e case description.

The forestry project has been created independent from other structures under the impetus of Mamadou to (a former school teacher who has initiated several local Non-governmental organizations) and the ve of the villagers. Forestry was one of the original projects of the now diversified program of ntions.

ption of Initiative

The project has fenced eight hectares of land of a 250 hectare plot for polewood production. A one e site in the center of the village near the well has been fenced for a nursery. The nurseryman hopes to a local "arboretum" there. Five hectares have been fenced to establish a communal orchard. Lack of constrains development of both the nursery and the orchard.

Reforestation started first in 1979 with the assistance of the Centre Liberte of Dakar with seedlings ed from the Forest Service. The first attempt to start a nursery failed. In 1985, a Peace Corps volunteer more intensive nursery and reforestation activities, and trained Lamine Diallo, the current nurseryman.

Technical difficulties led the sub-committee to stop attempts at introducing the Ban-ak-soof improved stove. The Coordinator of the Entente expressed hopes of beginning again this year with new outside technical assistance.

The forestry section of the Entente de Koumpentoum is subsidized by CRS and receives technical assistance from CRS, and the government controlled, Centre d'Expansion Rural. The latter lacks the resources to intervene very effectively.

The nursery in Diam can provide seedlings for several villages of the Bamba Thiallance Committee. The nursery is attached to that Committee, rather than to the Diam sub-committee.

The Diam-Diam village sub-committee counts three social groups that carry out reforestation with the support of the nursery; the adult group, the young men's group, and the women's group. Social organization of the forestry intervention is based on sex/age structure, building on traditional divisions and associations in local society.

Nursery work is carried out by the villagers in turn under the supervision of nursery manager, Lamine Diallo. It is his job to organize sowing, watering, field clearing, planting, and protection. Diallo also supervises the work on sub-group plantations, where the work is again collectively organized. He has also helped establish an individual woodlot.

The initial investment is made by the villagers (labor, seedlings) CRS has provided encouragement by making improvements to the well, installation of a wire fence, and provision of technical assistance.

Villagers expect to earn money from sales of eucalyptus poles. A successful sale was carried out last year in the nearby Bamba Thiallance wood lot, where 300-400 F CFA was charged per pole. These poles were harvested from the 1979 planting, which was subsidized by Centre Liberte. Proceeds of the sales will go into the communal treasury to finance subsequent projects.

Individual initiative is the bedrock of the system. For example, Lamine Diallo took advantage of a trip to his home area of Kedougou (southeastern Senegal) to collect seeds of trees that have disappeared from the Diam area. He collected seeds for 24 species and claims to have been able to sprout them all. Diallo claims to receive no compensation for his labors, and has begun to be discouraged about this.

Discussion of Initiative

On the basis of a village initiated analysis of the environmental situation, a reforestation project was conceived in Diam. Both technical capability, knowledge and goals of the program have evolved over the 15 years since the project was first conceived. For example, the villagers now have it in mind to pipe in water from the Ainoumane borewell some three kilometers away in order to water their orchard. Diallo wants to create a local "arboretum."

Further development of the project is constrained by several factors. The first is a shortage in water supply. The well is not providing enough water for the needs of the village population, nor its livestock. It is therefore difficult to motivate villagers to draw water for the nursery, and other reforestation activities and as a result trees in the orchard died for lack of water. A recently constructed, CEAO-financed borewell has never functioned properly and is technically inappropriate for the site.

A second constraint to the development of local forestry is lack of access to additional forestry management information. Diallo wants to learn more about the care of trees. He was ignorant, for example, of pruning technique. In addition, people are largely unaware of the potential of agroforestry to improve productivity, conserve soil moisture and prevent soil erosion.

Fire Suppression and Early Controlled Burning

The Canadian government is supporting a program of early controlled burning and fire suppression easures through the Projet Protection de Forêt du Sud. This project does not seem to be particularly successful r sustainable by the government of Senegal. However the village fire control committees created by the project ould form the basis of a more appropriate form of fire control. Approximately 1.7 million hectares and 2,734 illages in the Casamance region are affected.

ckground Information

The project covers the entire region of the Casamance in southern Senegal. The NRMS team visited e project headquarters in Ziguinchor, the sector office and committee in Bignona (27 km north of Ziguinchor), d the fire brigade in Diegoun (15 km west of Bignona).

The Casamance has suffered the largest absolute decrease in average annual rainfall of any region in negal since 1968. In Ziguinchor, the pre 1961 average yearly rainfall was 1,570 mm and the 1968 to 1983 erage yearly rainfall was 1,150 mm. The natural vegetative cover is dense tropical forest (Soudanean-Guinean rest) and there many well preserved national forest in the region. The region is the major wood reserve of negal, however, many areas of cleared fields and derived savanna occur, especially in the lower Casamance.

The lower rainfall coupled with the increased area of fallow fields covered in grass increases the threat forest fires and threaten to change the area toward a savanna type of ecology.

There is serious soil erosion in the eastern region. Agriculture is very diversified with peanuts, cereals, ts, and vegetables, especially in the western portion. The agricultural fields under go a fallow period of one three years and develop a thick grass cover. In the past farmers cropped upland fields for two to three years d then left them in fallow for up to 25 years. Agriculture in this region includes field crops, gardens, rice tivation, and fruit tree culture. Depressional areas are often used for rice culture. Burning of the fallow land been a traditional practice. Products derived from natural vegetation, such as palm wine and palm oil, vide an important source of income for many villagers. Pasturage is also important, especially in the eastern ion.

scription of Initiative

The Canadian government funded the project between 1976 to 1979 and between 1980 to 1985. The negalese counter part funds were to finance the continuation of the project but Senegal failed to provide the essary funds on a regular basis. The Canadian government restarted funding in 1985 and greatly modified project towards the use of fire control techniques that are more adapted to Senegal.

At first the Canadians planned to transfer the technique used in Canada which depend on planes, heavy ipment, sophisticated detection and information systems. This plan was rejected due to the prohibitive cost lack of technically trained Senegalese. The modified plan that was approved utilizes paid brigades and nteer committees, however, some aspects of the high technology approach was maintained in that observation ers and a radio communication system are still planned.

Twenty fire brigades have been created to fight large fires and provide support to the fire fighting mittees. Each brigade consists of a team of fire fighters and a 30 million franc CFA four wheel drive water k to help in fighting fires. Members of the brigade are hired for eight months of the year and paid through project.

The project organizes in each village a committee to voluntarily protect the forest from fire during the eason and for reforestation during the rainy season. The projet supplies the committees with a limited

amount of hand tool and training for fighting fires. The Forests Service provides the committees with seeds, seedlings, and technical service for reforestation. The reforestation aspect of the project was included so that contact with the villages is maintain throughout the year. The project is mainly interested in protecting areas around national forests, tree plantations, and along roads.

The project initiated the formation of the brigades which help support the fire fighting committees that were formed in 1976 under a different project.

The committee members are not paid, however, they occasionally receive food aid through the World Food Program. Some committee support their activities by generating income through communal tree plantations, gardens, orchards, and poultry production.

The fire brigades members are hired and paid by the project for eight months each year.

Women are the most active group in fire protection activities sponsored by the project.

Discussion of Initiative

A major frustration of the Canadians was the high turnover in Senegalese government workers through transfers ordered by the Forest Service. This made it difficult for the project to maintain a trained staff and required a longer presence of expatriate experts in order to train the new personnel. A major frustration of the Senegalese is that they will be unable to support the project on their own when Canadian funding stops. The government of Senegal will not likely fund the maintenance of the heavy equipment and pay for the brigade's salaries.

The positive aspect of this project is that it is helping to strengthen the village committees, however, more fund raising activities need to be developed. The committees realize that uncontrolled fires threaten to destroy their environment and enthusiastically support fire prevention and fire fighting activities. These activities are likely to continue after the project ends.

PRECOBA Private Nurseries and Rural Forestry

These initiatives are part of the PRECOBA project. The project's purpose is to fight desertification and to promote individual and regional wood self-sufficiency. It is implemented through the Forest Service with outside funding from FINNIDA (Finland).

Between 1981 and 1987, the project established 1,375 ha of woodlots, oversaw field planting of 734 ha of Acacia albida, encouraged the protection and natural regeneration of 3,580 ha of Acacia albida and 328 ha of Borassus aethiopum, protected 150 ha of sylvopastoral lands, and promoted the fabrication of improved wood stoves.

Background Information

The project covers the seven arrondissements (counties) in the Department of Kaolack. A small private nursery located 20 km southeast of Fatick (just north of Route 1), and eucalyptus plantation near the village of Dya further southeast are used as example sites in the discussion.

The PRECOBA project area covers 260,000 ha. This includes seven arrondissements (counties) and 33 rural communities. The area is situated within Senegal's densely populated peanut basin and borders on the estuary of the Sine Saloum to the south-southwest. Population density is approximately 100 people per km2.

The pre-1968 average annual rainfall was about 70 percent greater than the 1968 to 1983 average (850 and 500 mm, respectively). This has severely limited the productivity of peanuts and millet, the two major crops in the area. Sixty-two percent of the area is classified as agricultural land.

The topographic relief is minimal, the entire area lying less than 40 m above sea level. The majority f wells in the project area are less than 12 m deep.

The rural economy of the area is based on rainfed agriculture with peanuts and millet as the two major ops. Decreased rainfall and shortened fallow periods due to the high population density have decreased the oductivity of the traditional production systems. Animal traction is widely used.

escription of Initiative

The major technical interventions of the project are as follows:

omotion of at least one private nursery in each of the rural communities in the project area.

oodlots.

eld tree plantings of Acacia albida.

otection of naturally regenerated Acacias and Borassus trees in farmers' fields.

e majority of the project's activities are implemented through the rural communities (an elected level of nent representing about 15 to 20 villages, below the level of sous-prefeture). The objective of the project is e a structure for rural forestry interventions within each rural community that will be able to function dently upon project completion. Extension is done by Forest Service agents.

e seedlings required for tree planting are produced by a single nursery in each rural community. Each nursery p as a private enterprise to sell seedlings to the community and to villager associations, individuals and es. Each year the community decides what its planting program for the year will be, and orders the seedlings r nurseryman.

ial woodlots were mostly 10 ha block plantings of eucalyptus belonging to the community. recently, the s has shifted strongly to village woodlots, for two reasons: (1) Some of the early woodlots have been harvested s at considerable profit, sparking the interest in additional woodlot plantings; (2) Distrust of the rural ity level handling of funds has made villagers want to plant their own woodlots.

sh profit is the primary incentive for the nurserymen. Seedlings are sold to the rural communities for 50 F r seedling. Average production in 1987 per nursery for the woodlots alone, was 5,870 seedlings. Each man is encouraged to develop his own market. Most of the non-project sales are fruit tree seedlings.

r the purchase of materials costing up to 10,000 F CFA, the project pays one-half and extends credit for the lf. For wells, the project supplies at no cost, the cement and steel reinforcing rods while the nurseryman the labor.

madou Sow was visited in his nursery. He began as a trainee in 1983 with one other villager. The partnership work out, and after two years Mamadou took over full ownership of the nursery. Mamadou has produced d 16,000 seedlings, respectively in 1986 and 1987. In 1987 he sold 8000 seedlings at 50 F CFA of which only to the rural community. Another 4000 seedlings were sold at an undisclosed price or were traded to for ms, all but two of which he has since sold. Nearly all of Mamadou's sales to private individuals were of fruit dlings. (Another nursery run by two nurserymen had total receipts of 700,000 F CFA 1987.)

At the time of our visit, much of Mamadou's nursery was planted to onion seedlings that he will sell as transplants to local gardeners. Mamadou also has his own heavily manured, lush garden of red peppers and a plot of cassava interplanted with mango trees.

Their are other signs that the business is prospering. Mamadou has recently built a new house and has taken a second wife. He has purchased horses with which he hopes to start a water delivery business using his two remaining steel drums. Water is a problem for him, however. He has already dug four wells at the nursery site; one is completely dry and the yield of the others is not high.

Mamadou feels that he would be capable of operating his nursery without PRECOBA's assistance on the condition that he be shown where he can purchase the plastic sacks he needs. Mr. Bodian has promised to do this for him, as he intends to do for all the nurserymen that PRECOBA has helped get started.

The main incentive for the woodlot plantings is the production of poles for sale. Some of the oldest eucalyptus woodlots have already been harvested. One of the rural communities recently received the following prices for the products they harvested:

6 meter poles (ca. 12 cm butt diameter).....3000 F CFA
4 meter poles .....1000 F CFA
Handles for hillares (local weeding tool).....300 F CFA

The price they received from tourist hotels for the six meter poles, which were used for the construction of thatched roof shelters, is exceptionally high.

Thirty hectares of a rural communities plantation was visited near the village of Dya. The plantation had been established on marginal land bordering a tan (barren flats bordering mangrove swamps). 10 has planted in 1983 are slated for harvest within the next few months. Most of the trees will produce 4 to 6 m poles; there are roughly 500 trees per hectare.

Many of the villages in the project area have marginal land bordering tans that are suitable for woodlots. On such sites, the opportunity costs of tree planting are lower than in villages where cropland must be taken out of production to establish a woodlot. The proximity of beach resorts and urban markets in Dakar, Kaolack and Thies also favor the economics of pole production in the project area.

By fostering the creation of only one private nursery for each rural community of 15 to 20 villages, the project has greatly enhanced the chances for the financial viability of this limited number of nurseries. It has also monetized the production of seedlings to a far greater extent than other projects like PARCE or PAFOCSE that have sponsored a much denser network of nurseries.

Discussion of Initiative

This project has had impressive success in fostering the creation of rural nurseries as private businesses and in promoting investment in polewood plantations on a commercial basis. It seems likely that these activities will be continued after the completion of the project.

We were not able to visit the Acacia albida or Borassus plantings/regeneration nor the sylvo-pastoral areas "mise en defense". The latter intervention is of particular interest because it is based primarily on the social organization of a village and not on costly inputs. To rehabilitate degraded natural woodlands/ range, the participating villages have agreed to stop nearly all use of selected areas for two year periods. No woodcutting or pasturage is permitted. This is accomplished without fencing; the villagers enforce the agreement by their own surveillance. Hay is harvested from these areas at agreed upon times. This low cost management technique could have a major potential for replicability throughout the Sahel. Its application would certainly be complicated, however, in areas where transhumant herding is still an important use of the land.

SOIL FERTILITY IMPROVEMENT/BIODIVERSITY IMPROVEMENT

Gardens of Useful Shrubs and Trees

.Forest Service agent and Canadian volunteer working through the Canadian Gandiolas Dune Stabilization :are helping villagers establish irrigated gardens for useful shrubs and trees, many of which have become rare ırea. The project furnishes the seedlings and gives technical advice. In each of the 25 participating villages, ıub/tree gardens are enclosed by live fences. Although it is not farmer initiated, the local support and ısm for it have grown rapidly as a result of the extension work carried out by the Forest Service agent and the ın volunteer attached to the project.

ıe converted nursery is approximately one-half hectare in size. The horticulture/woodlots site is approximately ırter of one hectare in size. Similar size plots are established in other 25 villages in the region.

ınnd Informati

ıona (population 950) is the example village of this discussion and is located on the Atlantic coast, 35 km south ıuis and 20 km west of Louga in Senegal. Two locations were visited: (1) nursery converted to dry season ıg within the maritime dunes near Leona; and (2) horticulture/woodlot in the town of Leona. The soils in ı are loamy sand in texture, are low in organic matter, and have high infiltration rates. The water table is (often just below the surface) close to the beach. Average annual rainfall is approximately 300 mm.

ıs intervention is an important contributor to the horticultural diversity in the region. The idea is based on ıle concept of a project meeting local needs through local participation. Under the auspices of the rural component of the project, Mr. Faye works directly in a training and extension capacity with Ms. Sirois and ıen's groups in 25 of the 103 villages in the region to determine horticultural priorities. The purpose of the ıis to establish small gardens of perennial shrubs and trees with species chosen and cared for by the villagers. re no special criteria for species selection. Ms. Sirois tries to find the seeds preferred by the women's groups. ıect so far has been able to comply with nearly all of the requests. Choices have been made for a relatively ıge of shrub and tree species no longer abundant in the area. They include species for medicinal, cosmetic, ı supplement purposes. Few fuelwood species have been chosen. There is great interest in fruit trees but ıe been difficult to establish.

ıditionally, the areas around villages were rich in many species that provided special needs such as henna to e's nails or hair; Cassia sieberiana for a tonic against fatigue or Ziziphus mauritiana for its fruit. These ıecies have been lost or become rare over the past few decades from human pressure on the land, drought, ıerharvesting of medicinal plants for urban markets, etc. With the loss of these plants or the fragmentation ıint populations into isolated individuals, pollination and seed development decreased or disappeared and ıeneration collapsed. In addition, younger women could no longer use or grow the plants because first hand re and knowledge decreased and the cross-generational ties weakened. Many of these plants also had cultural ıich, although rarely documented, have suffered from lack of materials.

ıon of Initiative

: intervention consists of planting a variety of woody species chosen by the villagers to meet a wide variety : needs on small plots of land made available by the village chiefs. The project furnishes the seedlings and ınical advice. In each of the 25 participating villages, the shrub/tree gardens are enclosed by live fences.

: women's group (Groupement Feminin) of the village (53 members in Leona) is responsible for the ıent and maintenance of the shrub/tree garden. They prepare the site for planting and care for the trees ıs once established. Subgroups perform different tasks, particularly watering during the dry season and

intercropping of black-eyed peas during the rainy season. Some of the gardeners were men working for or in the women's group.

There is no direct economic incentive offered by the project associated with this intervention. The villagers (through the women's group) participate because they recognize the direct benefits they receive. For example, the availability of medicinal plants may lower expenditures for medicines.

All labor required to plant the live fences and the trees, and to care for them is voluntary, undertaken by the women's group on behalf of the village. Because the plot allocated to this activity is small (usually less than 1/4 ha), the time spent by individual group members on the intervention is relatively insignificant.

Collection of seeds, drying, and nursery work is done by Ms. Sirois and the nursery team near the Leona dunes. Ms. Sirois receives her salary from Canadian Peace Corps. Mr. Faye does his work under the salary received through the Forest Service. There was no growth and yield information available, nor on the relative values of the harvestable products and the criteria by which they will be distributed among the users.

Discussion of Initiative

N'Guissaly Kholle is the President of the women's group in the village of Leone. She is a dynamic woman and highly respected by the members of the group and the villagers as a whole. For her excellent work with the woodlots and other activities on behalf for her village and other villages in the area, she was decorated by Senegal's President Abdou Diouf last year. The apparent success of this intervention can be largely attributed to her personal leadership qualities. This is a lesson learned many times by the Team which cannot be stressed too strongly. Without this key type of person as a leader, one who has both the authority and respect of the members of the group, the intervention will probably not succeed, despite how well it is designed and implemented technically. The ability to motivate or rally potential participants in a particular intervention is probably a more important element of the success of the intervention than any of the other elements.

Mr. Faye, the Agent Technique, is also a major contributor to the apparent success of this intervention. He was attached to the project with a specific scope-of-work to carry out a much more conventional rural forestry program, e.g., participatory fuelwood plantations, etc. Instead, he detected, at an early stage, a lack of enthusiasm for this approach and subsequently changed the strategy entirely to its present form. In the original approach the underlying value judgement was that the Forest Service knows best what the villagers should want. Consequently, as has been seen so often, the villagers become reluctant recipients of project interventions for which they have little appreciation, and more importantly, in which they have little desire to donate their labor. By steering the intended intervention in a different direction, to let the villagers set their own priorities and let it be for them and by them, the level of enthusiasm ended up being much higher and the supply of voluntary labor has been abundant. Mr. Faye's attitude can be considered exceptional for the Forest Service.

Marie Claude Sirois came to the Leona area without a clear program from her Canadian volunteer organization. Through talking with the village women, she began to understand that many plants were difficult to find or scarce in the markets or had disappeared. She teamed up with Mr. Faye in this project. She travels about Senegal and collects seeds for the requested plants, prepares them for the nursery and distributes the seedlings to womens' groups. Her enthusiasm is great as she is learning as well as helping. This type project seems ideally suited for Peace Corps volunteers.

Irrigated Gardening Along Guier Lake

Church World Service (CWS) initiated improved irrigation practices and introduced new crops and crop cultivar to the farmers in the area. CWS provide technical and financial support. In the village of Ganket Balla, a total of 85 farmers in the gardeners association (Groupement Maraichage) have been given technical assistance in intensive gardening which utilizes the receding waters of Guier Lake during the dry season. Garden plots, approximately one-tenth of a hectare, are allocated to the participating farmers. In addition, the other CWS associations, (the appropriate technology group, health, reforestation, women, literacy, and youth groups), participate with the garden association in farming 17 hectares of collective gardens. Similar arrangements are made in eight other villages participating in

rogram. All of the collective farm production is sold and profits are used for village needs such as the uction of wells, purchase of a motorized pump for irrigation, irrigation hoses and other equipment. So far, its into the bank account have far exceeded the withdrawals.

round Information

Keur Momar Sarr and Ganket Balla are located 60 km east of St. Louis in Senegal. The moderately wealthy f Ganket Balla (population 300) practices dry season, irrigated gardening, predominantly on the sandy banks lope) above the Guier Lake flood plain. The area received a pre-1961 average 400 mm of rain per year but only d an average of 233 mm per year between 1968 and 1983. The soils on this sandy plain are generally very able, low in organic matter and susceptible to wind erosion if left exposed. Accumulation of sand along some live fences of Euphorbia balsamifera indicate that recent wind erosion has occurred. The predominant land this region is pasturage on fallow agriculture land (> 90%). The predominant vegetative cover is grass with small trees of Balanites aegyptiaca, Acacia ssp., and Adansonia digitata. Tree regeneration is limited, while e of harvesting from live and dead trees (trimmed branches and dead stumps) is common. The Ferlo Valley rough the area and provides permanent and seasonal ponds and lakes from collected runoff and flooding of egal River.

1983, a food-for-work program with food provided by USAID began in the Keur Momar Sarr area. A cereal d Programme Integre du Developpement (PID) were parts of this program which included reforestation, eight ng projects, an appropriate technology workshop, a fish culture project, and a livestock project. This g) intervention is one of three successful interventions among the eight that were started. The earthen dams ted across the Ferlo Valley retain the flood waters of the Senegal River and provide an increased area of water for a longer period of time. The increased water availability has facilitated irrigated gardening on the anks along the floodplains.

e farmers used the sandy banks along the Guier Lake for some millet and manioc production before the CWS : The use of this resource, however, was minimal.

ion of Initiative

igated gardening using simple hand pumps. The techniques introduced by CWS are new to the village. CWS tion of vegetable crops, improved management techniques, and simple hand pumps, have greatly increased table production on these soils and provide dry season incomes for the participating farmers. These technical ions consist of:

- Site preparation technologies
- Plant spacing
- Watering frequency and quantity applied
- Fertilizer and pesticide application
- Windbreak reforestation around garden plots

part of the CWS technical intervention, farmers grow live fences of mesquite (Prosopis juliflora) and a balsamifera to protect the crops from animals and dry winds. In order to increase the access to water, the dig short, shallow canals to bring water from nearby low spots in the floodplain to the edge of the gardens andy banks. This allows them to pump water from a permanent stations as the lake recedes. The pumps used ly make from the CWS project's appropriate technology group and can lift water up to three meters. The e of a simple but functional design and are easily moved to new locations. CWS has also trained people in e to repair and maintain the pumps.

irrigated loamy sand to sandy loam soils have high infiltration rates which pose problems for efficient water and distribution. The farmers fill watering cans (also constructed by project craftsmen) directly from the

pump or from small cement reservoirs (constructed by CWS) which collect the pumped water. The irrigated crops are grown in small rectangular, flattened beds (2-3m2) that are surrounded by small bunds which allows quick flooding of the beds for even distribution of water. The beds are orientated roughly along the contour in order to minimize the leveling needed for the beds. The predominant crops are onions, potatoes, manioc, sweet potatoes, lettuce, cabbage, and henna, young date palm trees were growing in some of the gardens. Chemical fertilizer (10-10-20), which is donated by CWS, is used along with manure on these light reddish brown, organic matter poor soils. Some composting of peanut stems is practiced by the farmers. CWS erected a barbed wire strand fence completely around areas to be gardened. This prevented intrusion by livestock. The fence effectively demonstrated CWS commitment to the project.

Association members have generally adopted the techniques extended by the CWS field experts. However, some farmers apply excessive amounts of fertilizer supplied by CWS. The problem has been the lack of precision with which they follow the technical advice.

The results of having adopted lake recession (irrigated) agriculture techniques have not only greatly benefited participating farmers economically and nutritionally, but have also served as a highly visible and effective demonstration tool. Many farmers from nearby villages observe the results of the CWS interventions and request technical assistance.

CWS originally contacted village chiefs and asked them what the villages wanted and needed. The villagers then formed their own group under the guidelines of "les Groupements Integres Economique" (GIE). This Senegalese law allows for increased "privatized" small business associations. It has the great benefit of being officially recognized. After GIE rules and regulations have been registered in Louga, conflicts can be brought into the court system. Each association member contributed 7,500 F CFA to establish a working capital (Fond de Roulement) to purchase seeds and other necessary items. The initial capital (600,000 F CFA) was provided by CWS. The creation of the association and the election of dynamic and enthusiastic leaders appear to have been essential factors in the success of this intervention.

The team sensed that the village participants in the CWS activities had close ties with leaders of the village. The Team could not tell, however, if the success of this project was, in part, due to the consolidation of land tenure by a particular group of powerful individuals.

The project offers few direct incentives (e.g., free fertilizer) to the participants. The major incentives are in the fruits of their labor. As a result of the increased rates of production, incomes to the garden association members have increased more than three-fold.

The following table gives some production and price data as obtained from the members in the Groupement:

Crops 1,000 m2 Plot	Production/(Kg)	Min. Price/Kg To Groupement
Onions	600	100
Sweet Potatoes	600-1000	100
Tomatoes	3,600	133

Note: The prices are minimum based on relative supply abundance in the open market. Prices increase when open market supplies are scarce.

This is one of three villages that have enthusiastically adopted CWS activities (see below). Five other villages ing with CWS had less than desirable participation. Those villages that are more active receive increased ort from CWS.

ssion of Initiative

CWS has provided the farmers with technical and financial support to promote the adoption of more intensive able gardening. To this effect, they have promoted hand pump irrigation using relatively inexpensive ($130) ps, and free chemical fertilizer. Mr. Corbeil, Manager of the CWS project, had mixed opinions of how well e 1 of the project (which ends this year) has succeeded. In his opinion, the CWS approach was far too one- land top-down in the beginning. Of the eight original participating villages (Gueo, Keur Aya, Keur Momar Sarr, iet Guent, Lobodou, Ganket Balla, Keur Kane, and Loyenne),only the latter three will likely continue with the entions once project support has ended.

But despite the lack of total success in all of the eight villages, the intervention has clearly demonstrated that it ssible to bridge, the gap between traditional subsistence level agriculture, and drastically increased economic being for the participants, with minimal investments. Before, the farmers had limited knowledge of vegetable ning. Now they have been well trained and the resulting increases in their incomes have been substantial. As oned above, many farmers from nearby non- participating villages have noted the results and want to learn and te.

It should also be emphasized again that the success of the gardening interventions depends on effective ship and/or possible connections to the more respected and powerful groups within a village. The reason given by five of the eight participating villages will probably not continue after CWS support has ended, is the absence h leadership. Intensive vegetable gardening, as practiced, is hard work and is a new form of agriculture that es constant attention. Unless the leaders of the association are successful in motivating the members, the ention will likely fail.

Another important element of the success of the gardening intervention is the integrated approach developed CWS project. According to farmers, success requires integrated management of:

- Seed source reliability
- Water source reliability
- Water delivery without exorbitant labor
- Fertilizer source and delivery techniques
- Correct crop choice
- Ability to store some food in order to safeguard for short supply situations and/or sell when the price is right

CWS should be complimented on taking all of these requirements into account when designing the project. The ention would have been less likely to succeed if the appropriate technology group had not been present. The ers would have had to purchase much more expensive pumps and watering cans and other tools in the open t. Repairs would have been much more costly. If the grain storage group had not been present, the gardening ention would have suffered. Without supply and price stability for the staple crops, it would be more difficult centrate on intensive vegetable gardening.

The second phase of the CWS intervention will correct the mistakes made in the first phase. The top-down ach will be avoided as much as possible when new villages are added to the program.

The lake recession agriculture in this area is about to be integrated in the Senegal River Basin water gement of OMVS. Local people are not aware that lake levels will no longer be "recessional" seasonally. Some

women do not have CWS-type plots but are dependent on lower lake levels for gardening. Conflicts may occur as certain citizens find the gardens are inundated in the dry season.

Africare Dry Season Gardening/Wells

Africare is assisting village associations to establish 0.8 ha dry season gardens and developing markets for 15 participating villages. The villages are located within an 1,000 km2 area near Kaolack. In each village there is one hectare of fenced garden.

Background Information

N'Diakhat, Keur Madicke, and Thiaklio N'Djrgane are three example villages used in this discussion and they are located 20 to 30 km south of Kaolack in the central western part of Senegal. The water table in this area generally occurs between 17 to 25 meters. The soils are deep, sandy loam in texture, and moderately high in organic matter. Soil erosion is minor with only a few areas of sheet and gully erosion. The major land use is rainfed agriculture (approximately 60%) with some fallow area that are used for pasture (20%) and forest land (20%). The main crops are peanuts and millet. The field trees are mostly of Cordyla pinata, Tamarindus indica, Adansonia digitata, and Cola cordifolia. Some of the villages had prior experience with dry season gardening.

Description of Initiative

USAID/Dakar invited Africare to submit a project proposal on agroforestry which was significantly modified and became a gardening/livestock project. The Prefet of Kaolack selected the villages for the project.

Africare is assisting villager associations to establish 0.8 ha dry season gardens in each of the 15 villages. Each garden is hand watered from a single, concrete lined well that is constructed at each garden site. Two concrete holding tanks at each site decrease the distance that water must be carried by hand. They are connected to the well by pipe. Well and reservoir construction are done by trusted professionals from the Thies area with whom Africare has had prior experience.

Fencing is done by the villagers using local materials. At N'Diakhat, part of the garden is surrounded by a pre-existing live fence consisting of an inner row of Euphorbia Balsamifera and an outer row of sisal (Agave sisalana). This very effective technique of live fencing is an old practice in this village. (Villagers in the Fouta Djalon Highlands of Guinea claim that a good sisal fence is even effective against monkeys).

Villagers are trained to handle and apply pesticides. Adult literacy training is conducted in Wolof. Arithmetic and basic health classes are also taught.

Each villager association is composed of 40 members with 25 men and 15 women. The creation of the association and its make-up was imposed by Africare. An equal number of garden plots are assigned to each woman at each site; men are not given plots. The men take main responsibility for fence construction and maintenance and help with the gardening in some cases. The gardening is done strictly on an individual basis; from prior experience, Africare has found that communal gardening rarely works.

Africare has required each village to specialize in only two vegetables. This was done with the idea of limiting the competition amongst villages in the weekly markets.

The project provides a direct economic incentive in the form of a 60% subsidy for the cost of the well and tank construction. To participate in the project, however, the association must first raise five percent of the estimated cost of well construction from its members and deposit this amount in a bank account opened with Africare's assistance. The remaining balance of 35% is in the form of a loan to the association to be paid back to Africare from the sale of garden produce. The villagers will benefit from the gardens through the sale and consumption of the vegetables grown and from the new water supply from the well.

The total cost of the 17 m well with two concrete holding tanks at N'Diakhat is about 800,000 F CFA or 47,000 FA per meter. As the first gardens had just been planted, no marketing experience had yet been gained. Africare ıs to help the associations market their produce by transporting part of it to Kaolack with an Africare truck. The deners will have to pay Africare for the transport.

The land for each garden site has been loaned by someone in the village. It was intended that the land would ormally transferred to each association before gardening began. This was not done, however, because of a late t-up, and the owners will continue to use the sites for crops in the rainy season. This could pose serious problems ie future.

ussion of Initiative

A number of the conditions imposed by Africare are of questionable value. Why should each association have ame number of members with the same ratio of men to women? Why only assign garden plots to women? It ıely that the chances of success would be greater if the associations had a greater voice in making these decisions.

The women have complained that their work in the gardens comes in addition to all of their very substantial ine chores. Nothing has been done to alleviate those chores. A mill for grinding millet would be a significant r saving device for them.

Requiring each association to specialize in two vegetables is of questionable value. It will force an increased etization of production through the exchange of the vegetables in the marketplace. But limiting the number of ables in a garden may greatly increase the risk of crop failure. And, certain types of vegetables are bound to g a higher return than others favoring one association over another. It would seem preferable to allow each nation to determine their own mix of vegetables, as they almost certainly will do in time, in any case.

This Africare project consists of forming collectives of 15 villages associations for the purpose of irrigated ming, literacy training, and livestock feeding. Africare requires that each village association consists of 40 bers, 25 men and 15 women who are involved in all aspects of project implementation and management.

The main activity of the project is dry season gardening on 2.5 acres. The land is provided by a member of the ciation who retains the right to cultivate the area for millet during the rainy season. Each one hectare garden is ed among the 15 women members of association who cultivate each plot individually.

The irrigated gardens include a concrete well and irrigation reservoirs which are constructed by skilled labors Africare had previously used in other projects. Labor and materials were financed through the association's Fencing for the gardens is predominantly constructed from wood, however, in N'Diakhat the garden a live already existed. The live fence consisted of an inner row Euphorbia balsamifera and an outer row of densely d Agave sisalana.

Africare trains the villagers in gardening techniques such how as to safely use, handle, and apply pesticides. are requires that each association and its members be responsible for the production of two vegetable crops ted by Africare) which are sold through the collective of 15 villages. Africare provides a truck for transporting ables and makes pickups every three days. The associations and Africare are searching for ways to transport and t the produce after Africare's support ends.

Africare involves the villagers in all aspects of project administration, purchasing, and financial operations. Sixty of the financing is supported by USAID and 40% by the villagers, five percent of which is paid by the villagers beginning of the project and the remaining 35% obtained as a loan from the bank. The village association and are for the first time learning how to manage their money from a bank account.

Literacy training is in local language and includes reading, writing, and arithmetic. Teaching method use practical examples that are useful in their daily life and association activities. The livestock feeding program has not begun.

The well is communally used by the fifteen women for their individual plots. The men help the women during the difficult tasks such as plowing and pulling water from the well.

Gardening provide dry season income for the women many of whom would have to work as maids in the towns and cities in order to help support their families. The extra vegetables grown provides an increased variety of food which would otherwise be purchased. However, the gardening activities add to the work load of the women. The project also provides incentive for the creation of the associations by absorbing 60% of the cost of construction concrete lined wells which provide long term benefits to the villages.

In addition to their financial participation the association members provide their labor. The project directly and indirectly benefits the whole village by educating and training association members who then pass the information to the other villagers.

The loss of dry season pasturage is more than compensated by the yield increases of millet during the rainy season because of the residual fertilizer and organic matter left in the soil from gardening.

Although it is questionable whether limiting the village participation to 25 members, the garden to 2.5 acres, and crop production to two vegetables per village is an ideal arrangement of the associations and the collective, the structure of these organization seems to work.

Vegetable gardening provides the focal point for a number of interventions. Beside providing the immediate benefits by increasing income and providing a better food and water supply, the gardening project provides an incentive and opportunity to improve literacy, health care, arithmetic, technical, organizational, and managerial skills. By creating a means to collectively sell their produce at a better price and more efficiently, the project also encourages cooperation between villagers and villages. The members are very enthusiastic about this project because it involved them in all aspects of implementation and management and provides them a means to achieve independence from outside assistance.

ORGANIZATIONAL IMPROVEMENT

The Village Association of Koumpentoum

The Koumpentoum "Entente" was founded in 1974 in the aftermath of the first wave of modern Sahelian ught. Historically in an 1000 mm rainfall zone, the sixteen year rainfall average since 1968 has been only 700 mm. 1987, the nurseryman in Diam recorded at total of 865 mm. The Entente (Understanding) was create by an ptional group of concerned local villagers to do something about their environment. The small nucleus of the nization received help and encouragement from a famous Senegalese extension worker named Mahamadou soko. After ten years of experience, virtually every activity is planned by the villagers themselves before seeking side financing. Participation is voluntary; some activities are self-financed. The association has received support n at least half a dozen NGOs and other donors, but has received for 10 years consistent technical assistance and ncial backing from Catholic Relief Services.

The village of Diam has undertaken a series of natural resources management initiatives. In 1981, the sub-mittee in the village of Diam set aside 250 ha of village land for reforestation activities. Of eight hectares of ted plantations for Eucalyptus, Australian acacias and local species have been set aside, seven have been planted. additional hectares of land are fenced for a future village orchard. A twenty-five acres woodlot and windbreaks been planted by the Coordinator of the Entente as demonstrations. Both the youth group and the women's up have planted 50 acres of Eucalyptus each. The village nurseryman has gathered seeds in a more southern zone xgin to regenerate lost or scarce native tree species. In addition, six hectares of fields per year are fertilized ough a planned, staggered program of animal stabling of collectively managed, but individually owned herds.

In addition to these natural resources initiatives, the village of Diam has built a collective granary, a cooperative , a small, unstaffed, health clinic, a warehouse, and is stocking bricks to build a mosque. The Entente purchased illet thresher for the village of Diam, and the village association itself purchased a millet mill. A clever scheme which co-owned goats and cattle are used to create the nucleus of individual herds is alsy underway. The sub-mittee expects to receive new technical assistance to launch an improved stove production program in the village n.

The project is distinctive in structure, but bears similarities to the AJAC project in the Casamance region. A nal, representative umbrella organization embraces numerous village level projects and sub-committees. This ciple is maintained at the level of the Entente as a whole.

Funding was originally generated from collective fields and this mechanism is still used. Thus, both the mittee and the sub-committee have cooperative granaries, "in kind cash boxes" in Diam. Recently the Entente instituted a compulsory cooperative savings scheme. Every year each male member must contribute 10,000 CFA each woman member 2,500 CFA to the fund. The Entente has over 1000 members and membership grows ly.

Diverse incentives exist within Entente projects. For example, from the proceeds of collective fields, threshers mills have been purchased which diminish women's labor bottlenecks. Buying at the local cooperative store, h is very well-stocked, reduces individual customer travel time. Store manager(s) receive an annual percentage-d indemnity. Polewood has been sold from the Bamba Thialene woodlot. Sales are expected to be made from a woodlot soon. Although prices are low, 200-300 CFA per hole, income from the seven hectares plot will be ficant. The livestock multiplication projects provide both immediate benefits (milk), medium-term benefits in the of cattle (manure), and long-term benefits (integrated agro-pastoralism) participants.

Villagers have diversified sources of aid. CRS provided fencing and inputs for the forestry component in the of grants. The Peace Corps provided forestry technical assistance for two years, basically as a grant. ONGs

finance most capital costs, but the villagers provide all labor on a voluntary basis. Traditional labor group structures are mobilized for collective field cultivation, and finds (double the initial outlay) are imposed on persistently delinquent participants.

Among the most interesting things about this intervention is its basis in an analysis of natural resource deterioration and the determination of villagers to do something about it. Continued flexibility and adaptability to the needs and requirements of all participants, and long-term sustainability as part of village life are its hall marks. Natural resource management is not an isolated activity in Koumpentoum. Sound preparation, years of study and discussion, and devoted management are at the root of this success.

The Bignona, Senegal Women's Fire Control Committee

sic Information

Location: Commune of Bignona, Senegal.

Major Characteristics of the Location: On the plateaux, are well drained slightly ferralitic soils, while others lude leached tropical ferruginous soils, and weakly evolved aeolian or alluvial soils. Of note in the environs of gnona is a complex mosaic of vegetation types: primary forest, clear humid forest, open woody savannah, and shy secondary savannah. The remaining mangrove swamp vegetation is in regression. Rainfall in this zone torically varied between 1,000 and 1,400 mm annually. Since 1969, rainfall averaged considerably lower.

Bignona lies within the old Mandinka division of Foni, but the population is virtually entirely Dioula.

Area Affected: Determining the area affected is difficult, since this is primarily an intervention with didactic plications. A small plot has been reforested, and the women plan to install a collective orchard. However, an determined number of hectares have been protected from burning thanks to great vigilance of the population.

Traditional Land Use Practices: The upland areas are devoted to the cultivation of peanuts, millet and sorghum the fallows tending toward the open tree or bush savannah. The clear humid forest is the zone of oil palm and ated rice production. Uncontrolled grazing of cattle is practiced in the dry season. With groundnut cultivation, hanization has become more significant. Controlled early burning was a traditional part of the their land use tices as was strict protection of numerous sacred groves.

Special Characteristics of the Case: Created by the Departmental Service of Eaux et Forets, it responds to the erns of women in several wards of Bignona. The idea to form the group sprung from publicity given to the blem of desertification in Senegal, the women's own recognition of the seriousness of the problem, and President ıf's call for a national program to fight against desertification.

Nature of the Initiative: The Bignona, Senegal women's fire control committee is an unpaid group of volunteers didactic and lobbying goals dedicated to preservation of the remaining forest.

ption of the Initiative

Technical Measures Taken: The committee has planted a communal woodlot in Bignona. They have been mental in extinguishing fires within the commune of Bignona which has both overgrown open spaces, and ted huts susceptible to fire. The group receives seeds, plants, technical advice, and sometimes food aid from Forest Service. It receives financial support to conduct consciousness raising sessions, small tools for fire-fighting, occasional grants in kind from the Canadian Fire Protection Project (PPPFC), based in Ziguinchor.

Social Organization of the Initiative: The women emphasize that technical success is largely a matter of nization. The group consists of 47 core members who have maintained their interest in the face of limited rces. The committee has an executive committee, and two sections based in two village wards. Over the past years, the difficulty of work and the constraints of space and material have discouraged many participants, but those who are left have decided to go forward. The women organize themselves. Small jobs such as watering andled by ward level or smaller sub-groups of women. Bigger jobs such as bush clearing were carried out by ffort of the full group or by young men who have been induced to help them. Fire control mobilizes the entire p, some of whom draw water, other apply water, others still use rakes and beaters to control the flames. Over ee year period, the committee has also organized extensive consciousness raising sessions with women in many

rural communities during the annual "Women's Fortnight" (Quinzaine de la Femme). Concerned about the attitude of the young towards the environment, the women have asked the directors of the town's schools to integrate environmental concerns into their curricula.

Economic Incentive System: At this point, incentives are primarily moral and socio-political in nature. The committee receives support from the administration and enjoys the respect of the people. In addition, the women are inspired by deeply held cultural beliefs in which the forest is a key symbol of bounty. (A sign read, "La foret, notre mere nourriciere"). Women quite correctly stated that their most distant ancestors recognized that the great trees were instrumental in maintaining soil humidity, promoting infiltration, and protecting the land from dessicating northerly winds.

Currently, the women volunteer their time. However they look forward to economic benefits from their woodlot and from a planned orchard. The women say they would like to be trained in nursery management techniques. They have already asked the prefect for four hectares in town on which to plant trees; and they have already begun to diversify their tree planting efforts.

General Discussion of the Initiative: Values can play a leading role in mobilizing populations for sound natural resource management, although successful interventions require that new knowledge and inputs be wedded to core values. The Women's Fire Brigade Committee of Bignona Senegal, located in an area of drought devastated Guinea Forest, provides an example of the leading role of values.

The main constraints faced by these women seem to be have to do with the contradictory goals of their supposed "encadreurs," the Canadian fire control project, which is uninterested in reforestation. Similarly the administration, and Forest Service officials seem mainly interested in the propaganda value of the Women's committee rather than addressing the women's goals. The women are frustrated by the lack of funding and would like to obtain help from an NGO or U.S.A.I.D.'s small enterprise development project for start-up capital.

MISCELLANEOUS

CWS Grain Storage Component

The purpose of the Church World Service/USAID financed grain storage facility is to attempt to stabilize millet, ice and corn supplies and prices during the year. The Groupement of Ganket Balla, population 400, buys the upplies in the open market when the prices are low and hold them until prices increase in the open market. Ganket Balla is located 60 km east of St. Louis in Senegal. Each participating family is allowed to withdraw up to 40 kg of grains per month for a maximum period of 4 months during the year and pay a fixed price of 85 - 90 F CFA (for the millet). The system is beneficial to the participants when the regular market prices for the grains increase beyond the fixed storage facility prices.

CWS proposed the original idea of grain storage facilities to the villages and offered to provide essential construction materials (cement in particular). Total cost of the grain storage facility is approximately one million F CFA. USAID provided the initial full inventory of rice to be stored (400 tons) through the Food-For-Work program. Since then, the Groupement (161 members) has turned over the inventories several times. To date, 14 similar cereal storage facilities have been constructed in centrally located villages in the region. A total of approximately 150 villages and nearly 17,000 people are affected and/or participating directly in the program. The total storage capacity of the storage facilities (all 14) is nearly 500 tons of grains.

Some of the technical problems include: rodents and spoiled grains when the storage period is too long. The spoiled grains are fed to the chickens. Nothing is wasted.

Villagers provided voluntary labor for the construction of the buildings. The day-to-day management is also provided without any pay by the elected president and other officers.

CWS does not offer any economic incentive to participate in the program. The incentive becomes obvious when supplies of grains are made available at reasonable prices through the Groupement when the open market prices are very high. This phenomena also usually occurs when the individual farmer granaries are empty and supplies to carry over to the next harvest must be purchased.

Although this intervention may not qualify directly as a NRM intervention, it represents an important component of an integrated approach to natural resources management and use. Without the grains bank component, the hardening intervention of the CWS project would probably not have been nearly as successful.

CWS Appropriate Technology Group: Tools, Fabrication, Repairs

The appropriate technology group (Groupement Artisinal composed of metal workers and mechanics) represents one of several components of the Church World Service's (CWS) project in the Keur Momar Sarr area. Keur Momar Sarr is located 60 km east of St. Louis. The idea for the appropriate technology workshop was originally proposed by CWS. Now, the present organization and day-to-day management of the workshop is carried out by the group.

CWS organized a shop and training center for metal workers and mechanics in the village of Keur Momar Sarr. This very popular vocational training program has greatly increased the skills and number of craftsmen in the region, many of whom leave the area to work in Dakar. The training center teaches craftsmen how to fabricate a variety of tools and useful objects from locally available materials. In addition, the center provides training in the repair of various agricultural tools and equipment. Also, the group is designing and fabricating new tools and equipment in response to the needs in the villages. They include wagons to transport water, small biogas digesters, windmills, water

lifters and other equipment. The group also fabricates improved metal charcoal and wood stoves for sale in the urban areas (Louga, St. Louis, Thies, Kaolack and Dakar).

At the recommendation of the CWS project, the village formed the appropriate technology group.

CWS provides only technical assistance and some equipment and supplies as economic incentives for the participants. The fabrication and repair workshop is intended to be a profitable operation to benefit all of the members.

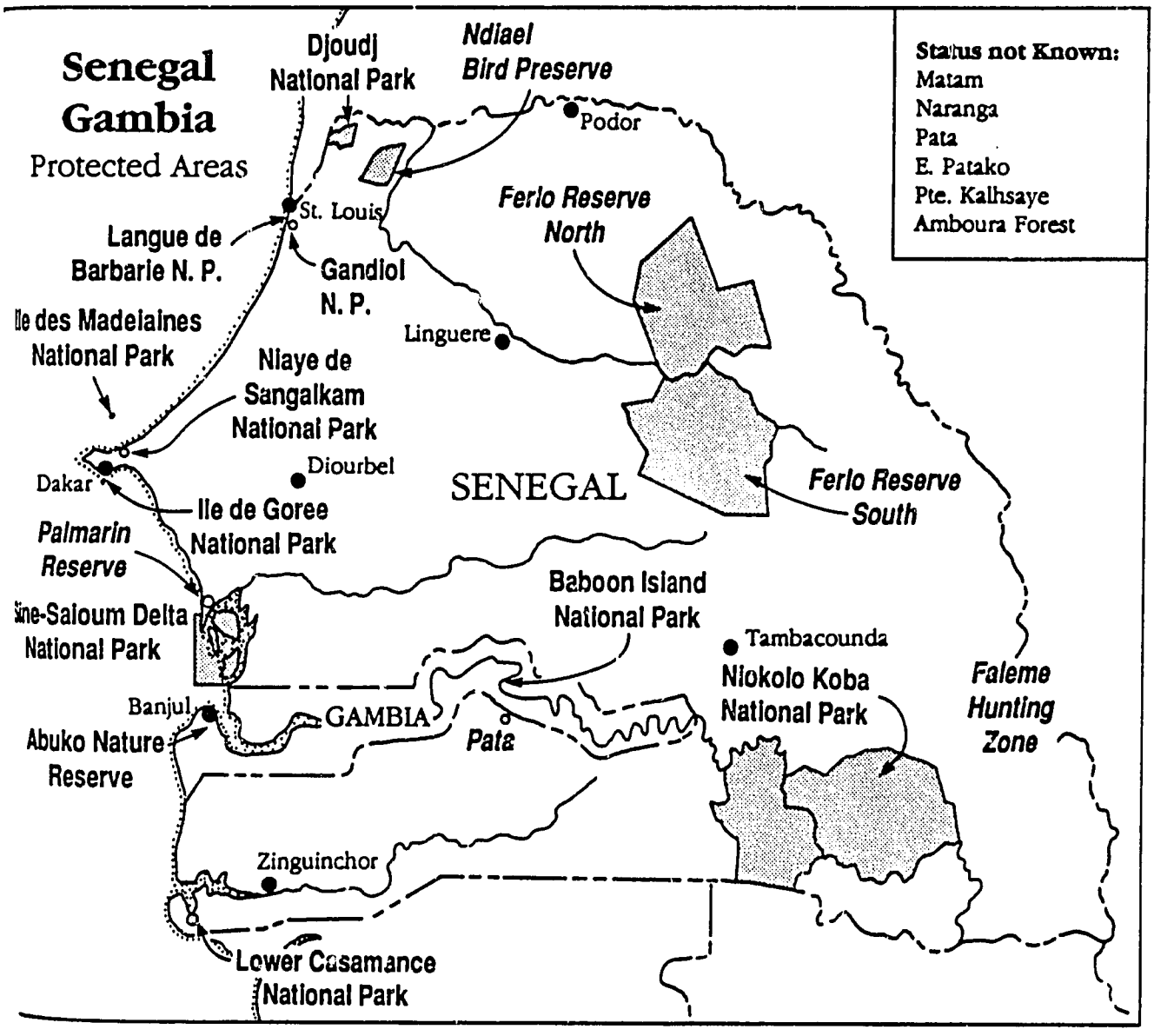
The following information was obtained at the workshop site:

Tools and Equipment	Approximate Production Cost F CFA
Shallow well hand pumps	35,000
Water transport wagon	80,000
Windmill	80,000
Biogas digester	60,000
Rotating water lifter	50,000
Watering cans	2,500
Improved wood stoves	1,000
Improved charcoal stove (avg. size)	2,500

The artisinal component of the overall CWS effort in the region has greatly contributed to the success of the other components, particularly the vegetable gardening component. This intervention would have been less likely to succeed if the appropriate technology group had not been present. They would then have had to purchase much more expensive pumps and watering cans and other tools in the open market, and repairs would have much more costly. The same is probably true if the grain storage group had not been present. Without supply and price stability for the staple crops, it would more be difficult to concentrate on intensive vegetable gardening.

The second phase of the CWS intervention will correct the mistakes made in the first phase. The top-down approach will be avoided when new villages are added to the program.

GAMBIA


Senegal
Gambia
Protected Areas
Djoudj National Park
Ndiael Bird Preserve
Podor
Status not Known:
Matam
Naranga
Pata
E. Patako
Pte. Kalhsaye
Amboura Forest
St. Louis
Langue de Barbarie N. P.
Gandiol N. P.
Ferlo Reserve North
Ile des Madelaines National Park
Linguere
Niaye de Sangalkam National Park
Diourbel
Dakar
SENEGAL
Ferlo Reserve South
Ile de Goree National Park
Palmarin Reserve
Baboon Island National Park
Sine-Saloum Delta National Park
Tambacounda
Niokolo Koba National Park
Faleme Hunting Zone
Banjul
GAMBIA
Pata
Abuko Nature Reserve
Zinguinchor
Lower Casamance National Park

WATER CONSERVATION

SWMU SALT Barrier and Water Retention Dams and Their Supporting Soil and Water Conservation Measures

The Soil and Water Management Unit (SWMU) has conducted campaigns to publicize its soil and water conservation services. It then responds to requests for help by villages to assist them in constructing saltwater intrusion dams, water retention dams, upland diversion and contour bunds, ravine check dams and grassed waterways. Requests are funnelled to SWMU from the villages through District Agricultural Officers. After a reconnaissance of the district requesting assistance, the SWMU decides what villages are most in need and prioritizes the work to be done in the district. Village committees organize the physical work while the SWMU provides technical support and some assistance. For example, SWMU provides a tractor and plow to facilitate earth moving for dams and to form contour bunds on upland sites. When materials are needed to build cement structures, such as drop drains, the villagers can easily get them from other donor organizations such as Action Aid.

Soil and water are conserved through these interventions. Productivity and fertility of the soil is increased. The fresh water retained behind the dams attracts livestock and wildlife. Also fish have appeared in some of the semi-permanent pond that have formed behind the dams. The increased water availability has reduced some of the risks of agricultural production and allowed an intensification of agriculture which utilizes human energy more efficiently. The number of hectares affected by the project at sites that the team visited are:

Somita: Approximately 10 hectares in the drainageway.

Jiramba: Approximately 25 hectares in the drainageway.

Jarrol: Approximately 75 hectares.

Sintet: Approximately 15 hectares in the drainageway and 30 hectares on the uplands.

Background Information

Somita, Jiramba, Jarrol, Sintet, Sare N'Gai, and Illiassa are sites the Team visited on the south bank of the Gambia. Also the Team visited the village of Bao Bolong which is located on the north bank of the Gambia.

Somita: The site is located in the bolon (tidal slews) just above the mangrove swamps. The soil surface is fine sandy loam to silt loam overlies white medium size sand. The soils closer to the mangrove and tidal areas frequently had salt crusting on the surface. The soils in the mangrove areas of the tidal slew may have high iron, aluminum, and sulfur concentrations which may be extremely acidic.

Due to the irregularity of the surface within the impounded areas, many spots accumulate a depth of water that requires transplanting of rice which the villagers as yet are reluctant to try. The area closest to the tidal area is salt affected but the salts seem to be diminishing since the dam was constructed. The GARD project has research plots in the impounded areas at this site.

Jiramba and Jarrol: The site is located in a bolon just above the mangrove swamp. The soils are clayey and form moderate size cracks when dry. The clayey surface overlies white medium size sand. The soils in the mangrove areas of the tidal slew may have high iron, aluminum, and sulfur concentrations which may be extremely acidic.

In Jiramba the dam is located just above a mangrove swamp and contains salt affected soils. The demonstration plots of transplanted rice in areas that were flooded 30 to 50 cm deep were very successful and the project is waiting to see if the villagers will transplant rice in the deeper flooded areas.

Jarrol is the site of the project's first dam which was done completely by the villagers without the aid of a tractor plowing and loosening the soil. This dam which affected 25 hectares required 4,260 person-days of work to construct.

Sintet: The floodplain soils above the bolon (tidal slews) have surface textures of fine sandy loam to silt loam. These are recent alluvial soils. Sheet and gully erosion on the uplands result in the deposition of sand where the sediment loaded water runs out on the floodplain from small drainageways. The resulting layer of sand that accumulates prevents rice culture. A sacred grove along the small creek feeding the rice fields was dominated by Ceiba petandra with Ficus spp. and Bombax costatum, and Khaya senegalensis. Also, below the village and along the drainageway was an orchard belt above the mangrove swamp with Elaesis guineinsis, Borassus aethiopum and mangoes.

One of the interesting things about this case is that the Foni Jarrol district is an historical and locally-recognized political-geographical entity with agro-ecological traditions distinct from those of the neighboring Kiangs and Casamance areas. The Sefo is a very influential individual whose support for the project was judged crucial to the success of the intervention by SWMU staff.

Sare N'Gai: The site is located on a sandy plain with soils that have fine sandy loam to loam textures. The area has the highest agricultural production in the region. Also, herds of livestock were unusually large and numerous around this village. Livestock is also a major means of investment and a source of income. The chief of the village, who owns a used Massey Ferguson farm tractor, was written up in national agricultural newspaper for his exceptional yields. Major crops are peanuts, millet, sorghum, corn.

The village is located at the confluence of three drainageways. This village had experienced severe flooding that was destroying buildings and had killed young livestock. There are no drainageways in this area where the conditions are appropriate for rice cultivation.

Bao-Bolong: Due to poor communication between SWMU, Save the Children, and the villagers of Bao-Bolong, a 2.6 km long salt barrier and water retention dam has failed to achieve its goal. Many of the areas within the impounded area were affected by salt and/or high acidity. Also, the apparent misunderstanding of the amount of work involved in constructing a 2.6 km long dike resulted in the villagers not building the dike to SWMU's specifications. This has resulted in complete loss of confidence in the SWMU dams by the village, and finger pointing by all involved in the project.

The vegetation of the sites were similar. The tidal slews have mangroves (Ryzophora sp. and Avicennia sp.), Phragmities sp., and Typha sp. The non-tidal areas have Khaya senegalensis and Elaesis guineinsis trees, and water lilies (Nymphaea lotus). Acacia albida is sprouting in some of the areas.

The upland vegetation included Ficus spp., Bombax costatum, Combretum nigricans, Piliostigma reticulatum, and Acacia albida trees. Due to cultivation and burning practices very little regeneration of trees is occurring on these sites. The highly valuable forage grass Andropogon gayanus, similar to big bluestem that occurs in the U.S., has greatly diminished during the past twenty years. It has been replaced with less valuable annual grasses.

Rainfall in the areas visited averaged over 900 mm historically but has recently has averaged around 700 to 800 mm per year. During the rainy season the tidal slew areas are flooded with fresh water for the four month rainy season. During the rest of the year the slews are flooded with saline tidal water.

Rice culture, predominantly a women's crop, is mostly direct seeded by hand. In Sintet, at least one woman farmer digs furrows equivalent to tied ridges which captures and holds rainwater on the higher part of the floodplain which floods infrequently. Upland agriculture consist of field crops of peanuts, millet, sorghum, and corn. Production is frequently mechanized. Livestock production is common though out the area and is a major way of saving accumulated wealth.

Description of Initiative

The SWMU provides technical support for the construction of small earthen dams (up to three meters tall) which retain water for rice cultivation and act as a barrier to salt water in tidal areas. In addition, contour bunds are plowed on the cultivated uplands with the SWMU tractor to help retain runoff and identify the contour. Diversion bunds are plowed in areas where excessive runoff is creating erosion problems. Rock check dams and grassed waterways are also used when needed to correct or prevent gully erosion.

The area around villages that have requested help are surveyed by SWMU in order to determine physically optimal sites for dams and to determine areas where other soils and water conservation measures are needed. SWMU then discusses with the villagers their recommendations and then works with them to determine the sites for these interventions.

The sandy or otherwise permeable soil where the dam is constructed is replaced with a core of compacted clayey soil that acts as slowly permeable barrier to water. The only time that villagers have available to work on conservation measures is during the dry season when the soils are extremely hard. Therefore, SWMU uses a tractor to facilitate digging of fill material by disking nearby sites that have sufficiently clayey soils for constructing the dam. Women as well as men carry the earth to the dam site while the men are responsible for digging up the loosened soil and filling the baskets. An earthen spillway is always constructed at one end of the dam which allows water from exceptionally large floods to escape without breaching the dam. For some situations concrete drop drains are constructed as well in order that impounded water can be diverted to desired areas below the dam.

The usual pathway for villages receive help is that they discuss their problems with District Extension Supervisors. The District Supervisors inform their Division Supervisors who request help from SWMU.

SWMU agents then go to the villages and describe their activities. The project presently uses a portable slide show programs narrated in the appropriate language to help explain SWMU activities. The project is developing a video tape version. Since SWMU staff are all former extension workers, they take special pains to explore problems and solutions with the villagers before proceeding to any work on the ground. Another important aspect of this discussion period are visits to older sites that illustrate how farmers have benefited from conservation measures. Concrete success is often convincing.

SWMU requires villages to elect a committee which oversees the work and which contains both men and women from all villages or hamlets within the affected watershed.

During site work, men usually do the digging; women transport earth and place it where needed. Men also do the bulk of the repair work. In order to mobilize a lot of people to help in the work the committees use the traditional method of organizing group work by forming a party around the work, much like a barn raising party. Work party usually begins by 7 AM and breaks for lunch around 2 PM.

Construction requires a significant input of village labor time. In Sintet and Illiassa (Bao Bolong), villagers who would otherwise have gone on dry season labor migration stayed around to work on the project, thus forgoing alternate benefits. If the project is not a success, the cost to people is high. Recognition by SWMU of the time value of peoples' labor is part of the reason they normally take care that their interventions will be technically successful overall.

The incentives for participation are straightforward. In Sintet and Kalaji, people recognized deleterious environmental changes which had occurred to undermine their productive capacity. Thus, the goal of increasing and/or stabilizing their limited resource base is an important incentive.

In addition, both productivity and yield increases in Sintet for example on protected and reclaimed lands.

Individual participants were motivated by recognition they received in the form of plaques and rewards issued by SWMU in the case of Kalaji, the first Gambian soil conservation district. However, it was also apparent that self-interest was at issued in some cases. The increased period of time that rice can be cultivated using water retention dams has created conflict with herders from neighboring villages who release their animals after the rice has been harvested in their area. The animals graze the rice and prevent the farmers from obtaining multiple harvests.

The salaries of the 15 person SWMU staff are paid by the Gambian government as are the cost of operations and maintenance for a small number of tractors and associated disks and plows.

An economic analysis of water retention dams for rice culture was done by Christine Elias in 1985 (Evaluation of the Gambia Soil and Water Management Project, USAID, December 1987). She calculated the internal rate of return on eight water retention structures covering 111 hectares to be 42%. Even when the estimated benefits were reduced by 10 and 20%, the Internal rate of returns were as high as 34 and 26% respectively.

Discussion of Initiative

SWMU benefits from the fact that diking itself is not an innovation; but is a traditional practice. What SWMU has done is to introduce better engineered techniques. Unfortunately, SWMU relies on surveying techniques for finding contour lines that are not transferable to the villagers. Even though villager enthusiasm is high, individual resources are limited to pay for the use of equipment. One woman felt that if they understood the techniques of surveying and finding contour lines they could continue the work. Simpler, although slower and less accurate, techniques exist that villagers could learn, which, in turn, would lessen their dependence upon the project.

Dams and diversion bunds, in the case of the village Sara N'Gai, are usually well maintained because these structure provide a noticeable benefit while other structure lay is disrepair. Contour bunds, dug and formed by the project tractor, reduce runoff, increase water infiltration, reduce erosion and the siltation of the dams but these processes are not as noticeable as water being impounded behind a dam or being diverted from a field. Even though some farmers do notice their positive results many of the structures are not maintained. For example in Sintet, women complained that sand eroded from the uplands was covering their rice fields and forcing the women to abandon their field. While on adjacent upland fields the contour and diversion bunds constructed to stop erosion that they were complaining about were frequently broken especially at points where animal paths crossed the bunds. At one break the diverted water was causing a gully and depositing more sand on the women's fields. Obviously a stronger extension program is needed and possibly requiring a minimum level of maintenance on the structures before new SWMU activities are initiated. Protecting the bunds, especially on sandy sites, with a perennial cover such as Andropogon gayanus and reinforcing the bund where animal paths cross them will help reduce the maintenance that is required.

Absent from the SWMU activities are extension of agro-forestry initiatives and improved cultivation practices. This is unfortunate, since the enthusiasm generated by land reclamation could be used to channel other innovations. Addition of windbreaks of forage species, protection or planting of nitrogen fixing Acacia albida, direct seeding of Andropogon gayanus to bunds, and other multipurpose interventions should be integrated into

the package. The village organizational structure created through soil and water conservation activities can directly or indirectly lead to collective fund raising programs to start other activities such as grain banks or purchase equipment for the village such as a grain mill.

Since the SWMU relies on the villagers to organize themselves to get work done, certain traditional mechanisms and behaviors come into play. Thus in the past, youths worked together to cultivate a common farm. They also work together to construct the dams. Similarly, the village chief redistributes the rehabilitated land to the participants if need be. In other cases, people simply return to lands which were once worked, but which had fallen out of production due to degradation.

Even though there are large increases in rice yields and expansion of rice cultivation due to these dams, the people in these villages consume all the rice that they produce. Further improvement in agricultural techniques plus expanding the areas possible for rice cultivation through the building of more dams will help allow farmer to produce a surplus. For example, Sintet has four more years of possible work to do to reclaim the available rice lands.

In the beginning, SWMU gave one village food-for-work but they have since stopped doing this. They are now discouraging other organizations from providing food-aid for similar type activities. They have correctly perceived that food-for-work often prevents people from realizing that they are working for themselves and encourages a pattern of dependence. Usually after the food distribution ends the people quit the project and wait for more food aid to continue the work. Once the pattern is established it is very difficult to break. This form of paid work as well as service or obligated work was introduced during the colonial period and does not create a sense that the people are working for themselves.

In Sintet and Kalaji, an improvement in a habitat conducive to the preservation of biological diversity was an unintended consequence of dam construction. The dams which collect and hold fresh water create a habitat for fish, aquatic insects, and tadpoles which attract water birds such as plovers, a variety of herons, kingfishers, hammerkops, ground hornbills, and gulls. At Sintet, a cookoo falcon and a golden sunbird were also observed. The dam also provides surface water for livestock and other animals such as the banded mongoose (Mongos mungo), monitor lizards, crocodiles. In the fallowed rice fields, a plant which looks similar to clover and is used in sauces had reappeared for the first time in ten years.

The water conservation measures also reduce erosion and sediment loading of the river. These measures, although insignificant individually, if spread throughout the Gambia River Basin could significantly reduce the turbidity of the water and increase the algae production which will result in increased fish production.

Freedom From Hunger Campaign: Earth Dam

Freedom From Hunger Campaign (FFHC) proposed and helped construct a water retention dam for the village of Jattaba which took one dry season to construct. FFHC paid workers in food-for-work and in cash.

Soil and water are conserved through this intervention. Productivity of the soil is increased. The fresh water retained behind the dams attracts livestock and wildlife. The increased water availability has reduced some of the risks of agricultural production and allowed an intensification of agriculture which utilizes human energy more efficiently.

A one kilometer long earthen dam was built three years ago to protect a rice field from salt intrusion and to impound fresh water for rice cultivation. Approximately 15 ha has been protected of which only about 2 hectares were planted to rice in 1987.

Background Information

Jattaba is on the Bintang Bolon located in Kiang West region of the Lower River District, on the lower bank of the Gambia. It is 80 km east of Banjul in the Gambia. The site is on a bolon on the flats bordering the uplands at some distance from the former mangrove stands. The area is subject to salt intrusion. Soils are black, clay loam in certain areas. The mangroves along the tidal slough have died since the onset of the drought. The upland tall grass savanna forest has been highly degraded by agricultural practices. Major crops include rice, peanuts, and millet. Annual rainfall between 1968 and 1983 averaged about 850 mm per year.

The earthen dam has had little effect on biodiversity. The only before and after difference attributable to the presence of the earthen dam is a perceived increase in rice yield behind it. The increased productivity is only a perceived since only small areas were planted last year and measurements were not taken. The placement of the dam appeared to be arbitrary. Immediately inside the reservoir, in the protected area, nothing grew in a band approximately 20 m wide. This area has remained unproductive for three years.

The site protected had been used in the past for rice cropping, but the villagers reported that this had become impossible in recent years.

Description of Initiative

A low bund about 30-40 cm high and 5 m wide was built with hand tools. The bund closely follows the uplands; at some points not more than a 20 m strip could benefit from the bund. The bund was built to stop the intrusion of salt water onto the rice fields and to impound fresh water for rice cultivation. The Team was not able to confirm it, but it appeared that the crest of the bund was not level.

Both men and women are involved in this intervention. The men were responsible for the actual building of the bund and are responsible for any repairs. The villagers were paid with food-for-work and in cash for the construction of the bund.

Since the Team was not accompanied by any FFHC representative no economic and/or socio-economic data on the actual intervention was available. The village of Jattaba has a population of approximately 1,000 people, all Mandinka.

Discussion of Initiative

The bund is supposed to protect and rehabilitate rice fields from salt intrusion entirely for the benefit of the population of Jattaba. However, as has been observed in several other interventions in The Gambia, it was necessary to pay the villagers to participate in an intervention which was intended to benefit them directly.

A second problem with this particular intervention is technical--it does not seem to have worked. A large portion of the target area intended for protection is still completely unproductive. In other areas inside the protected zone where some rice had been cultivated, productivity had increased, but not significantly. As a demonstration tool to convince the farmers to do this on their own, this particular intervention is not convincing.

SOIL FERTILITY IMPROVEMENT

Traditional Manure Application to Fields

The village chief or Alikali of Sare N'Gai, El Hadj Falay Baldé, has his cattle tied to stakes in his field during the night so that the accumulated manure will increase crop production during the next cropping season.

Sare N'Gai is south of Georgetown in the Gambia. It is predominantly a Fulani village with some Mandinka living there. Rainfall has averaged over 1000 mm per year historically but recently averages around 700 to 800 mm per year. The site is located on a sandy plain with soils that have fine sandy loam to loam textures. The area has the highest agricultural production in the region. Also, herds of livestock are unusually large and numerous around this village. Livestock is also a major means of investment and a source of income. The major crops are peanuts, millet, sorghum, corn.

El Hadj Baldé, who was written up in national agricultural newspaper for his exceptional crop yields, has his cattle staked 4.5 to 5 meters apart during the night, a density of approximately 440 cattle per hectare. He leaves the animals on an area for ten nights. If the animals are left longer on an area the young crop will scorch and die two to three weeks after planting. This may be the result of excessive amounts of ammonia being released from the manure once the rains begin and decomposition commences. He only manures his fields that are close to the village because it is easier to guard the animals from predators and robbers.

This type of fertilization is not available to every farmer. The farmer must own livestock or be able to pay someone to keep their animals on the farmers field. Guarding the animals is a problem and not everyone is willing to camp out with their animals in order to fertilize isolated fields. The poorest of farmers are not likely to have the means to fertilize their fields and are least likely to use credit to have them fertilized.

BIODIVERSITY IMPROVEMENT

Action Aid: Wells and Gardens

The Action Aid wells and gardens project helps villagers construct wells for irrigated gardens and introduces new crops and cultivars to the area. It depends on direct economic incentives for farmer participation. To a large extent, Action AID pays for wells, equipment, seeds, and gives some technical advice once the infrastructure is in place. Action Aid is involved with gardening interventions in five villages in the Jattaba area.

The Team visited one garden in Jattaba, 1.3 ha in size. The site has four wells. The water table is approximately six to seven meters deep. Jattaba is located along the Bintang Bolon on the main road near the Brumen bridge in the Kiang West region of the Lower River Division in the Gambia.

The Action Aid program is based on direct economic incentives to attract participants. The Team feels that the approach does not nearly have the same replicability potential as, for example, the Church World Services approach to wells and gardens in Keur Momar Sarr in Senegal). The Action Aid approach consists of the following:

A group or village is approved for participation in the program.

Action Aid provides all the necessary farm equipment. If the group requests a plow, for example.

Methodist Mission: Orchards, Nurseries, Wells, Gardening

The Methodist Mission is providing technical and financial support to villagers in the area around Brikama. The mission introduces new crops, fruit and other trees to the area. The tree planting initiative is basically for environmental stabilization and preservation. The nursery directly impacted three hectares on each site. The central nursery in Brikama produces enough trees (14,000) to plant 84.7 ha at the 8 x 8 meter spacing.

Background Information

The Methodist Mission is based in the village of Brikama, The Gambia, 15 km from Yundum, in the Western Division. The village of Kiti, approximately 10 km from Brikama, has a project satellite nursery and the village of Jiboro has a project supported garden/orchard.

The soils in Kiti are gravelly loams over marine formations. They were cultivated semi-permanently. The garden soils in Jiboro are alluvial soils that overlie older marine sediments. Vegetation around the nursery in Brikama has been drastically modified by human intervention. In Jiboro, ditta (Detarium senegalensis) was identified as a popular gathered fruit which had become less available as a consequence of the drought. The preferred firewood species was keno. Women had to travel long distances to obtain it, but it was still used. Other preferred species included koulou-koulou, and walo (Terminalia macroptera). Stands of Elaesis guiments. Vegetation around the nursery in Brikama has been drastically modified by human intervention. In Jiboro, ditta (Detarium senegalensis) was identified as a popular gathered fruit which had become less available as a consequence of the drought. The preferred firewood species was keno. Women had to travel long distances to obtain it, but it was still used. Other preferred species included koulou-koulou, and walo (Terminalia macroptera). Stands of Elaesis guineinsis are common with older stands of Ceiba petandra and Khaya senegalensis being less common. Grasses included Cymbopogon gigantaeus and Andropogon gayanus.

Water tables have been declining throughout the area. Present water tables are 10 m deep at the Kiti nursery and 15 m deep in the women's garden at Jiboro. The project has dug four wells on three hectares.

Traditional farming system basically a mixed farming system involving mechanized upland cereals (coos) production and palm oil and in more recent years, fruit tree exploitation. Women grow swamp rice and claim to have plenty of land. The combination of fruit trees and vegetable gardens is an introduced land use practice. Land for the garden and nursery was obtained from the Alkali, the local traditional authority.

The Methodist Mission is a charitable organization and, as such, is performing services for free that villagers could probably have performed for themselves. The end result of this approach may be that villagers have little incentive to dig wells, plant gardens and fruit trees etc., if someone else is willing and ready to do it for them at little or no cost.

Description of Initiative

The Mission has 10 acres under cultivation in Brikama. This is their main nursery where 8,000 mango seedlings, 5,000 cashew, and 4,000 of sweet grapefruit. Guavas and bananas had also been produced. In addition, they have begun propagating Saloum plum, Spondidas mombin, and Sweety Sop, Spondidas purpera, both of which are relatively drought resistant and much appreciated. Recently, they have also begun trials with living fences of Euphorbia balsamifera, Ananium obesum, Parkinsonia aculeata, and sisal, but no results are available.

The Mission has established four peripheral nurseries: in the villages of Kiti, Marakissa, Darsalami, and Manduar in the Western Division (WD). In addition, smaller nurseries have been established in Ker Patty in the North Bank Division (NBD), and one in the McCarthy Island Division (MID). At Ker Patty, the nursery was placed adjacent to a market to maximize the public relations impact. Nurserymen are paid employees of the Mission. Trees are produced from seed in plastic sacks as at Brikama, and sold for the same price as there.

The Mission has installed gardens in 32 villages in the NBD, MID, and WD zones. In each case they have sunk cement-lined wells. Wells are dug and maintained by Mission well diggers on demand. The condition of installation of the wells is the villagers' commitment to plant fruit trees in the garden plots. No horticultural technical assistance is provided.

The four nurseries and the main nursery were staffed by employees paid by the Mission. Their production was largely devoted to providing fruit and seeds for the headquarter's nursery in Brikama for its seedling production program.

The garden projects are destined for women. In Jiboro some 20 women were currently cultivating although, some 150 women are somehow affiliated with the group, up from an initial group of 55. The women were required to elect a management committee, but basically all decisions regarding the organization of labor, marketing and distribution of product are made by them. We learned that women individually pocket the receipts of production, but are likely to spend some money on the household food supply.

The gardens were worked by women. In Jiboro 20 women were active, although the team's informant indicated that 200 women were implicated overall, up from 55 in 1982. All gardening labor inputs are provided by local women.

The Methodist Mission project provides incentives to villagers that are difficult to turn down, in order to attract participation in the project's major thrust, fruit tree planting. The system works as follows:

The existence of the available Methodist Mission (gift) services is almost common knowledge. The services are provide under the conditions:

> If the village or collective group within the village agrees to plant fruit trees, then the project will finance, 100 percent, the construction of wells in areas deemed suitable for gardening.

Of primary interest to the villagers are the wells and hence, the possibility of growing vegetables. The fact that the project insists on being "paid" in the form of fruit tree planting in the vegetable production beds (where they will be watered along with the vegetable crops), is considered a bonus by the villagers.

The project sells the fruit tree seedlings to the villagers or collective group for three Dalasis each. This is a subsidized price. Production cost per seedling is between 10 and 15 Dalasis per seedling. Fruit tree seedlings sell for approximately 7 - 10 Dalasis in Banjul.

Upon receiving a request from a village, the extension agents associated with the project surveys the site and determines location and number of wells to dig. The Methodist Mission then sends in its salaried well-digging team, supplies (concrete and reinforcing rods, etc.) and equipment. All well digging work is carried out by the well-digging team, not the villagers. The cost of a well is approximately 1,100 Dalasis per meter, everything included. If the water table is lowered and the well runs dry, the project, again not the villagers, deepens the well as required.

Nurserymen hired for the Brikama nursery or the other four project nurseries located in the Western Division, are motivated by their wages, on the order of 275 Dalasis per month. In addition, the fact that all garden infrastructure is provided to the villagers as grants or at subsidized prices is a motivating factor in participation.

Interestingly, women in Joboro said that they did not sell their cashew production, their being little local demand. Women are able to sell produce and to contribute to the household food (e.g, rice) supply. Their income is their own.

Local farmers, in addition to Wolof speculators in Banjul are attracted by the local, Senegalese, and international markets for fresh fruit. The requests for mango, cashew and sweet grapefruit seedlings from the Mission nurseries are approximately 40, 30, and 20% of the total nursery production respectively. Mango and cashew trees will begin producing in the third year. Sweet grapefruit trees will begin producing in the fifth year.

Women gardeners are motivated by the food and market value of their mango and garden production. The following are approximate minimum prices (during the "glut" season) for various fruits in the local markets:

Fruit	No.	Dalasis
Mangoes	1 avg.	0.5
Plum (Saloum)	1 "	1.0
Grapefruit	4 "	1.0
Cashews	4-5 "	0.5
Guava	4-5 "	5.0
Oranges	4-5 "	1.0

Villagers contribute half the cost of the barbed wire used to fence the gardens. Private nurserymen may purchase seeds from the mission for 0.5 Dalasis a mango. The Mission provides pots and training. Allegedly, they are visited twice weekly by Mission extension staff. The Mission assures they propagate the seedlings properly, but nurserymen are free to sell or plant as they wish. They are basically self-selected volunteers.

Discussion of Initiative

The Methodist Mission orchard/garden project is a classical example of a gift-based project. Farmers already know how to plant and even grow trees; women in Jiboro were propagating fruit trees. However, the attraction of free wells, subsidized fencing, subsidized seedlings, and the like is virtually an irresistible inducement for women and other farmers to participate. For a modest investment of time and cash, women stand to reap substantial long term increments to their cash income.

The project seems to have a very narrow technical focus, i.e., tree planting, and has not made use of known techniques of grating, root stimulation, and other practices. No gardening advice is given, i.e., women do not use canals, although they probably could and should. Extension efforts combine the economic incentive enshrined in fruit trees with a concern for forests as an end in themselves. They have, however, began to diversify the trees produced to include local species.

The Methodist Mission approach in this intervention should be compared to those followed by the Action Aid in the Jattaba (Lower River Division) and the Church World Service (CWS) interventions in Senegal. The Action Aid is also favoring a "gift" approach, but one totally different from the Methodist approach. There is no real incentive on the part of the villagers to replicate the activities of the project so long as there is some group ready and willing to do it for them for free. The CWS interventions in Senegal, on the other hand, has a totally different approach. It promotes self-organization and gives technical assistance, very little direct financial assistance. Villagers are sensitized to the potential profits they can earn if they change their agricultural practices according to the technical advice given, etc. All work is performed by the villagers, and they decide what to do with the earnings. The CWS approach will have lasting development impact because people are motivated by the fruits of their own investments, whereas the Methodist and Action Aid approaches motivate people through direct and outside economic incentives. Without any further assistance the replicability potential for the direct and outside economic incentive approach is low. However, without any further outside assistance the replicability potential of the CWS approach is very high.

PRODUCTIVITY IMPROVEMENT

Lamin Seed Multiplication Project

Basic Information

Location: Lamin Village Area, Upper Niumi District, The Gambia.

Major Characteristics of the Location: Rainfall varies between 600 and 800 mm. Soils are diverse with slightly evolved sandy upland soils, and low lying colluviums and reclaimed swampy soils subject to acidification and salinisation along the bolongs under drought conditions. Populations densities are high but stabilized through southerly outmigration.

Nature of the Initiative: A program to introduce a short cycle rice variety into Lamin Village Area.

Description of the Initiative

Technical Measures Taken: A new 90-day Pekin variety helps restore rice cultivation in drought-affected lowlands areas, and expand production into upland fields. The USAID-financed GARD project provides certified seed.

Social Organization of the Initiative: Save the Children Fund (SCF) staff have brought a number of individuals and organizations together in this program. The GARD project operates a demonstration plot near the village of Bakindig. Members of Lamin's women's group visited this plot and chose Peking and other varieties of interest to test in their own fields. SCF monitors fertilizer and pesticide use. The Grasshopper Control Unit in Lamin provides the pesticide. SCF purchases some seed for distribution in other villages and a small amount is sent to the Sapu Research Station for testing.

At the beginning of the rainy season, the community development agent visits Lamin and tells people when to plant. The village development committee sets the day for communal sowing. The agent also provides villagers information on cultivation practices. He tells villagers when to weed as well. The agent is well-liked and trusted. Villagers have even renamed Peking variety rice after him (Danjomano). An agricultural extension agent provides pesticides and sprays twice a year against blister beetle. The women's group grows the seed under contract to SCF in order to have the seed certified for distribution. They provide the bulk of the field labor.

Economic Incentive System: SCF guaranteed the 1985 crop and has subsidized fertilizer and seed supplies for six villages for two years. The Lamin group sold 16 bags of rice on the open market in 1986 and received 2000 Delasis (approximately $250). This was turned over to the treasurer of the village development committee (VDC). This money has been banked and is available for community uses. SCF also purchases rice from individuals at a price determined by the village up to a maximum of 10 to 20 kilos per village. SCF is helping Lamin to become registered with the Sapu center as a multiplication center for the Peking variety. This entails a transfer of new technical and administrative knowledge. Finally, SCF has provided materials for a storage building, while the VDC provides the labor.

Socioeconomic Data: The new rice variety grows well under prevailing technical conditions, tastes good, and matures in less than three months. Women are well aware that monocropping Peking makes them vulnerable to disease and are actively experimenting with new varieties to renew biological diversity. Men are beginning to grow rice in the more upland fields and will start using this variety a way to expand crop lands.

General Discussion of the Initiative: The people of Lamin have accepted the reality of a permanent change in rainfall conditions. They are eager to adjust to these conditions. This case illustrates how biodiversity and productivity increasing goals can be integrated.

OPPORTUNITIES FOR SUSTAINED DEVELOPMENT

Successful Natural Resources Management in the Sahel

Asif Shaikh

Eric Arnould
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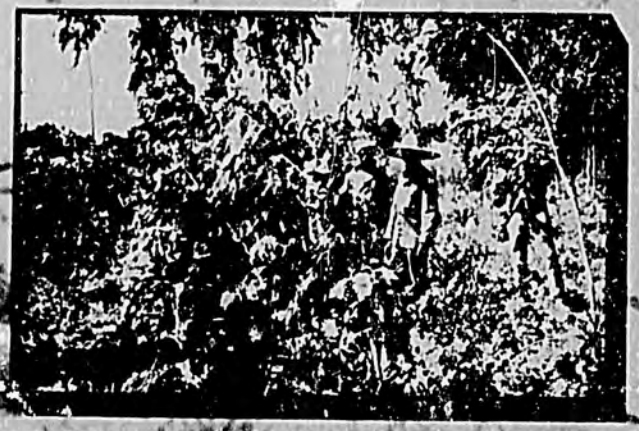

VOLUME III/FINANCIAL ANALYSIS

Funded by the United States Agency for International Development
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Bureau for Africa

e/dt

OPPORTUNITIES FOR SUSTAINED DEVELOPMENT

Successful Natural Resources Management in the Sahel

Volume III/Financial Analysis of Interventions

October 1988

Volume III prepared by:

Kjell Christophersen

Funded by the United States Agency for International Development
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NATURAL RESOURCE MANAGEMENT INTERVENTIONS: FINANCIAL ANALYSES

1. INTRODUCTION

This annex presents financial analyses of several NRM interventions observed in the field. They include windbreaks, contour ridges, organic fertilizer and compost, chemical fertilizer and agroforestry interventions. The analyses are from the farmer's perspective -- the investment decisions he will have to make for each of the NRM interventions discussed. Unless the interventions make financial sense to the farmers, they will most likely not succeed. A second focus of the annex is the role of the donors in funding natural resource management (NRM) activities. This focus -- the different ways that the donors could facilitate, provide incentives for, or otherwise attract farmers to participate -- is discussed in Section 5.

This annex has five sections. Section 1 discusses the problem and outlines the general analytical approach. The general base case assumptions and analyses are presented in Sections 2 and 3 respectively. Sensitivity analyses of base case assumptions are carried out in Section 4. The role of the donors is discussed in Section 5 along with conclusions and recommendations.

1.1 The Problems

The problems with which this annex are concerned are:

- Does it make financial sense to the farmer to undertake the land improvement investments required in order to increase crop yields? What would entice him to forego alternative uses of his time during the off-season, or work harder during the peak planting season in order to build ridges along the contour lines in his fields?

- What should be the role of the donor?

Faced with the recent severity of recurrent drought conditions, and with observed instances of resource degradation, it is clear that the donors have ample opportunity to play a major role in helping farmers to make rational resource management decisions, and in the implementation of those decisions. On the one extreme, the donors could opt to undertake NRM interventions on a large scale by employing and paying farmers to build contour ridges, plant windbreaks and live fences, etc. These (employment opportunities) certainly would make financial sense to the farmers. On the other end of the scale, donors could design initiatives that promote, sensitize and organize farmers in villages to improve their stewardship of the natural resource base, without having to do the work for them or give direct economic incentives to attract participants. Or, the donors could opt for a middle ground solution of sharing the costs of the interventions and work toward the sensitization solution. Several interventions observed by the team fall in this latter category.

Two key measures of the success of an intervention are whether participating farmers will continue without any further support after the project has ended, and whether there has been a demonstration effect whereby other farmers have observed and subsequently adopted the new techniques. (A·10 to 20 year demonstration period is not unreasonable). If these have occurred, then the intervention has succeeded. As a general "rule-of-thumb," therefore, the emphasis should be placed on finding formulae that minimize the direct financial incentives to attract participation.

1.2 The Approach

This annex presents financial analyses from the perspective of the farmers. The macro perspective -- the economic analyses -- is not directly part of the analyses. The basic premise is that any intervention at the farm level must, above all, make financial sense to the farmer or he will not invest his time or money.

The purpose of the financial approach is to show which interventions are financially feasible and which are not. In-field planting of Acacia albida, for example, shows benefits in terms of significant increases in yields only after a long time period. In a financial sense, this delayed benefit stream may not be very attractive to the farmer because the present value of benefits received several years hence is low. This does not mean that Acacia albida protection should be discouraged. It means, rather, that an opportunity has been identified for the donor to generate the necessary interest and enthusiasm for the intervention by way of providing certain incentives to attract participants. The State must, usually by way of donor funding, consider the economic perspective and be prepared to share the costs of natural resource stewardship where necessary before the process of degradation has gone too far. See Section 5 for a discussion of donor involvement.

The technical argument that contour ridges, windbreaks, chemical and organic fertilizers, and many other field interventions can increase crop yields is made elsewhere in this report. The team observed and documented many such interventions. Farmers agreed when questioned, that yields had increased, and they were happy with the results of the interventions and the technical support provided by the sponsoring projects.

For a rigorous financial analysis of these interventions, however, the problem is that the benefits have not been adequately measured. We do not know, except in a few isolated cases, the extent to which crop yields increase as a result of the construction of contour ridges, the planting of windbreaks, the application of fertilizer, etc. The team received some information from project personnel, farmers and government officials, but generally not in the form of reliable and documented data. There has been virtually no effort to collect and publish this kind of information. Moreover, cost and benefit streams associated with these kinds of interventions are likely to be highly site specific.

The use of a straight forward benefit/cost (B/C) analytical technique presumes the availability of the data to do the analyses -- that the magnitudes of costs and benefits associated with each intervention are known. However, since reliable data were not available, the team used break-even analyses to determine how much yields would have to increase in order to justify the investments made. This approach generated useful, albeit

less than ideal, information. The team also used a net present value (NPV) approach where it was possible, based on the sketchy and site specific information obtained in the field, to estimate the yield increases as a result of the interventions.

Focusing first on the farmer -- what are his concerns and what does he need to know in order to make the time and financial investments required to implement a particular NRM intervention? Typically, the Sahelian farmer is more of a risk averted than a risk taker. He is concerned about security -- that the harvest will provide enough millet or sorghum to last until the next harvest. He knows, from several years of farming experience, that with his present methods and technologies he can produce what he needs if there is no drastic crop failure, but rarely any surplus. If he is asked to take the risk to change his methods which he knows work, even if they only work to provide a subsistence level of production, he is likely to be reluctant unless there is promise of greater food security in the future.

One example is windbreaks. While one hectare may, under average conditions, typically produce what the farmer needs, part of the same hectare will now be planted in trees which gives him less area to cultivate. It has to be demonstrated to him that windbreaks must not only increase yields, not only enough to recover the loss of cultivable area, but also substantially beyond this point in order to justify his investments of time and money. Only after having been convinced that the yields will so increase will he be interested in undertaking the investments.

The introduction of contour ridges and other similar water and soil conservation techniques, and the application of organic fertilizer, etc., does not involve similar risks. The farmer is well aware that soil and water conservation and the application of fertilizer will increase yields, but also that to do so is often back-breaking hard work. Although he knows that his hectare will typically produce at a subsistence level barring a total crop failure, he also values his leisure time. If his granary contains just enough to last until the next harvest, why should he give up his leisure time to get more, particularly if the work would have to be performed during the peak season? A key question is: how much of an increase in yield would he have to have in order to entice him to forego his leisure time during the off-season, or work harder during the peak planting season?

The risk of total or partial crop failure is due to one major factor: inadequate rainfall. This is a key factor in the farmer's decision making process. The implementation of NRM interventions such as organic or chemical fertilizer, for example, implies considerable risk of crop burnout if rainfall is low during the period of fertilizer application. In the analytical framework developed for this annex, however, risks associated with rainfall adequacy are addressed in the sensitivity analysis, not in the base case analysis. The base case assumes average rainfall conditions, which may be considered unrealistic by some. The reason: there is nothing "average" in the Sahel; the amount of rainfall during a growing season cannot be reliably predicted. Rainfall may be overly abundant in one year and non-existent the next.

Ideally, the risks associated with rainfall should be addressed in the modeling framework with as great a precision as possible. Crop yields should be linked to annual

rainfall. To do so, however, requires reliable rainfall data and crop yield measurements for several years. In Sahelian countries such data is not available. The analysis, nevertheless, had to be anchored to a set of base case assumptions. In this annex, average rainfall conditions are assumed because there is no real evidence to support that next year will be either above or below the average. This assumption, therefore, is just as valid as a no rainfall or abundant rainfall assumption. The impacts of low or high rainfall are manifest in yield differences. In the modeling framework, these impacts are expressed, in the sensitivity analysis, in terms of different initial (1st year) yields than those assumed in the base case.

The break-even approach -- the increase in yield a farmer would require in order to be enticed to do the work -- is based on costs only. Information on the costs associated with the different interventions is generally available, or can be estimated. For all of the interventions analyzed, the team derived estimates on labor, materials and other costs. With the cost dimension covered, financial break-even analyses were carried out using the standard benefit/cost (B/C) analytical technique.

If the cost assumptions are reasonable, the break-even yield increases give an indication of the attractiveness of the proposed intervention from the farmer's perspective relative to the traditional farming methods (without the interventions). Those intimately familiar with the productive capacity of the site in question (perhaps agronomists), would be able to say with some authority whether the break-even yield increases exceed or fall within the productive capacity of the site [1]. Thus, if a minimum 10% increase in millet yields will be required to justify the investment in a particular intervention, and the agronomists are confident that, given the intervention proposed, a 30% increase would not be unrealistic, then one can conclude that the investment will probably be attractive to the farmer. The closer the gap between the break-even yields and the agronomist's best educated yield increase guess, the less attractive the intervention is from the farmer's perspective.

A generic modeling framework is used to analyze interventions separately or in combination with each other. In this sense, one can consider the economics of contour ridges as a separate intervention as well as in combination with windbreaks and other interventions. The results are expressed in two ways:

- If the yield increases attributable to the interventions are not known, the results are expressed in terms of the minimum yield increases required in order to recover time and money investment costs. The investments are the number of person days the farmer spends on the interventions based on some assumed value of his time, plus any

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[1] Productive capacity as used here is not the same as sustained productive capacity. Contour ridges by themselves, for example, will increase yields only temporarily because they make much better use of scarce rainwater. The constraining factor now becomes the gradual depletion of soil nutrients instead of low rainfall.

required cash outlays. The analysis allows different values for the farmer's time during the off season vs. the peak planting season.

- If the benefits as a result of the interventions are known or estimated, the results are expressed in terms of how many additional kilos of the crop or F CFA's the farmer will obtain per unit of time invested, and in terms of NPV's.

The minimum yield increases required to recover the investments of time and money can only be determined if we know the value of the farmer's time, and the value of the crops he will be growing. Time, not money, is the major investment required from the farmer. How much is his time worth? The answer is not simple since a typical Sahelian farmer is neither salaried nor operates in a cash economy. He consumes nearly all of his production and sells some to get cash for other necessary purchases such as soap, clothes and condiments, etc. If the harvest is deficient he may have to sell some of his livestock, if he has any, to get the cash to buy what he needs. Operating under these subsistence conditions, the Sahelian farmer does not forego any salary by choosing to construct contour ridges or introduce other interventions on his farm fields. It is a question of foregoing his leisure time (if during the off-season), or working additional time during the peak season. Section 2.7 below discusses the method used to value the farmer's time.

2. BASE CASE ASSUMPTIONS

The base case assumptions are derived from unpublished and oftentimes highly variable information obtained by the team during the field visits. The analytical results presented in this annex should, therefore, be interpreted with caution. The absolute magnitude of the results -- the present values and the breakeven increases in yields required to recover costs -- are less important than the relative differences between them. A net present value of 100 for intervention A and 60 for intervention B, for example, allows us to predict, with some assurance, that farmers would probably be more interested in doing A than B, other things being equal.

2.1 Discount Rate

A 20% real discount rate is used for purposes of the base case analyses. It is higher than the 10% rate used so often in project analysis because of the farmer's propensity to be a risk averted (see discussion above). His (intuitive) real discount rate would typically be much higher than bank lending rates, indices, or other benchmark statistics used to determine discount rates. The 20% rate will be varied substantially in the sensitivity analyses [2].

2.2 Crops, Yields and Prices

In Sahelian countries farmers plant their fields according to their needs. In the arid areas, farmers are limited to planting staple crops such as millet and sorghum because of soil and climate conditions. In the wetter areas, cash crops such as peanuts and cotton are often planted in addition to the staple crops. Under the traditional farming methods, the crops, their combinations and how they are rotated change as the productivity of the land changes.

The staple crops considered in the analyses are sorghum and millet. The cash crops are peanuts and cotton. The assumptions associated with yields, market prices and the number of person days the farmers has to spend on each crop from planting to harvesting, are given in Table 1. The assumed yields (kg/ha) given in the table are those likely to be obtained during the first year, just after the land has been brought back into production

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[2] From the economic perspective the situation is different. The environmental problems -- desertification, degradation of the soils, etc. -- in the Sahelian countries are acute and need immediate attention. Unless action is taken, the resource base will either be lost, or the costs of restoring the land will increase exponentially the longer one waits. One cannot, therefore, separate the economic from the environmental considerations. Because of the magnitudes of the problems, the economic discount rate to use should probably be very low, if not negative in some cases. What this means is that governments in Sahelian countries could prioritize NRM activities vis-a-vis alternative investment priorities, by using low discount rates.

from fallow (see Section 2.3 below). The impacts of low or high rainfall on crop yields are addressed in the sensitivity analysis below.

Table 1
CROPS, YIELDS, PRICES, PERSON DAYS/HA

Crops	Yields (1st Year)	Prices F CFA/Kg	Person Days
Sorghum	800	40	61
Millet	800	35	61
Cotton	1,100	85	70
Peanuts	900	80	70

Notes to the table:

- The assumed prices are at the field site. Prices will be higher in the towns and urban areas.
- Yields and person days per crop for millet and sorghum were obtained from Operation Mils Mopti (Mali). Average cotton and peanut yields were estimated on the basis of field interviews with farmers and extension agents.
- One person day equals: one day spent in the field during the growing season by the active farmer, one day spent by his spouse, or two days spent by each child.

2.3 Reduction in Yields Over Time Without the Interventions

When the land is brought back into production after fallow it is assumed to be at its maximum productive capacity [3]. As it is farmed in the traditional way, without the benefit of any major land improvement interventions, the land will eventually tire and yields will gradually drop. This phenomenon is common throughout the Sahel. The reasons include: increased population, changing weather patterns (increased frequency of drought periods), increased erosion, etc. In the end, the productivity of the land may decline to the point where it barely produces enough seed for next year's planting. Well before this point, the land is returned to fallow and new land cleared to replace it.

[3] Maximum productive capacity here is a relative term. If the land is brought back into production too early its productivity will be lower than its potential under ideal conditions.

A 6% annual crop yield reduction caused by soil depletion under the traditional farming system is assumed in the base case. This estimate, obtained from Operation Mils Mopti agronomists in Mali, was not based on any documented research.

2.4 Increase in Yields Over Time With the Interventions

The major purposes of the NRM interventions are: 1. to increase crop yields for the farmers and, therefore, to increase their overall economic welfare; and 2. to restore and maintain soil fertility to the point where yields remain constant or increase over time so that return to fallow will no longer be required. In effect, the problem to be resolved is to at least offset the 6% decline in crop yields assumed above under a traditional farming scenario.

Reliable information on crop yield increases over time attributable to NRM interventions is scarce. Only general and some site and case specific information is available. We know, for example, that windbreaks lead to increases in crop yields, but not how much under different conditions, nor the lag time required before the yield increases become significant. We cannot estimate the rate of crop yield decline attributable to soil nutrient depletion if windbreak (or live fence) interventions were implemented by themselves (without any corresponding soil conservation interventions).

Contour ridges, for example, will cause yields to increase immediately, but again only temporarily as soil nutrients become the limiting factors instead of water. The Acacia albida, chemical and organic fertilizer interventions, on the other hand, will help restore soil fertility. By themselves, they will probably not increase yields as much as would be the case if they were combined with other interventions. There will be a synergetic impact on crop yields when soil physical property interventions (contour ridges) are combined with soil fertility restoration interventions (Acacia albida and fertilization interventions). In combination, these interventions will provide increases in soil fertility, better plant micro climates, hydrologically stable soils, better soil physical properties, etc., all resulting in increased yields and more stable agriculture. The total physical benefits of the two interventions combined should be greater than the sum of the two separately.

The benefits (increases in crop yields over time) of the NRM interventions are expressed in terms of: 1. Crop yield increases per hectare, and 2. Soil restoration impact. Table 2 shows the assumptions for both. They are based on field interviews where the responses varied considerably with sites and cases. For this reason, it is emphasized again that the NPV results should be interpreted with extreme caution.

The soil restoration rates define the extent to which the 6% yield decline (base case scenario), is offset by the interventions. Windbreaks slow the rate of decline to 3.5% per year (6 - 2.5 = 3.5%). The 3.5% rate of decline becomes the base on which the annual (assumed) yield increases are calculated. Acacia albida is assumed to have a soil restoration effect of 6%. In this case, the yield/time curve is horizontal since the base case 6% crop yield decline is entirely offset by the soil restoration effect. The increased crop

yield attributable to the intervention, therefore, is calculated on the basis of the horizontal, not the declining, curve.

The crop yield increases for the Acacia albida and windbreak interventions need additional explanation. The increases given in the table are those produced when the trees have reached their maximum mean annual growth. When the trees are young, they have less impact on the crop yields than when the trees are biologically mature. Tree growth follows a sigmoid growth function where annual increments increase at increasing, constant, and then decreasing rates over time. The assumed 24% increase in crop yield for the Acacia albida intervention (Table 2), therefore, is associated with the point of maximum mean annual tree growth where the impact on crop yields is greatest.

2.5 Timing of the Interventions

The interventions do not all have to be introduced at the same time. They can be spread over several years. In the modeling framework developed for this annex, interventions can be introduced any time over the 20-year time horizon. For purposes of the base case analyses, however, the assumption is to introduce all of the interventions (separately and in combination) in year one. The reason for making this (simplifying) assumption is that the interventions are highly site specific in the four countries visited. Probably no more than two interventions can be realistically carried out simultaneously on any given hectare in the region. Fields where windbreaks make sense may not be appropriate for contour ridges, for example.

Table 2
PERCENTAGE YIELD INCREASES WITH INTERVENTIONS

Interventions	% Increase in Crop Yields	% Soil Restor-ation Effect	Yr Yield Incr. Take Effect
Windbreaks	18	2.5	5
Acacia albida	24	6.0	6
Live fences	5	2.5	4
Agricultural chemicals	75	5.0	1
Organic Fertil/Compost	80	6.0	1
Contour Ridges	6	8.0	1

Notes to the table:

- Windbreaks: the 18% increase is taken from the Maggia Valley windbreak experience in Niger.
- Acacia albida: The 24% increase is taken from a composite of information obtained in the field and in unpublished documents.
- All other interventions: assumptions are based on information obtained in field interviews and unpublished documents.

2.6 Crop Sequencing and Associations

A common sequence and association of crops in many regions is to grow millet or sorghum one year to meet staple food needs, and rotate with cotton or peanut cash crops the next. The assumptions for the 20-year time period are given in Table 3. The information was obtained from farmers in the four countries visited.

2.7 Labor Cost

As discussed above, the major investment required from the farmer for all of the interventions analyzed, except the chemical fertilizer intervention, is his time. His time has different values depending upon the seasons:

During the farming season, the value of a farmer's time is assumed to reflect the average value of the crops he is producing each year divided by the number of person days he is investing in producing them. As crop yields decline over time, as in the base case scenario, so do the farmer's returns to his labor input.

In the base case analysis, the composite average value of the farmer's time is 451 F CFA per person day. This figure is derived from the summary table (Table 4) below which shows the yields, crop values/ha/year and the value of the farmer's time as it changes with the decline in productivity under the traditional farming systems scenario.

Table 3
CROP SEQUENCING AND ASSOCIATIONS

Year	Sorghum	Millet	Cotton	Peanuts
1			100 %	
2	100 %			
3		70 %		30 %
4				100 %
5			100 %	
6	100 %			
7		70 %		30 %
8				100 %
9			100 %	
10	100 %			
11		70 %		30 %
12				100 %
13			100 %	
14	100 %			
15		70 %		30 %
16				100 %
17				100 %
18	100 %			
19		70 %		30 %
20				100 %

Table 4

YIELDS, PERSON DAYS PER HECTARE AND VALUE OF TIME: BASE CASE

TRADITIONAL METHODS Yr	Crop	%	Yield	Crop	%	Yield	Prod: Kg/Ha /Yr	Cash Value/ Crop	Labor: PD/ Crop	Value of Time /PD
1	Cotton	100%	1034				1,034	87,890	70	1,256
2	Sorghum	100%	707				707	28,275	61	464
3	Millet	70%	465	P.nuts	30%	224	689	16,778	64	263
4	Peanuts	100%	703				703	56,214	70	803
5	Cotton	100%	807				807	68,620	70	980
6	Sorghum	100%	552				552	22,076	61	362
7	Millet	70%	363	P.nuts	30%	175	538	13,099	64	206
8	Peanuts	100%	549				549	43,889	70	627
9	Cotton	100%	630				630	53,575	70	765
10	Sorghum	100%	431				431	17,236	61	283
11	Millet	70%	284	P.nuts	30%	137	420	10,227	64	161
12	Peanuts	100%	428				428	34,266	70	490
13	Cotton	100%	492				492	41,829	70	598
14	Sorghum	100%	336				336	13,457	61	221
15	Millet	70%	221	P.nuts	30%		328	7,985	64	125
16	Peanuts	100%	334				334	26,753	70	382
17	Cotton	100%	384				384	32,658	70	467
18	Sorghum	100%	263				263	10,506	61	172
19	Millet	70%	173	P.nuts	30%	83	256	6,234	64	98
20	Peanuts	100%	261				261	20,888	70	298
AVERAGE VALUES									66	451

This average labor cost estimate is the assumed value of the farmer's time for all interventions analyzed except for the contour ridges, Acacia albida and organic fertilizer interventions. A lower figure per person day is justified for the latter interventions because they usually occur during the dry season. Acacia albida seedlings, for example, generally need protection against livestock damage only during the dry season when the livestock is free to roam everywhere. (During the rainy season in the 5th Region of Mali, for example, livestock movement is restricted by village decrees). Thus, the farmer's time is valued at 30% of the rainy season rate for the contour ridges and Acacia albida interventions, and at 50% for the organic fertilizer interventions, to reflect less competition for labor.

2.8 Windbreaks

Properly placed windbreaks, oriented perpendicular to the predominant winds, reduce wind erosion and stabilize the soils. A series of windbreaks, such as those established in the Maggia Valley in Niger can cause millet and sorghum yields to increase by 18% when they are well established (see Table 2).

For the individual farmer, the windbreak intervention provides two benefit streams -- protection of his field against wind erosion, and wood products. Both benefit streams occur only after a lag period of several years when the trees are well established. The windbreaks can be exploited for fuelwood and poles provided that the integrity of the windbreak is not compromised. The windbreak assumptions are summarized in Table 5.

Table 5
ASSUMPTIONS: WINDBREAKS

Field Activities	Assumptions
Person Days/ha:	
Planting (yr 1)	4
Replanting, 30 % (yr 2)	1.2
Maintenance (1st 3 yrs)	7
Trees/hectare	50
Cost per seedling (F CFA)	60
% of land/ha occupied by windbreak	14 %
Harvesting begins	Year 9
Fuelwood	.5 stere
Poles	5
Prices	
Fuelwood/stere (F CFA)	1,050
Poles (F CFA)	800

2.9 Acacia albida

The presence of Acacia albida trees in the farm fields is presumed to increase crop yields and restore soil fertility. (The team was told that sorghum yields can double in some areas). The tree is nitrogen fixing and the leaves and pods provide excellent fodder for livestock during the dry season when grass forage is scarce. During the dry season, farmers lop off branches from the Acacia trees to feed the livestock. Acacia albida trees are usually widely spaced and crops grow immediately adjacent to the trees. Their presence does not significantly reduce the cultivable area.

In areas where Acacia albida occurs naturally, the present stocking density is usually far below an optimal density of roughly 50 - 60 trees per hectare (estimated by the Chef de Cantonnement de Djenne, Mali). The analysis is based on the low (present) stocking density of 15 trees/ha and the time and effort it will take to bring the stocking density up to the optimal level. The analysis assumes that trees are regenerated naturally, and the

only investment the farmer must make is 10 person days per year of his time to protect the seedlings for a period of four years.

2.10 Live Fences

Live fences serve several important and distinct purposes. One purpose is to delimit fields, particularly intensively cultivated vegetable gardens, another is to function as a barrier against livestock intrusion onto the fields. A third purpose is to provide forage and wood products. A fourth is to reduce the amount of vegetation cleared in a given area.

The measurable benefits from live fences, however, are difficult to evaluate. Although a live fence generates some soil conservation benefits, the real benefits are the values protected by preventing livestock trampling and other damages. It may be that the fence is essential to the prevention of the destruction of the crops by livestock and wild animals. The farmer may choose a barbed wire fence at a considerable cash outlay, a dead fence which requires considerable maintenance and which contributes further to the deforestation of the area, or a live fence which requires more of his time up front but less cash and much less subsequent maintenance. The latter is by far the preferable option, both environmentally and economically. The assumptions associated with the live fencing intervention are given in Table 6.

Depending on the type of live fence planted and its intended function, there is also the possibility of earning a small cash income from marketable products -- fuelwood, poles, fodder, etc. -- from the fence as it grows and matures. One effective live fence species, the Prosopis juliflora, provides the protection against livestock damages and some fuelwood and poles. The Prosopis fence (analyzed in this financial annex) is usually planted at a two-meter spacing or less. Once the trees are well established, the thorny branches are intertwined to provide an effective barrier against livestock intrusion. Another commonly used live fence species is the Parkinsonia aculeata [4].

2.11 Chemical Fertilizer

Chemical fertilizer (NPK) is a purchased item and is assumed to apply only to the peanut and cotton cash crops. Table 7 presents the recommended level of chemical fertilizer application in the rainfed cotton fields in the Fansebougou (Mali) area, which is also the base case assumption used for purposes of the analyses.

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[4] The live fence intervention is not analyzed in combination with any of the other interventions. The four crops considered -- millet, sorghum, cotton and peanuts -- are extensive field crops, generally not grown inside live fences. It is more common that they surround collective and small individual vegetable gardens, and small woodlots in some areas. Recently, however, farmers have begun to plant live fences around their staple crop fields as well.

With these amounts of fertilizer, insecticides and herbicides applied per hectare, cotton yields can reach as high as 1,500 kg/ha (under average rainfall conditions). (The base case assumption is 1,100 kg/ha, Table 1). At the fixed and guaranteed price of 85 F CFA per kg for the cotton, total revenues equal 127,500 F CFA per hectare. The net revenues of nearly 95,000 F CFA per hectare (127,500 - 33,100) appears to be a very attractive rate of return. Farmers in the area are taking advantage of the credit system for fertilizer and other inputs. An added advantage of the cotton production is that the sorghum and millet grown on last year's cotton fields generally have high yields because they benefit from residual fertilizer in the soil.

Table 6

ASSUMPTIONS: LIVE FENCES

Field Activities	Assumptions
Meters of live fence/ha	400
Person Days:	
Site preparation and planting (yr 1)	16
Protection and weeding (1st 3 yrs)	4
Plants/meter	2
Cost per seedling	25
Years before fence becomes effective	4
Harvesting begins	Year 6
Poles/ha/year	100
FW/ha/year	1 stere
Prices	
Poles (F CFA each)	75
FW (F CFA/stere)	1,050

Table 7

ASSUMPTIONS: AGRICULTURAL CHEMICALS

Fertilizer, Insecticide, herbicides	Kg or liter applied/ha	F CFA/ kg or l	Total cost/ha
Fertilizer complex	150 kg	140/kg	21,000
Urea	50 kg	130/kg	6,500
ULV insecticide	5 l	1,000/l	5,000
Herbicide	2.4 l	250/l	600
Total			33,100

2.12 Organic Fertilizer

Organic fertilizer and compost is collected by the farmer. No cash transactions take place (unless it has to be transported over longer distances). The use of organic fertilizer prepared in compost pits (fosses fumieres) is being promoted in some Sahelian countries, particularly in Mali. In USAID's Operation Haute Vallee project, for example, 24 compost pit installations have been completed as demonstration sites. Each installation can supply up to ten tons of excellent organic fertilizer per year. An estimated 6 - 10 tons/ha of organic fertilizer are required to significantly increase crop yields. In the village of Fansebougou (Mali), for example, the result from one test on a cotton field in the area indicated that approximately six tons of organic fertilizer produce a slightly higher cotton yield than the yields obtained using chemical fertilizer.

The compost pit intervention is not widely replicable in the Sahel. It is an excellent idea for Malian farmers (in the 3rd Region) because they also typically own several animals. Herd owners have already built pens where the animals bed down at night. Only a small additional investment of labor to dig the compost pit adjacent to the already existing pen would be required in each case. The dimension of the compost pit is roughly 2 x 5 x 1 meters. The assumption associated with the organic compost intervention are given in Table 8 below.

Table 8

ASSUMPTIONS: ORGANIC FERTILIZER, COMPOST

Field Activities	Assumptions
Person Days:	
Digging compost pit	4
Annual operation/maintenance of pit	5
Field application	2
Tons of fertilizer produced and applied/yr	6

2.13 Contour Ridges

Contour ridges are earth and rock structures built along the contours of the fields to retain rainwater and control run-off. The distance between the ridges depends on the steepness of the slope -- short on steep slopes and further apart on gentle slopes. When the ridges are properly constructed, water run-off is slowed considerably to allow a much higher rate of infiltration.

The construction of contour ridges in the farm fields should be treated as a special case. In view of the severity of the soil erosion problems in the majority of Sahelian countries, it is more of an either/or situation -- a farmer either does it or he loses his land.

Much land in Mali's 5th Region has already eroded far beyond the point where any restoration is feasible. Near the village of Sinkarma on the Dogon plateau, for example, one farmer had lost a large portion of his field to erosion before he constructed approximately 300 meters of contour ridges/ha in his remaining field (with technical assistance from the USAID's Village Reforestation Project). The same year he seeded the land but harvested nothing because of insufficient rainfall. Despite this disappointment, however, the farmer has adopted a long term view seeing the either/or importance of the ridges. This long term view was also the case with several other farmers interviewed in the area (Christophersen and Karch, 1988).

The time it takes to build contour dikes varies considerably depending on the terrain. Rocks have to be transported to the field and broken into smaller pieces; the contour lines will have to be identified; the shallow trenches where the rocks are placed will have to be dug, the rocks properly placed and the sealing between the rock spaces with dirt will have to be done. It is a time consuming process. The team observed several contour ridges in the field and discussed time requirements with the farmers. In all cases, the farmers used the labor of their entire extended family, often 15 people or more for several days. Some families received help from other villagers. The best researched information obtained was from a GTZ field agent (Projet Vulgarisation Agricole, Bandiagara, Mali). According to this source, one group of 12 persons working seven weeks, three full days per week, can build 525 meters of contour ridges, or approximately 2.1 meters per person day.

It is important to note that many farmers, particularly in Mali's 5th Region, are already responding to urgent needs to practice soil and water conservation by constructing their own versions of contour ridges. As observed throughout the area, farmers mine and break rocks and place them in rectangular patterns in their fields (Christophersen and Karch, 1988). This system improves yields and conserves the soil, but not nearly as much as can be accomplished with ridges constructed along the contour lines. For the farmers who have already invested their time and effort, the additional effort required will be to reconstruct the ridges along the contour lines. In their case, the rocks will already have been mined, broken and transported to the field. The only additional time will be to move them to a different location.

How many meters of contour ridges per hectare to construct depends on the nature and condition of the terrain. In the several fields visited, approximately 300 meters of ridges had been installed per hectare on the average. This is the base case assumption used in the analysis. The assumed time required to construct 300 meters of contour ridges is 300 m/2.1 person days, or 142 person days in the case when no ridges exist. If the farmer version ridges already exist, the time required to reconstruct the ridges along the contour lines reduces to 10 person days per hectare. Eight person days/year/ha are assumed to be needed to maintain the ridges.

The assumptions associated with the two contour ridge intervention scenarios are summarized in Table 9. The labor cost assumption used for the contour ridges intervention is 30% of the rainy season rate, or approximately 135 F CFA per day.

Table 9
ASSUMPTIONS: CONTOUR RIDGES

Field Activities	Ridges Do Not Exist	Farmer Version Ridges Exist
Person Days:		
Construct catchments (yr 1)	142	10
Maintenance (all yrs)	8	8
Meters of catchments/hectare	300	300

3. ANALYSIS AND RESULTS

The analyses compare NRM interventions with the traditional farming system base case scenarios given the assumptions specified in the previous section. The basis for this comparison -- the situation facing the farmer over the next 20 years if none of the interventions were undertaken -- is presented in Table 4 above. The table shows the gradual (6%) decline in crop yields over time, the approximate number of person days spent on the crops from planting to harvest, and the value per person day spent on raising the crops, based on the assumed prices for the crops (see Table 1).

3.1 Intervention Scenarios

The results are summarized in Tables 10, 11, 12 and the graphs presented at the end of the annex. The graphs show the differences in total yields between farming under the traditional system or with the benefit of NRM interventions. The graphs are based on the assumptions that crop yield increases are known (as given in Table 2 in the previous section) and on average rainfall conditions. That the curves fluctuate sharply over time is attributable to the different crop combinations which generate different yields over time.

In the graphs, the base case and intervention curves are parallel in some cases and diverging in others. The shape of the intervention curves changes with the assumptions on crop yield increases and the soil restoration assumptions given in Table 2. In all of the cases, the farmer has bought additional time before the land has to return to fallow. Where the two curves diverge, the land productivity is improving over time as a result of the interventions which means that the return to fallow can be postponed indefinitely. This is a very significant environmental benefit since the pressure to clear additional land to replace recently fallowed land, will be lessened. Because of this reduced pressure, the now fallowed land will be able to remain in failow for a longer period of time which will further add fertility to the soil. This land will be more productive when it is eventually brought back into production.

The breakeven and NPV results are given in two tables (Tables 10 and 11) to avoid any possible confusion with the interpretation of the results. The breakeven and NPV's results are mutually exclusive. The former uses cost information only to generate the breakeven results. The NPV results are based on sketchy, highly variable, and site specific information on benefits, as given in Table 2. Table 10 shows the breakeven average crop yield increase per year that the farmer must receive per hectare over the 20-year period in order to recover his costs. The breakeven figures are calculated using composite and weighted averages of traditional farming (base case) yields (which are given in Tables 1 and 4) and crop prices. Table 11 shows the NPV's per hectare associated with the costs and benefits of intervention assuming that the actual crop yield increases are known.

Table 10

BREAKEVEN RESULTS: SEPARATE AND COMBINED INTERVENTIONS

Interventions	BE Crop Yield Increase (Kilos/ha)
SEPARATE INTERVENTIONS	
1 Windbreaks	18
2 Live Fences	7
3 Organic Fertilizer/Compost	28
4 Agricultural Chemicals	751
5 Acacia albida: Natural Regen.	7
6 Contour Ridges: New	114
7 Contour Ridges: Replace	26
COMBINED INTERVENTIONS	
8 Windbreaks, Organic Fertil., and Contour Ridges (replace)	69
9 Windbreaks, Agric. Chemicals, and Contour Ridges (replace)	792
10 Organic Fertilizer and Contour Ridges (replace)	51
11 Contour Ridges (replace) and Acacia albida	32
12 Windbreaks and Contour Ridges (replace)	44

Table 11

NPV RESULTS: SEPARATE AND COMBINED INTERVENTIONS

	Interventions	NPV (F CFA/ha)
	SEPARATE INTERVENTIONS	
1	Windbreaks	882
2	Live Fences	11,953
3	Organic Fertilizer/Compost	208,921
4	Agricultural Chemicals	37,495
5	Acacia albida: Natural Regen.	7,242
6	Contour Ridges: New	-120,481
7	Contour Ridges:	3,821
	COMBINED INTERVENTIONS	
8	Windbreaks, Organic Fertil., and Contour Ridges (replace)	219,599
9	Windbreaks, Agric. Chemicals, and Contour Ridges (replace)	48,173
10	Organic Fertilizer and Contour Ridges (replace)	218,716
11	Contour Ridges (replace) and Acacia albida	17,038
12	Windbreaks and Contour Ridges (replace)	4,703

3.2 Separate Interventions

Windbreaks: If the benefits attributable to the windbreak intervention are not known, the farmer would need a composite average (over the 20-year period) of approximately 18 kg/ha/year increase in crop yields, over and beyond the yields he can expect under the traditional farming system, in order to recover his costs. If the benefits are known (Table 5), the farmer will earn a positive NPV of 882 F CFA/ha. Because the NPV is positive, the farmer will receive at least the 20% return required to attract his participation (the discount rate). In addition, he will receive a "bonus" measured by how much crop yields increase beyond his required minimum.

The windbreak intervention also provides some revenues in the form of poles and fuelwood sold. After nine years, .5 stere of fuelwood and five poles are harvested per hectare in the windbreaks each year. Based on the fuelwood and pole prices assumed in Table 5, the present value per hectare of these benefits over the 20-year period is 2,794 F

CFA/ha for the poles, and 367 F CFA/ha for the fuelwood. These returns are reflected in the NPV of 882 F CFA/ha.

Figure A1 (at the end of the annex) illustrates the impact of the windbreak intervention on crop yields over time. The intervention begins to take effect in year five when yields begin to increase. Yields subsequently decline at the same rate as the base case yields.

Live fences: The live fence intervention is not generally applicable to the four crops considered -- millet, sorghum, cotton and peanuts. These are extensive field crops which are generally not surrounded by live fences (although it is beginning to happen in some areas). Large collective and small individual vegetable gardens, and some small woodlots, on the other hand, often are fenced.

To determine the financial attractiveness of live fences based on vegetable crops associated with different yields and prices, however, would have required different assumptions and separate analyses which are beyond the scope of the study. The results for the live fence intervention given in Table 10, therefore, are based on the limited application of live fences surrounding the four field crops, not vegetable crops. Reference is made to the sensitivity analyses below (in Section 4) to test higher yield and price combinations which could reflect vegetable yields and prices instead of field crops.

If the benefits of the live fence intervention are not known, the composite average break-even yield increase over the 20-year period is seven kg/ha year, each year for the entire 20-year period. If the benefits are known (as assumed in Table 6) the intervention has a positive NPV of 11,953 F CFA/ha including the revenues from poles and fuelwood.

Figure A2 illustrates the impact of the live fence intervention on crop yields over time. The intervention begins to have an impact on crop yields in year four. As with the windbreak assumption, yields subsequently decline at the same rate as the base case yields.

Organic fertilizer and compost: Of all the interventions analyzed, the organic fertilizer and compost intervention has the highest positive NPV (208,921 F CFA/ha). The returns far exceed what the farmer would require in order to recover his costs given the assumptions. It should be emphasized, however, that the intervention has limited replicability potential. It will work only where there is little competition for land between farming and grazing. With the possible exception of some areas in Mali's 3rd region, there are few such areas in the Sahel. Moreover, the assumptions reflect a situation where the farmer already owns the cattle, has already built his pen where the livestock is confined during the night, and the only additional work that must be performed is to dig the compost pit adjacent to the pen, manage the composting, and spread the finished fertilizer. The investment would be considerably higher for farmers who must first acquire the livestock and build the pen.

Figure A3 illustrates the impact of the organic fertilizer intervention on crop yields over time. The intervention brings immediate high yield increases followed by a decline at the same rate as the base case yields.

Agricultural chemicals: The agricultural chemicals (NPK fertilizer, herbicides and pesticides) intervention has a very high break-even crop yield increase requirement (751 kg/ha/year for the 20-year period) in order to recover costs. Each year, crop yields will have to be at least 751 kg/ha higher than the yields given in Table 4 to pay for the out-of-pocket cash investments and the time invested in applying the fertilizer. The NPV of 37,495 F CFA/ha indicates that the use of chemical fertilizer is a financially attractive land improvement option. The replicability of this intervention, however, depends on the availability of local farmer credit.

Figure A4 illustrates the impact of the agricultural chemicals intervention on crop yields over time. It is almost identical to Figure A3 (organic fertilizer) in terms of its impact on crop yields. Yields increase immediately followed by a decline parallel to the base case yields.

Acacia albida: The Acacia albida intervention requires time investments early whereas significant benefits do not appear until much later, often as late as 6 - 10 years after planting the trees. The NPV (7,242 F CFA/ha) gives the farmer a much narrower gap between the increases in crop yields he must have to recover his costs and what he can expect to receive, than the organic fertilizer intervention, for example. The required break-even increase in crop yield of seven kg/ha/year, on the other hand, is low compared with the organic fertilizer intervention. In terms of required time investment, therefore, a farmer would favor the Acacia albida intervention. It only requires a total of 10 person days/year/ha for four years (see Section 2.9). The organic fertilizer intervention requires a higher time investment commitment.

Figure A5 illustrates the impact of the Acacia albida intervention on crop yields over time. Crop yield increases begin to take effect in year six. Yields subsequently decline at a slightly lower rate than the base case yields.

Contour Ridges: In areas where farmers need contour ridges and no "farmer version" ridges exist (as on the Dogon Plateau in Mali's 5th Region), the investment does not appear to be financially attractive to the farmer, even when using the lower labor rate (30% of the full rate). Given the assumptions (in Table 9), the NPV is -120,481 F CFA/ha.

The negative NPV, however, should not be interpreted to mean that the intervention should be discouraged. Where contour ridges are needed there may be extenuating circumstances that justify the investments of the farmers' time. More often than not, the situation is either-or: either construct the ridges, or lose the land. Also characteristic of areas where contour dikes are a recommended option, are that farmers have barriers to exit. There are few, if any alternative employment opportunities available. Farmers have no other options left but to make the land improvement investments or lose the land to erosion altogether. If the investments are not made, the land will have a permanent zero value. Protecting this land assumes a much higher importance than can be explained by the financial results given in this annex.

The financial result for the contour ridge intervention increases to a positive 3,821 F CFA/ha where "farmer version" ridges already exist. In these cases, farmers have realized the severity of the problem and have installed their own (rectangular) version of ridges in their fields. The time consuming and heavy work has already been done and the only additional work consists of breaking up the rectangular ridges and moving the rocks to the contour lines in the fields.

The required break-even increase in crop yields for the contour ridge intervention (where farmer version ridges already exist) is low -- 26 kg/ha/year for the 20-year period.

Figure A6 illustrates the impact of the replacement contour ridge intervention on crop yields over time. Crop yield increases are immediate followed by a decline at the same rate as the base case yields.

3.3 Interventions in Combination

Five different combinations of interventions are analyzed with the results summarized in Table 10. All of the combined interventions appear to be financially attractive from the farmer's perspective. NPV's range from as low as 4,703 to a high of 219,599 F CFA/ha. Crop yield increases required to break even on the investment of time and/or money range from 32 to 792 kg/ha/year. The graphs at the end of the annex (Figures A7 - A11) illustrate the differences in crop yields between the base case traditional farming and the interventions in combination. In all of the cases, except where Acacia albida is included, crop yields increase according to the assumptions specified in Section 2, followed by a decline in yields parallel to the decline in base case (traditional farming) yields. Where Acacia albida is included, yields decline at a much slower rate over time than the rate assumed in the traditional farming base case scenario.

Windbreaks, organic fertilizer, and contour ridges (No. 8): In NPV terms, this combined intervention is most attractive (219,599 F CFA/ha). In break-even terms, the intervention requires an increase of 69 kg/ha/year in crop yields for the 20-year period in order to recover the time and cash investment costs. It should be noted that the applicability of this combined intervention is limited to areas where wind erosion is a problem, where contour ridges are needed and where organic fertilizer can be produced as assumed in Table 8.

Windbreaks, agricultural chemicals, and contour ridges (No. 9): Purchased agricultural chemicals in combination with windbreaks and contour ridges generate a positive NPV of 48,173 F CFA/ha). This result, although far lower than the previous case where organic fertilizer was assumed, would still be an attractive option where organic fertilizer is not available. The limiting factors in this case are the availability of farmer credit and sufficient rainfall. When rainfall is insufficient, yields may actually be lower than the traditional crop yields if agricultural chemicals are applied. The required high break-even increase in crop yields of 792/kg/ha/year for the 20-year period, and the unreliability of sufficient rainfall, may make this option too risky for the majority of Sahelian farmers.

Organic fertilizer and contour ridges (No. 10): This is the second-most attractive combined intervention in NPV terms (218,716 F CFA/ha). In break-even terms, this combined intervention requires only 51 kg increase in crop yields/year for the 20-year period whereas combined intervention No. 8 (with windbreaks added) requires an additional 18 kg/ha/year. To a farmer, intervention No. 10 may be the more attractive option because of the low breakeven increase in crop yields required, and because no cash outlays are necessary.

Contour ridges and Acacia albida (No. 11): These two interventions combined produce a synergetic effect on crop yields. The contour ridges make better use of scarce rainwater and the Acacia trees add soil nutrients. Figure A11 shows the divergent pattern of crop yields between the traditional farming base case and the intervention. As the soil improves over time, so does productivity.

Windbreaks and contour ridges (No. 12): This combined intervention appears to be the least financially attractive to the farmer in NPV terms. Windbreaks involve some out-of-pocket cash outlay and it takes a full five years before the effects begin to take place. Contour ridge construction is time consuming and labor intensive.

4. SENSITIVITY ANALYSES

Sensitivity analyses cover the "what-if" questions. Although base case assumptions are supposed to be representative and realistic, the real world is filled with uncertainties and all variables are subject to unanticipated fluctuations. What would happen to the analytical results if the price were X instead of Y? What would happen to the results if costs were higher or lower than those originally assumed, or if the probability of success is less than 100%? The following parameters have been subjected to sensitivity analyses: the discount rate, market prices, initial yields and rate of soil depletion over time.

The changes in the results from changing the assumptions are displayed in Table 12. In the table, base case assumptions are bracketed by a maximum of plus and minus 50% on either side by a desired range reflecting both pessimistic and optimistic scenarios. For illustrative purposes, only one of the combined interventions analyzed is subjected to the sensitivity analysis (No. 8 consisting of windbreaks, organic fertilizer and contour ridges). This combined intervention is chosen because it is financially optimal in NPV terms and because it can possibly be implemented without running into labor shortages. Any intervention, or combination of interventions, can be analyzed in a similar fashion.

Table 12
SENSITIVITY ANALYSIS: COMBINED INTERVENTION N0. 8

Assumptions For Which Changes areas Made	NET PRESENT VALUES ('000 F CFA ROUNDED)						
	-50%	-25%	-10%	Case	+10%	+25%	+50%
Discount Rate	378.8	281.9	241.5	219.6	200.9	177.6	148.2
Market Prices	191.2	205.4	213.9	219.6	225.3	233.8	248.0
Initial Yields	190.5	205.1	213.8	219.6	225.4	234.1	248.7
Crop Yld Decl.	261.9	239.5	227.2	219.6	212.3	201.9	186.1

Note to the table: An increase in the crop yield decline of 50%, for example, means that the rate of decline increases from 6 to 9%.

The base case NPV for intervention No. 8 is 219.6 F CFA per hectare. The most sensitive of the four parameters analyzed is the discount rate. If the base case assumption of a real discount rate of 20% were increased by 50% (from 20 to 30%), the NPV will drop to 148,200 F CFA/ha. A 50% increase in the decline in crop yields assumption (the second-most sensitive parameter) from 6 to 9%, will reduce NPV to 186,100 F CFA/ha.

The results do not appear to be critically sensitive to changes in the base case assumptions. Even with changes as wide as plus or minus 50% of the base case assumptions, the results all stay well within the bounds of financial feasibility because they are all still positive.

5. THE ROLE OF THE DONOR: SOME CONCLUSIONS AND RECOMMENDATIONS

Given the premise that any intervention must first make financial sense to the farmer, and at the same time recognizing that the costs of doing nothing may be insurmountable, there is ample opportunity for donor involvement. The key problem is to determine how donor funding should be prioritized. The following are several conclusions and recommendations based on the Team's findings and on the analytical results derived in this annex:

Conclusion 1: Finding workable solutions to natural resource, recurrent drought, and deforestation problems is now given high priority by the donors and the host countries alike. This is evidenced by the Team's observations of activities carried out by the several donor projects visited in the four countries.

The NRM activities observed in the field show that workable technical solutions are available in relative abundance. The majority of the activities and techniques observed, particularly those analyzed above, are excellent and have considerable potential. The major problem is that the overall impact of the activities carried out in the field remain local.

With the exception of the recent widespread diffusion of improved woodstoves in Mali, there is little evidence that the NRM activities and techniques tested and carried out in the field, such as soil conservation techniques, organic compost piles, etc.. have resulted in any significant nationwide impacts. Despite the fact that these activities and techniques may be just the right thing to do, they have yet to make a significant dent in the magnitude of the environmental problems in the four countries visited. The major obstacle is that the gap between the demonstration stage and widespread implementation in the field has not been bridged. The techniques are available, they work, farmers who receive the necessary training adopt these techniques and thus slow progress is being made. But it is not nearly enough.

Recommendation 1: Donors should place a much stronger emphasis on extension and training at the grass roots level if the NRM problems are to be resolved. Much more important than the development of additional new techniques is to widely diffuse the techniques now being applied on a nationwide scale.

In Volume II of the report, the Team documents several interventions where grass roots level training is or has been successfully carried out. Among several examples, one of the most notable interventions is USAID's OHV project in Mali where the primary target audience for extension and training is the village farmer. The project offers training in the forms of: mass contact (radio, TV, etc.), groups (small groups of 6 - 15 villagers trained by extension agents), individual contacts between the project extension agents and the farmers in the field, and demonstration (model site) plots. Several technical "how-to" course modules have been developed according to the needs observed in the field. All of the courses have been taught in the field and, according to OHV representatives, the spread effect has been quite substantial. Once the selected groups apply the new techniques in the field, and the results are favorable, others will follow. The course modules include:

- o Soil conservation techniques -- diguettes, micro-catchments, dams, contour planting, etc.
- o Preparation and use of animal and other organic matter as fertilizer
- o Planting density (agricultural crops)
- o Use of synthetic fertilizer
- o Different crop varieties, improved seeds, etc.
- o Chemical pest control
- o Use of phosphates
- o Improved wood stoves
- o Seed production and use of improved seeds
- o Preservation of perishable seed and crops

The training occurs at three levels: 1. Training trainers (field agents) in "how-to" techniques. 2. One full day of field training given to groups of 6 to 15 pre-selected farmers. The group of trainees are selected by the villagers themselves. 3. Regular follow-up with individual group members by the field agents. They work directly with the trained group members to ensure that the techniques are properly applied and to correct errors.

Probably the most important aspect of the OHV training and extension program is the recognition of the importance of grass roots level training. That there may be problems with how the training is carried out and/or whether the training modules offered are the most appropriate, are of secondary importance to the fact that such grass roots level training has in fact been given high priority. The recognition of the importance of this kind of training is a major step. The field problems associated with the training and extension program are mostly technical and resolvable.

The majority of natural resource strategy documents prepared for USAID and the major multilateral donors usually include a strong emphasis on training. The questions, however, are: training in which subject matters and for whom? Most often, donor funded training means either long term university level (MS and/or PhD) education for mid to high level government officials, or in-country seminars and workshops for the same people. This kind of training may be necessary, but it is not nearly sufficient. There is a tendency of promoting too much high level training and not enough at the farm level. In-country training of low to middle level extension and NGO personnel with the ultimate goal of having a cadre of well-trained and motivated extension personnel is equally, if not more, important. This aspect of donor funded training has been promoted far too little.

If NRM interventions are to succeed, there must be mechanisms by which farmers, herders and other local people can participate directly. The availability of a cadre of well-trained extension agents and/or NGO's, whose mandate will be to work with, teach and motivate the local people on a continuous and regular basis, in the basic "how-to's" of natural resource management, could prove to be a key and essential ingredient to the success of future natural resource development efforts.

Conclusion 2: Continued traditional slash and burn agriculture is damaging to the environment.

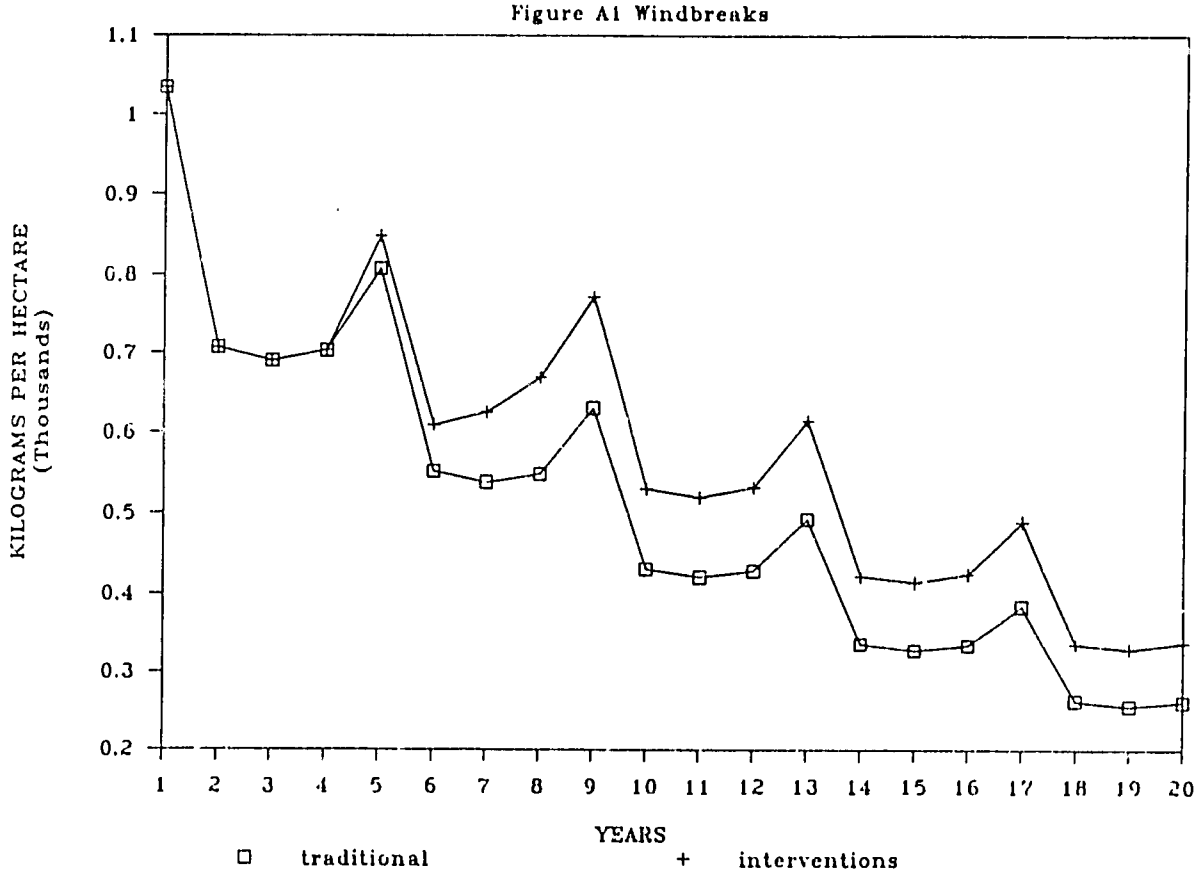
Slash and burn agriculture is a traditional system that has been practiced without too much stress on the environment for centuries. Because of intense population pressures and prolonged drought periods, there is no longer enough land to allow the continuation of this traditional land use practice. Now, crop yields decline rapidly over time because new land is being cleared too soon. Soil fertility cannot be adequately restored if the land is taken out of fallow too soon. As population increases, more new land is brought into farm production, which increases deforestation in the country.

Recommendation 2: A 2-pronged approach is recommended in order to address these problems. The first is to prolong the use of the existing farm fields by conserving the productivity of the soil. The activities and techniques observed in the field will contribute to this end if implemented on a much larger scale than is now the case. The results of the analyses presented above could be used to guide the design of the kinds of NRM interventions USAID may want to consider funding. To increase the probability of success, for example, A.I.D. should probably focus on providing farm level technical assistance for activities that offer immediate or near term benefits to the farmers, without having to provide direct financial incentives to attract participation. For the NRM activities that do not provide immediate financial benefits (windbreaks, Acacia albida and live fences), the donor could choose to provide direct financial incentives, such as provided through the UNSO project in the Dosso Department in Niger.

The second approach is to look for financially attractive investment opportunities in land farmers would otherwise abandon to fallow. The objective would be to reduce the amount of time that land will have to remain in fallow. Relatively little is being done in this second category.

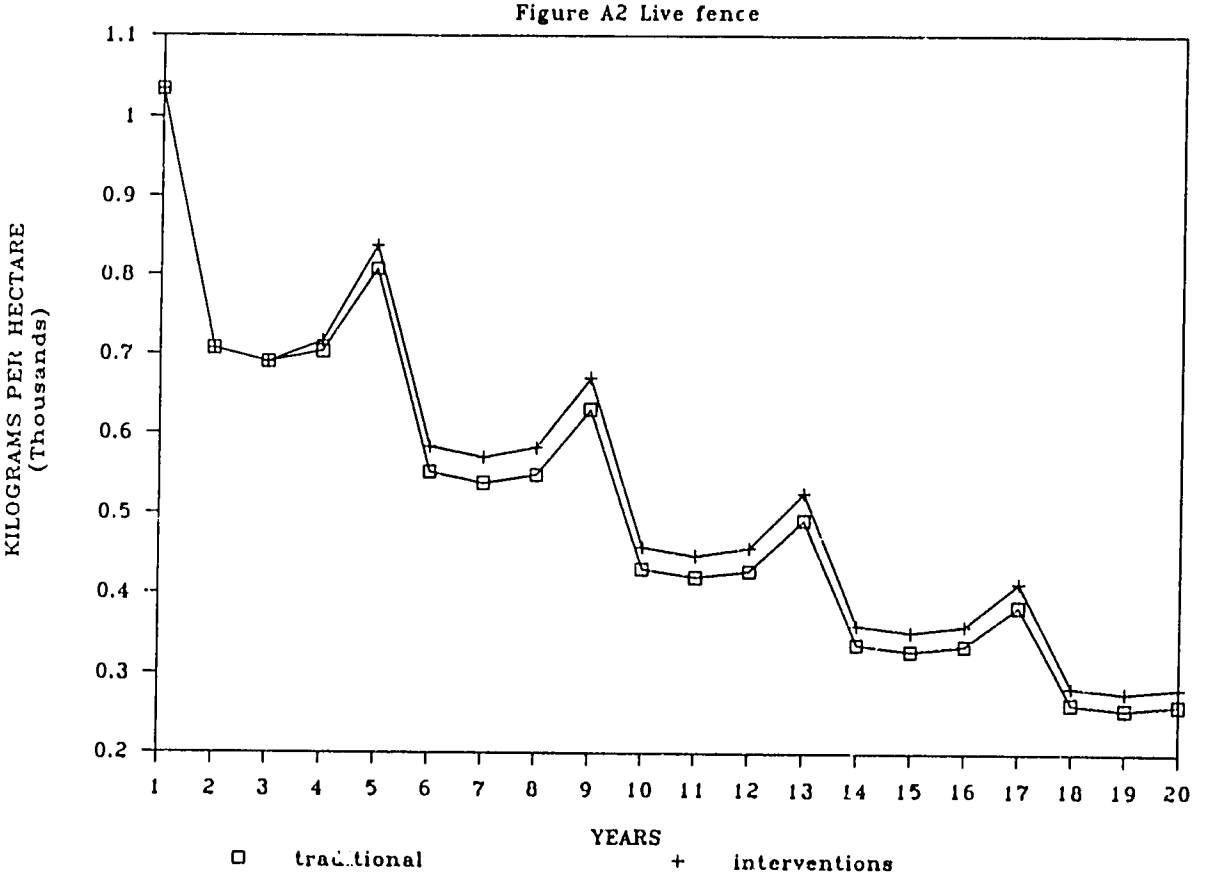
TOTAL YIELDS

Figure A1 Windbreaks



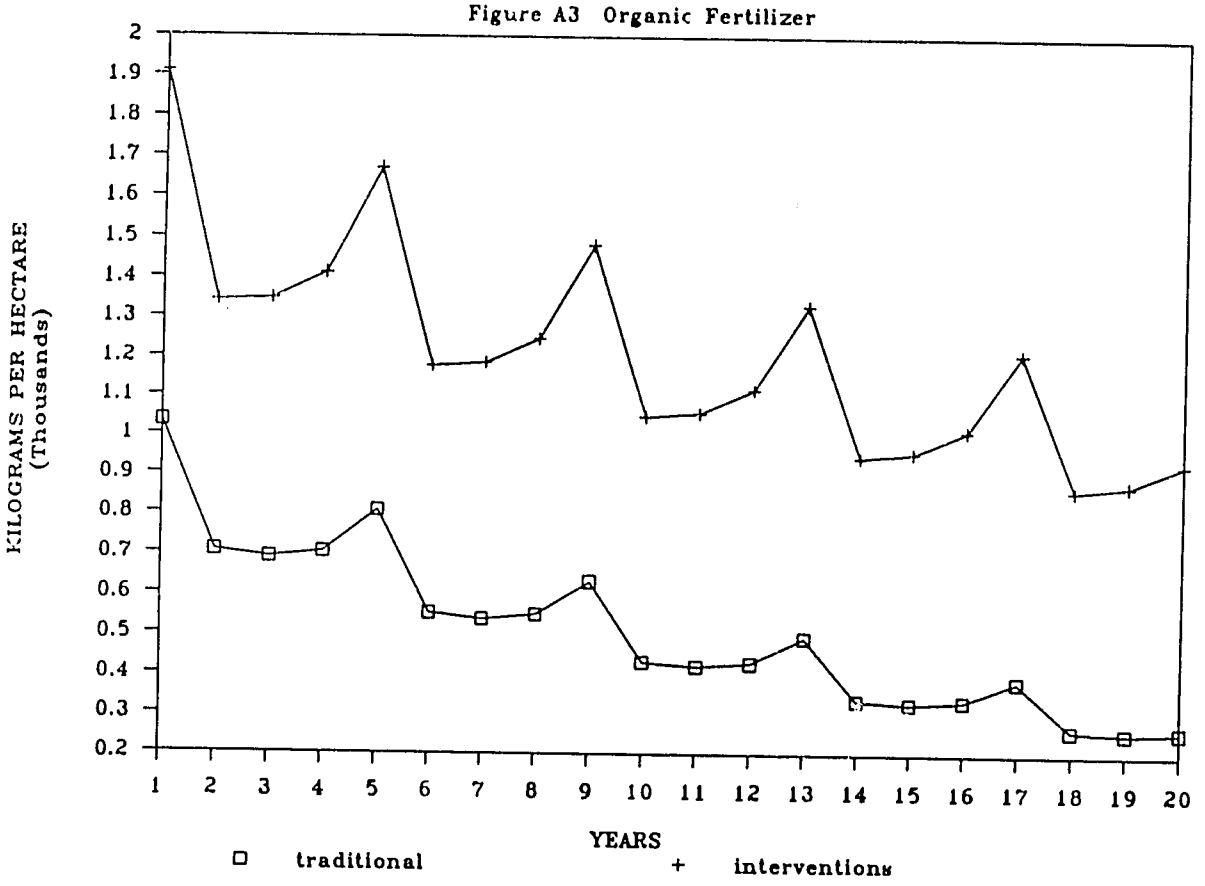
TOTAL YIELDS

Figure A2 Live fence



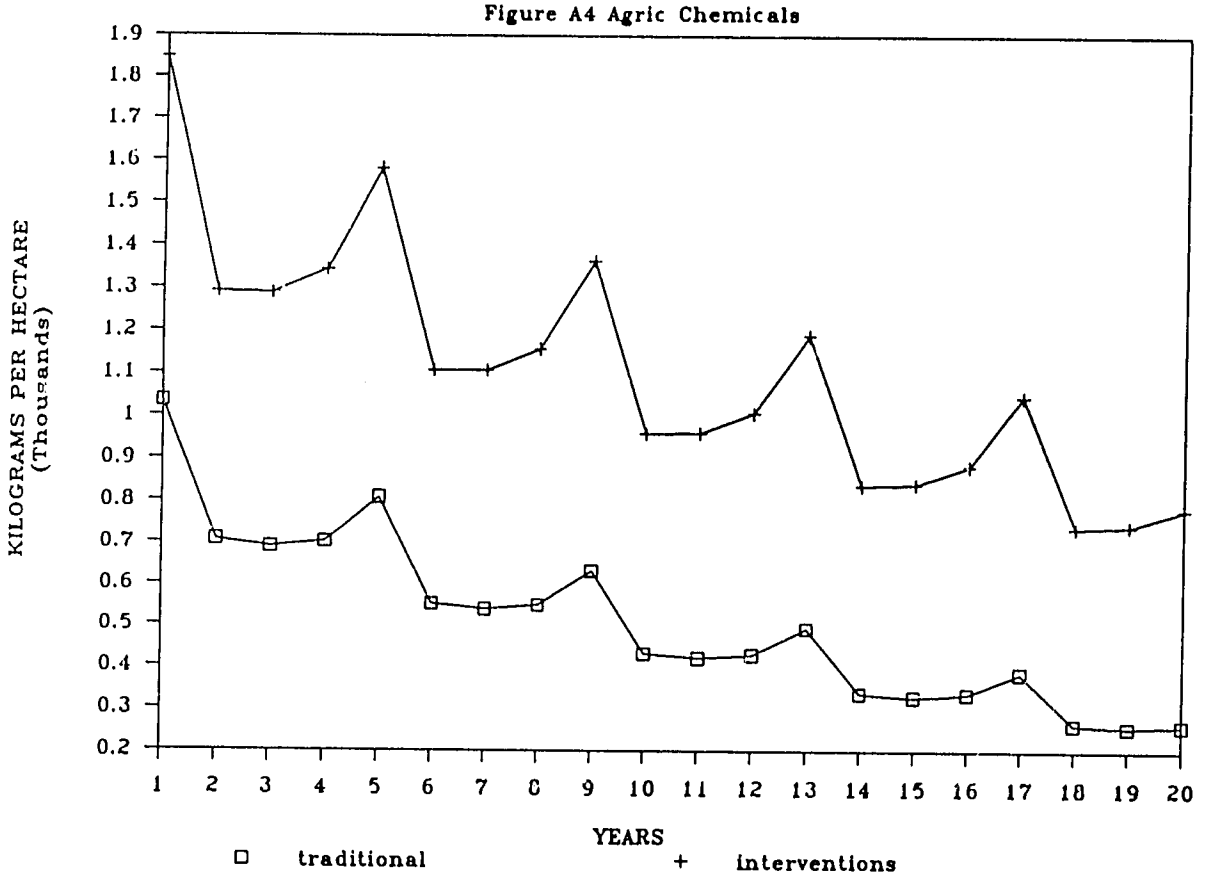
TOTAL YIELDS

Figure A3 Organic Fertilizer



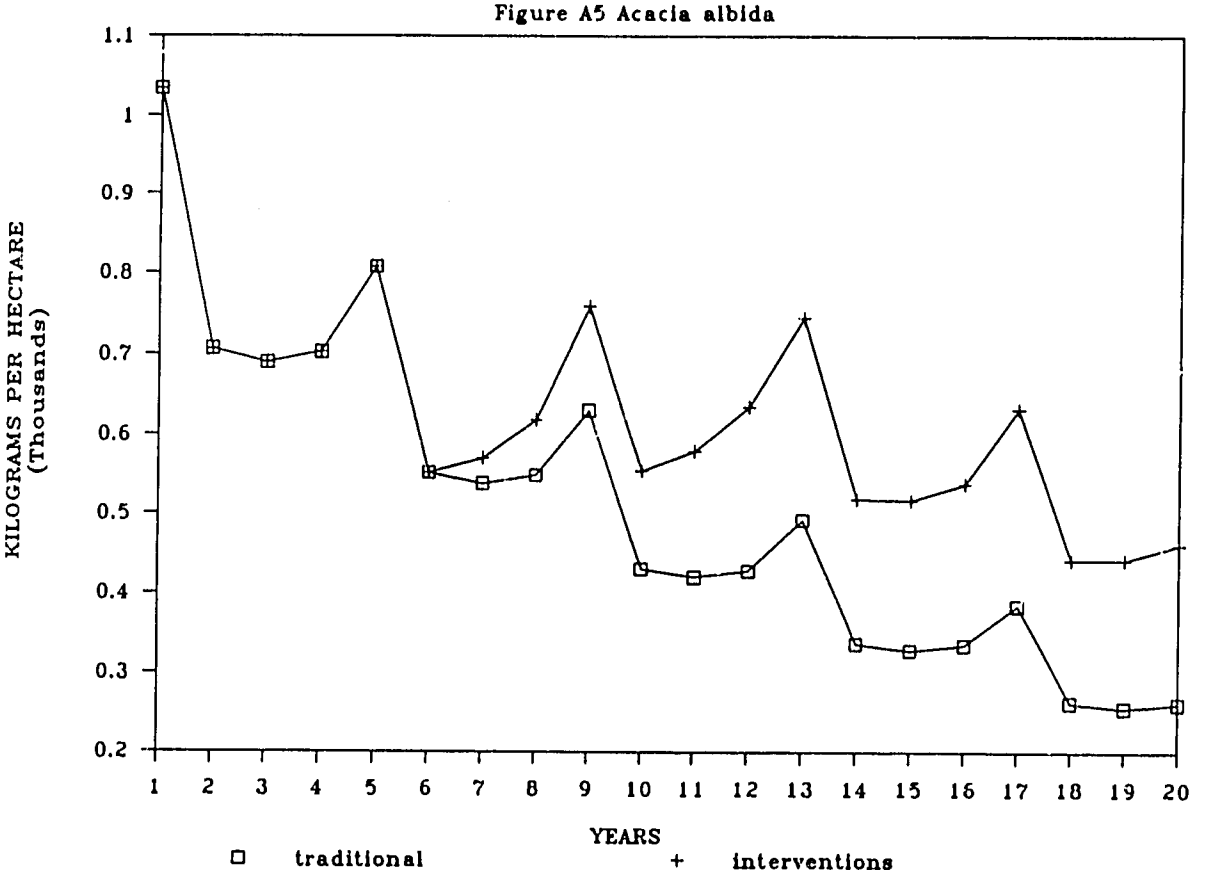
TOTAL YIELDS

Figure A4 Agric Chemicals



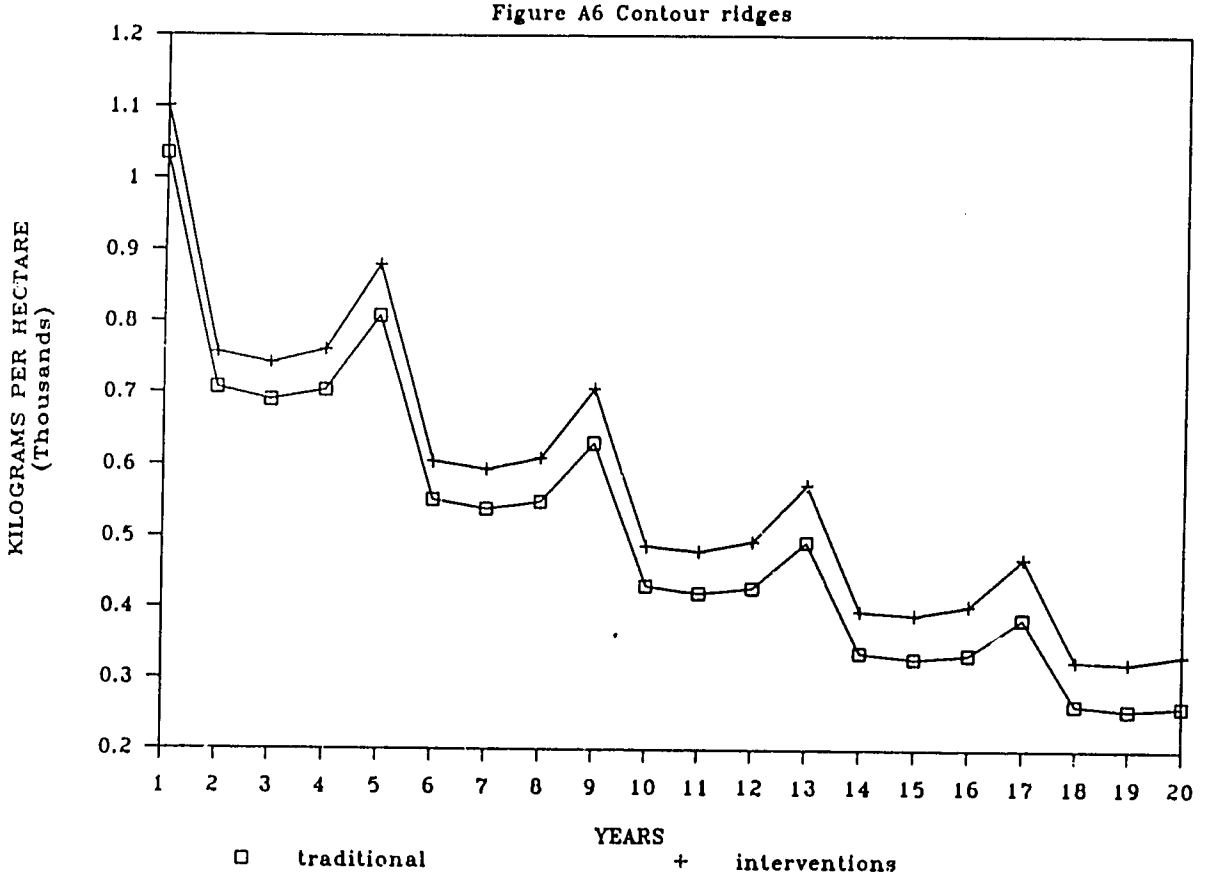
TOTAL YIELDS

Figure A5 Acacia albida



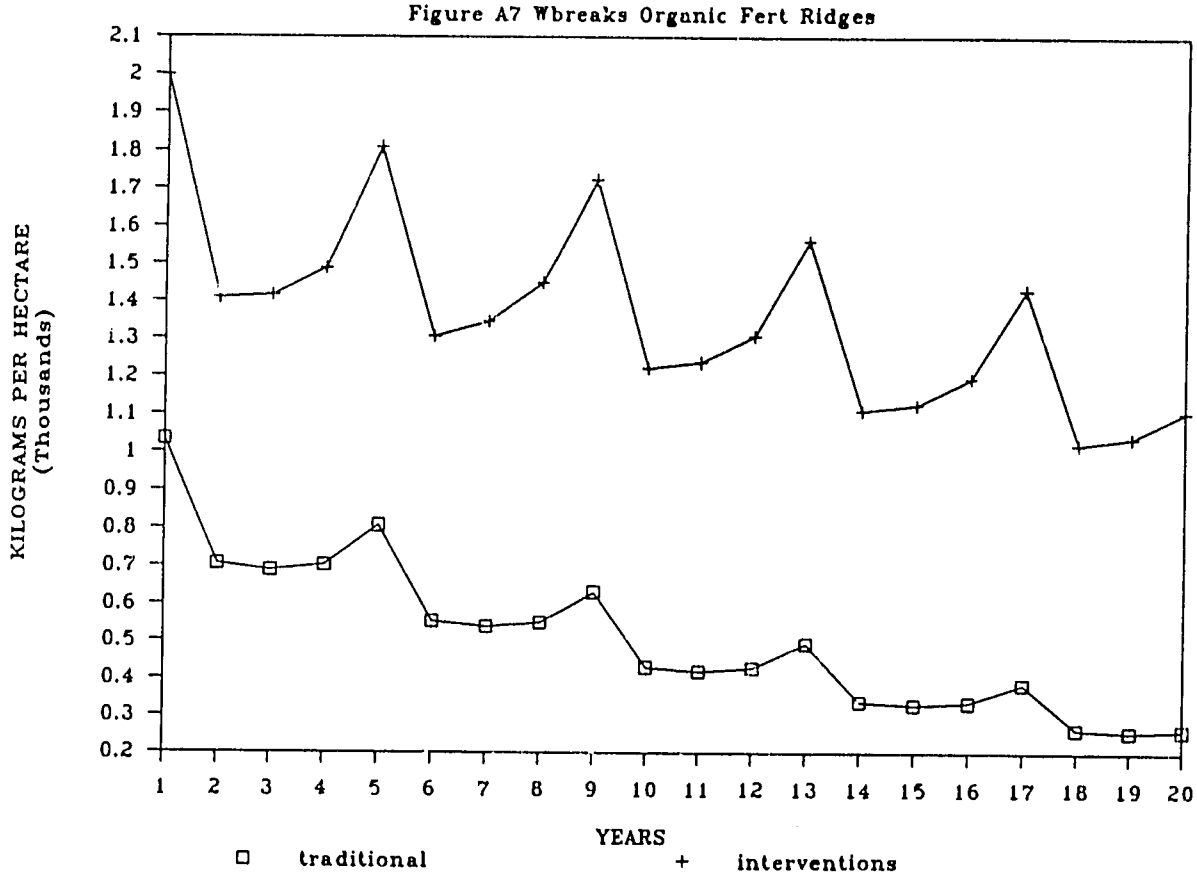
TOTAL YIELDS

Figure A6 Contour ridges



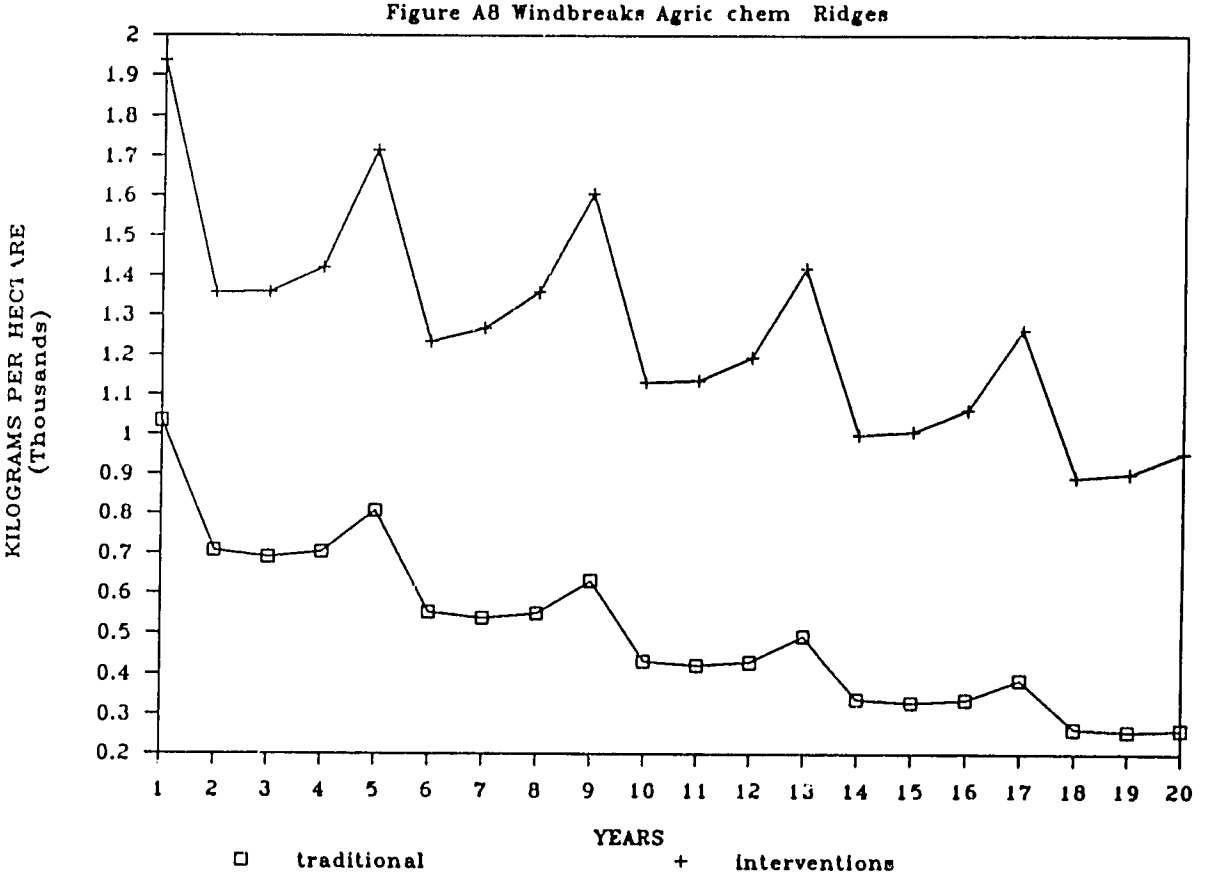
TOTAL YIELDS

Figure A7 Wbreaks Organic Fert Ridges



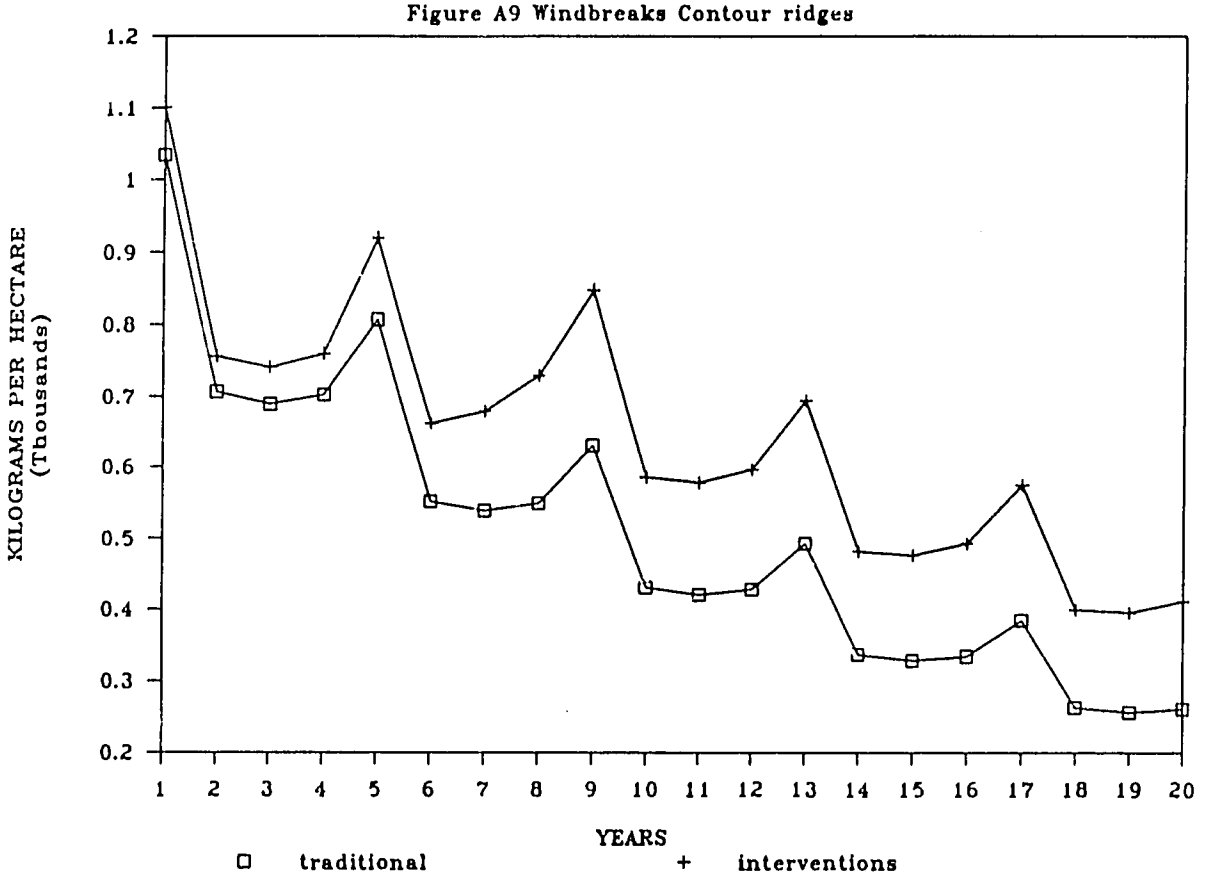
TOTAL YIELDS

Figure A8 Windbreaks Agric chem Ridges



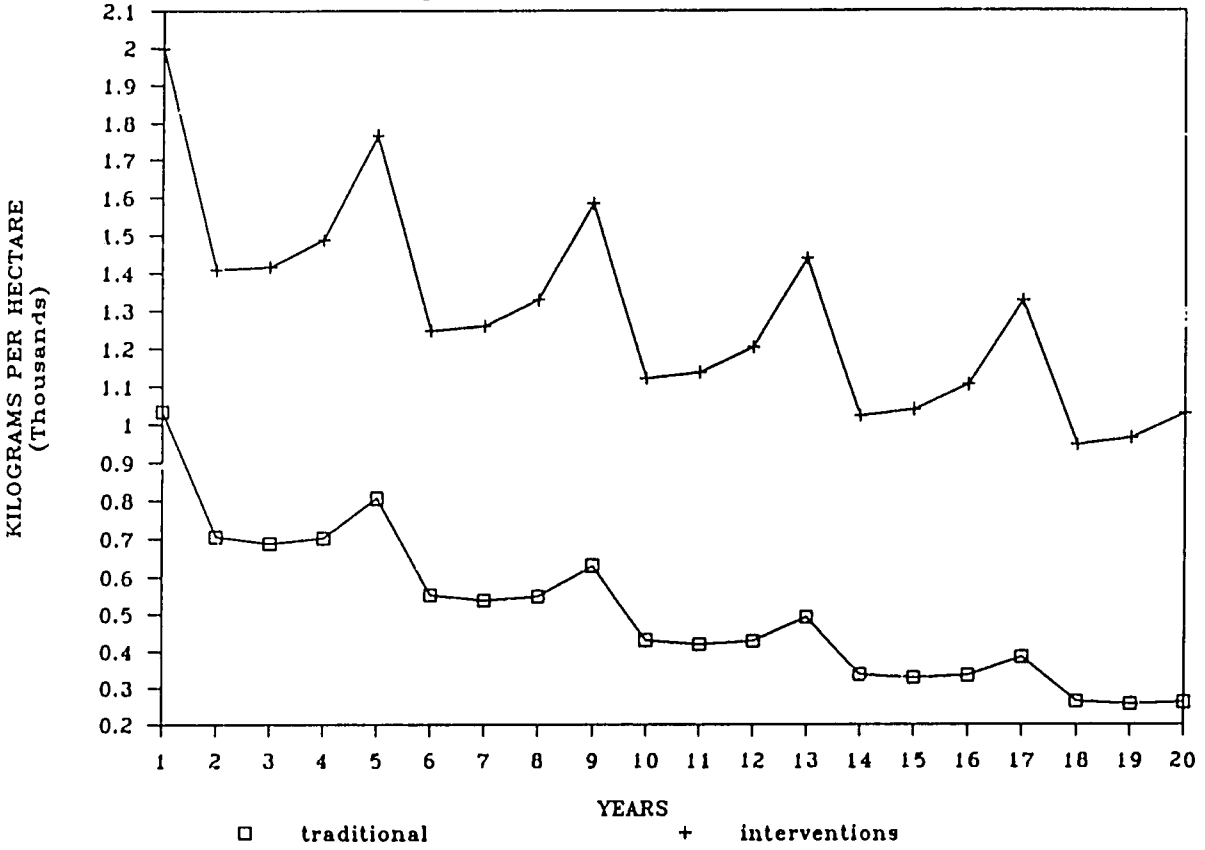
TOTAL YIELDS

Figure A9 Windbreaks Contour ridges



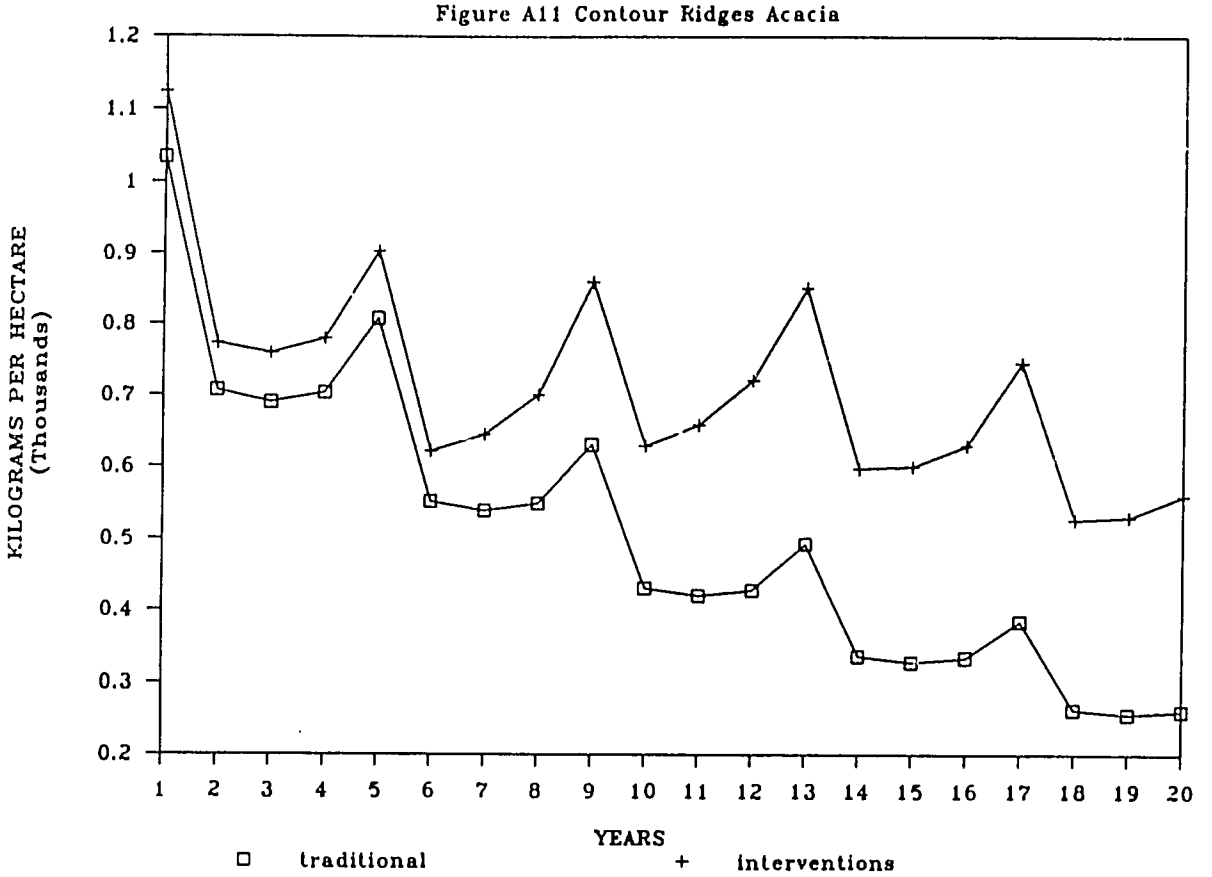
TOTAL YIELDS

Figure A10 Organic fert Contour ridges



TOTAL YIELDS

Figure A11 Contour Ridges Acacia



OPPORTUNITIES FOR SUSTAINED DEVELOPMENT

Successful Natural Resources Management in the Sahel

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Eric Arnould
Kjell Christophersen
Roy Hagen
Joseph Tabor
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VOLUME IV/BIODIVERSITY

Funded by the United States Agency for International Development
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Volume IV/Biodiversity

October 1988

Volume IV prepared by:

Peter Warshall

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EXECUTIVE SUMMARY

In the simplest terms:

Biodiversity will be maintained only if conservation planning is integrated with development planning.

Site-specific protection areas must be designed as integrated parts of a much wider (regional, national, continental and international) landscape.

Up to now, planning for biodiversity has focussed on attempts to isolate protected areas from the rest of the ecology and economy of Mali, Senegal and the Gambia. This "intensive" approach is not working in West Africa. This report recommends an "extensive" approach that integrates the remaining "habitat islands" into the landscape that surrounds them.

Specifically, natural habitats can only be found as fragments in West Africa. Some of these fragments are too small to support large faunal populations during stressful times like the current drought. Even the largest protected areas (Niokolo Koba National Park) are too small to support wide-ranging mammals and birds who migrate or wander into the hostile landscape surrounding the protected areas and get shot (e.g., giraffe, garganey, manatees, crocodiles, hippos, elephants).

This report recommends the linking of a constellation of these fragments and the buffering of each habitat island. "Buffering" can be accomplished by land use planning and/or conflict resolution. Land use planning can reduce the extreme contrasts between adjacent habitats (agriculture vs. old-growth forest) which create policing and protection nightmares. Land use plans should encourage surrounding the protected area with less intense human uses (agroforestry or classified forest). Conflict resolution includes agreements that limit local access and destructive natural resource exploitation in exchange for aid that improves the local resource base, its reliability, and marketing efficiency. Long-term conflict resolution requires education. The IUCN project in the inner Niger Delta and WALIA magazine are two excellent and successful examples of interventions that promote both biodiversity and wise natural resource use.

The NRMS team suggests a planning document for each country that includes:

- a description of the remaining habitat islands (both protected and non-protected fragments); their distribution ("the archipelago of habitat islands"); and their linkages (ecological corridors such as drainageways, valleys, mountain passes, wetlands, river crossings).

- a description of the landscape immediately surrounding areas of concern and the kind of buffer zones that would reduce the conflicts between neighboring people and biodiversity maintenance (the "parks-vs-people" syndrome). The ultimate goal is integration of local economies and assignment of land stewardship responsibilities to the neighboring population.

- the natural resource use conflicts that prevent biodiversity maintenance (e.g., poaching, over-fishing, non-targetted pest management) and that require resolution by culture brokering or new natural resource regulations. Some regulations and policies will be local (quelea control), some regional (elephant migrations), some intra-African (marine turtles and the Sousu dolphin) and some international (migrating birds).

This approach and documentation does not, at present, exist for any of the West African countries. Local distributions of animals and plants have rarely been surveyed and mapped.

The most widely expressed difficulty in protected natural areas was upkeep and maintenance. The international community should consider supporting a "Natural Areas Maintenance Revolving Fund." The revolving fund could receive applications directly from park directors and classified forest managers to address their needs. Each year the revolving fund board would judge priorities and help the protected areas most in need, or refer administrators to appropriate donors. The planning document and revolving fund would enhance the protection of both threatened habitats and species.

Further recommendations include:

1. Location maps with estimated population sizes for threatened and endangered species. Large information gaps concerning chimpanzees, Sousu dolphins, marine turtles, giraffe, ostrich, elephants, cheetahs, addax, oryx, and hippos exist.

2. Fund re-introductions of locally extinct species in areas that are truly protected. Senegal has begun such a program. Increased species diversity will increase tourism attractiveness.

3. Start a "Natural Areas and Threatened Species Emergency Fund" that can respond more quickly than existing program funding. The emergency fund concerns emergency projects in such places as Basse Casamance where the watering holes have disappeared or Niokolo Koba where the last remaining wild hunting dogs are disappearing rapidly.

The NRMS team found that biodiversity and pest management have not been reconciled. There is no study available of medium to large mammals and crop protection. Yet, the wanderings of elephants in Mali, hippos in rice fields and many other mammals have contributed to their population collapse from pest control practices. There is a great need for a summary document of mammal pest control methods. New "scarecrow" methods and wildlife management tools to limit movement (e.g., creating year-round attractive environments) need research, documentation and application.

Similarly, it is recommended that biological control of and targeted control methods for birds, small mammal and insect pests be reviewed from the point of view of biodiversity

maintenance. A position paper made available to all bilateral and USAID programs would be useful. The use of sterilants, natural predators (e.g., pythons for rice rats), parasites or deleterious genes has not been summarized in the West African context. Positive conclusions could significantly help the economy. The importance of waterfowl reserves and wetland reserves needs more emphasis, especially in the lower Senegal River basin. As in North America, these reserves help increase rice production by keeping water birds safely away from the fields. Finally, methods for combining pest management with profitable trade and food production have only begun to be defined. The sale of grasscutter rats for food or the selective capturing of long-tailed parrakeets for the pet trade are promising combinations of pest management and economic opportunities.

The status of the flora of each nation needs review. Rarities, endemics and specialized communities need to be defined, located and proposed for protection. Drought and population growth have accelerated: the extinction rates of native plants, the introductions of non-natives, the "naturalization" of non-natives and altered species distribution.

Little attention has been paid to the urban and peri-urban environment and biodiversity. The Abuko Nature Reserve is a good example of how biodiversity and the peri-urban environment coordinated planning needs. Botanical gardens with native plants in the large urban centers have not been developed. Botancial gardens could be major centers for educational and research opportunities. The combination of sewage effluent recycling to create wetlands or other "natural" urban habitats has not been reviewed.

The single most influential contribution to biodiversity in the rural sector could come from diversifying nursery plant stock. This stock should include native shrubs and grasses as well as trees. The populace is hungry for useful and interesting plant species, and any extension training (e.g., pruning techniques) will be readily and enthusiastically absorbed. Donors should pay more careful attention to nurseries when designing reforestation, anti-desertification and woodlot projects. The need for an institute such as Mircen to research, produce and distribute innoculum has been re-emphasized from the biodiversity point of view.

River basin plans have underestimated the importance of sustainable, natural resources (including biodiversity) in river basin development:

1. Neither the ecological nor the economic importance of the flood pulse has been appreciated. There is a pressing need to structure dam releases to mimic the flood pulse. In the Niger and Senegal rivers, the restoration of the flood pulse by controlling water releases would benefit both the economy and biodiversity. Fisheries production, grazing, and large aquatic mammals have been particularly injured by the controlled flows and the drought.

2. There is a great need to establish an instream flow right for the controlled rivers (the Niger and Senegal) to maintain biodiversity, aquatic food plants (bourgu, wildrice and lily seed production) and fish production.

3. There is a pressing need to define release scheduling by "type year" (low, normal, high flows) in order to insure instream flows.

The IUCN has proposed to study the inner Niger delta to define the economic and ecological consequences of varied water releases. This study should be funded. In addition, OMVS should be encouraged to fund its own study for the Senegal River, keeping in mind the still viable floodplains on the north banks. OMVS should fund the repair of the Djoudj waterworks, the artificial estuary and mitigation measures at Manatalli Dam to help compensate for species and population losses from river basin development. The Gambia River Basin requires further study before any dams are built. The Balingho and Kekreti dams will obviously do great harm to both biodiversity of the river and the existing economy.

The best educational tools for teaching biodiversity and natural resource management were the magazine WALIA and the back-up school visits by the WALIA staff. WALIA should serve as a model for other regions in Mali and other West African nations. As the only nationwide summaries available, the University of Arizona Environmental Reports have been useful to many agencies but require additional funds for updating and integration of French and local literature.

The national governments have not yet integrated concerns for the diversity of species into their programs or between ministries and departments. Many cling to the false separation between species preservation and development planning. Biodiversity will need some time to influence the agricultural ministries which sponsor large-scale, industrialized farming projects. Immediate food self-sufficiency overwhelms their perspectives on long-term sustainable development.

In general, biodiversity is a new concept and a neglected natural resource. The USAID missions were not quite sure what to make of Section 118 and 119. A questionnaire on biodiversity has been included in Section V for their benefit. It is hoped that this report, especially the more detailed vignettes describing the entanglement of biodiversity and development in Section IV, will help the missions.

Finally, throughout the countries visited, there seemed ample opportunities for Peace Corps volunteers to participate in biodiversity projects. For example, a CIDA volunteer in Senegal coordinates women's groups and helps them replant locally extinct species. She travels and collects seeds and learns horticultural techniques reguired for replanting. In Mali, a former Peace Corps volunteer now works as a translator and facilitator for natural resource conflict resolution in the Niger delta. There is a need for personnel familiar with animal reintroductions, park planning and management, solar radio installations for anti-poaching radio systems, integrated pest management, waterfowl reserves, environmental education, urban forestry, river basin management, nursery development, aquaculture, floral and faunal surveys, innoculum, seed conservation, fisheries and so on. USAID has already helped in funding many similar kinds of projects in East Africa and Asia. It is simply time for a greater emphasis.

I. BIODIVERSITY IN THREE WEST AFRICAN NATIONS: INTRODUCTION

A. Introduction

Along with air, soils, water, and minerals, the hereditary materials of living organisms (germplasm or genes) are a natural resource. This natural resource is the of basis all the varieties of plants and animals, natural, cultivated, and employed by humans in construction, fuelwood, medicines, nutrition, art, etc. The importance of maintaining and preserving this hereditary base has recently become popularized by the rapid loss of species in tropical rainforests. But, the same losses are occurring throughout the biotic communities of the planet.

"Biodiversity" has come to include more than just rare species, races or varieties of plants and animals. It also includes the maintenance of these species in populations large enough to ensure their existence into the future. It has come to include the habitat or ecological community that supports these species. (Table I.A)

The NRMS team took a broad outlook on biodiversity: the maintenance of variety (habitats, species, crop varieties) in human as well as more natural habitats. For instance it looked at problems of urban forestry surrounding the Abuko Nature Reserve near Banjul. It looked at biodiversity conflicts between hippos and farming along the Gambia river. It included a few non-native trees which increased the diversity of horticultural and agricultural settings and, perhaps, indirectly helped support additional non-human forms of life. It included educational projects that help create a social context more conducive to preserving and restoring biodiversity. I visited the inner Niger delta where IUCN promotes biodiversity and economic development by conflict resolution. The team compared the effectiveness of biodiversity protection in four Senegalese national parks.

The motivation for adding biological diversity to the NRMS assessment was the passage of Section 118 and 119 of the Foreign Assistance Act which directs foreign assistance to carefully evaluate development projects that might reduce species numbers or populations. It specifically directs attention to tropical forests. The NRMS team report is not intended to fulfill Section 118 and 119 requirements. It did, nevertheless, have a similar focus and used U.S. AID's Memorandum (1988) on biodiversity as a partial guideline.

The team did not have the time to visit any National Parks or the Saharan habitats of Mali, nor coastal and marine fisheries in Senegal and Gambia. It rarely had time to discuss its findings with members of the appropriate governmental agencies. It did not have time to thoroughly investigate any one area of biodiversity concern such as protected areas, germplasm or endangered species in West Africa. For these reasons, the Annex should be considered a guide to a more thorough assessment to be done for Section 118 and 119. The more complete biodiversity report would have answered questions listed in Section VII -- which can serve as a questionnaire/guideline for USAID Missions. The "tentative" qualities of the report based on time and terms of reference are the reasons it is an annex.

TABLE I.A

ECOLOGICAL COMMUNITY AND BIODIVERSITY

The ecological community has been incorporated into biodiversity because:

1. Of our ignorance of unknown species or ecotypes (races) of plants and animals in an area. Preserving whole communities allows for future discovery;

2. Of our ignorance of linkages (foodweb, nesting requirements, nursery plants, etc.) that together comprise the mutual life-support network of animals and plants. Preserving whole communities protects against destruction of co-evolved, dependencies among species. Biodiversity's focus on protected areas rests, in part, on the understanding that many species have co-evolved and are mutually dependent;

3. Ecological communities can support larger populations and increased genetic variability compared to zoological or botancial gardens. In whole natural communities, subtle micro-differences of habitat preserve genetic variability;

4. Ecological communities can support multi-purpose economic development as well as conservation. For instance, the protected areas can act as breeding grounds for fish, plants or bushmeat species that replenish harvested stocks outside the sanctuary.

5. Each habitat "island" is a "cradle" for evolution. Creation of a series of habitat "islands" can serve as stepping stones for wide-ranging animals. An archipelago of protected areas, by providing habitats for wide-ranging birds and browsers, encourages seed dispersal and natural forest regeneration throughout a much wider region; and

6. It is a cheaper and more manageable method of protecting many species at once, especially endangered species, compared to zoos or salvage programs.

This Annex highlights biological diversity investigated by the NRMS team in three countries: Mali, Senegal and the Gambia. The biodiversity specialist did not accompany the team to Niger. Section II summarizes themes observed, pondered and puzzled over during the fieldwork. Section III presents these same themes on a country-by-country basis. It indicates what's known and what needs to be researched in order to fulfill the Section 118/119 requirements. Section IV gives detailed vignettes on eight projects in which biodiversity concerns featured strongly. I feel they give the best feel for how biodiversity, conservation planning, development goals and the daily lives of the people of West Africa have become entwined. The Executive Summary summarizes the policy and funding priorities.

B. Biodiversity and the Drought

The situation is West Africa is in many ways more difficult than even the tropical rainforests. The ecology has been so altered that most biodiversity work must focus on restoration, reintroduction and stabilization of already degraded communities. Given the drought and population growth, small successes and just holding-the-line deserve great respect.

The drought's general affect on the Sahel has been summarized in Volume 1, Chapter 1. Here we summarize its specific effects on biodiversity as background to this annex:

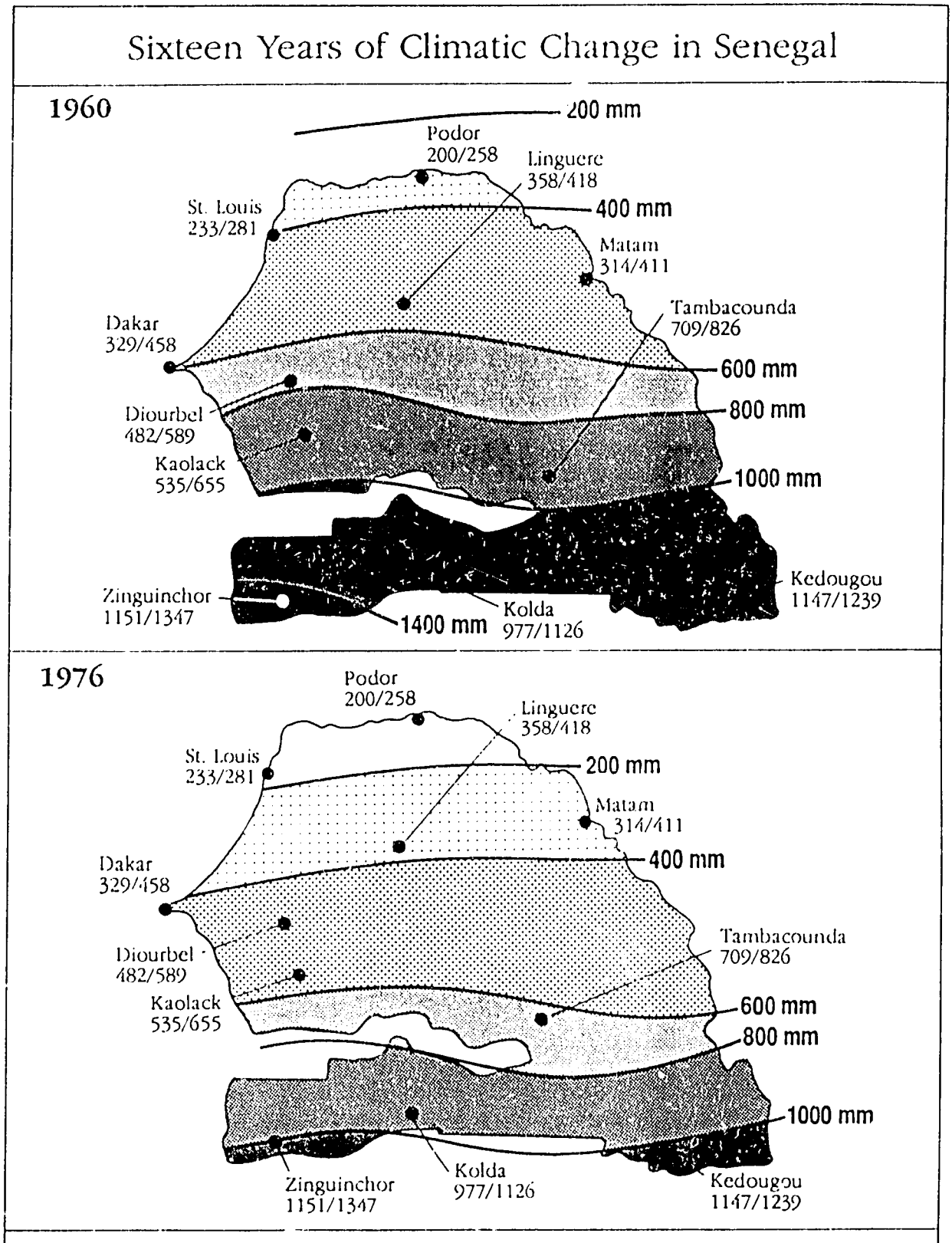
- The drought plus intensive grazing and browsing has caused the diminution of seed stock in the Sahelian soils and, occasionally, the loss of a species from a local community. Regeneration of grassland and woody species will require human interventions such as re-seeding of particularly desirable species to maintain biodiversity.

- The drought has been so extensive that certain trees have died off. The die-off has created a demand for seeds from the south for replanting with irrigation to compensate for the low and erractic rain.

- The drought has been so "permanent" that there is now a demand for northern, more drought-resistant species as well as cultivars that can grow in shorter rainy seasons with less rainfall. Essentially, the Sahara, the Sahel and the Sudanian biotic communities are moving south. This shift in species has moved anywhere from 60 to 130 kilometers. (Figure I.A)

- In extreme cases ("desertification"), the soils have lost their microbial community (rhizobial bacteria, mycorrhizal fungi) which promote establishment and growth of various plant species. Without the microbial community, the landscape can be considered "sterile" and biodiversity essentially extinct.

FIGURE I.A



Isohyets of mean annual rainfall in 1960 and 1976 showing southward migration of drought by 113 km. Each city shows the mean amount of rainfall for the last 16 and the last 30 years. The last 16 years show reduced mean rainfall at all stations.

- The previous ten years has seen an explosion of tree planting that is based on limited, usually exotic, species. There is a need and desire among many local villages to diversify these species and add trees and shrubs with special or multi-purpose uses.

- The lack of biodiversity among horticultural and agroforestry sites is, in part, because the nurseries do not grow and stock the diverse species.

- The fragmentaion of the forest and accompanying loss of granivore birds and mammalian browsers have led to the loss of animals involved with pollination and seed dispersal. Browsers are major dispersers and fertilizers of the large seeded legumes (Acacia, Albizzia, Bauhenia, Cassia, Entada, Parkia, Prosopis, etc.). Wind pollination is less effective because of the distances between forest or grassland fragments. In short, natural thicket and forest regeneration has become more difficult without the stimulating effects of manure, seed scattering, microbial organisms and seed production.

- Some national parks cannot produce enough food for several species during the drought. When designed, years in which the food biomass drops drastically were not taken into account. In search of food, elephants, hippos, and other large mammals usually migrate. But, in today's world, migration brings them into contact with farmers. At these times, they are shot.

- Similarly, the dropping of the watertable and diminished rain have dried up many wildlife watering holes within parks. Species -- especially those dependent on wetlands such as the sitatunga -- have abandoned parks and been shot. The disappearance of water supply has reduced biodiversity in many parks.

- The drought has made bushmeat, certain fruits and plant species premium items. Rapid depletion of large game has occurred in the Sahel, especially north of the Niger River and the areas around the mid and lower reaches of the Senegal River. Many of these mammals can only be found in National Parks. This has led to the use of the parks by villagers -- sometime in conflict with good wildlife management. It has increased conflicts between farms and the national parks and between tourist hunter permits and traditional hunting rights.

- The difficulties of the drought and the rapidly changing politics of West African states have fractured, if not eliminated, former cultural beliefs supporting a balance between non-human and human creatures. These traditional modes of thought need re-enforcing and re-introduction by education, extension workers and government policy.

- The populations of West Africa increasingly migrate to the urban areas. In the cities, they have become alienated from natural resources and conservation. To reduce pressure on natural resource uses (such as firewood which indirectly is habitat and supports biodiversity) requires a new education program about the environment and its connection to the economy.

II. BIODIVERSITY THEMES

This section summarizes observations and thoughts that resulted from travelling in Mali, Senegal and the Gambia. For convenience, the section is divided into four themes. They are, of course, inseparable in any intervention. The ethics, attitudes, and history of a community cannot be separated from its economics and ecology. The four themes are: (A) Protected Areas and Biodiversity; (B) Animal Resources and Biodiversity; (C) Plant Resources and Biodiversity; and (D) River Basins and Biodiversity.

A. Protected Areas and Biodiversity

Protected areas exist, on paper, in all three nations. They vary in the degree of access and resource use allowed by the local population. The most restrictive areas are national parks. The national parks protect special species, especially old growth forest species like the yellow-casqued horn-bill that requires dead snags for nesting. (Dead wood is otherwise harvested for firewood and building). National parks can protect samples of representative biomes for both education, useful plant resources, restocking of bushmeat into adjacent areas, seed sources as well as to support tourism and national pride. Less restrictive, the faunal reserves attempt to control specific resource uses (hunting, egg collecting) but do not limit access or general use of non-specified resources. Classified forests rarely have access limitations but limit cutting of dead or living wood.

The existing "paper" protected areas have created the illusion that discrete sanctuaries will somehow compensate for the developed areas outside the protected areas. But, this attempt to isolate and cloister protected areas has not worked in West Africa. The drought has forced animals to leave the protected areas undermining the purpose of protection (e.g., Basse Casamance). It transformed protected areas into premium locations for good soils, water, firewood, grazing and food. Humans have encroached and settled (e.g., Bouale du Boucle National Park) or become poachers. Lack of donor, national and local funds have left the protected areas without adequate plans, floral and faunal surveys, training, operations and maintenance budgets. In some instances, confusing sets of administrative rules, traditional laws, and unresolved access and use traditions have pitted local villagers against the guardians of the protected areas. Population pressure and the low income generation associated with protected areas have kept biodiversity a low priority compared to food and employment.

Two rather abstract generalities emerged from these observations that can act as reminders or reference points throughout this section:

> Biodiversity will be maintained only if conservation planning is integrated with development planning. Isolation of biodiversity projects from development practically guarantees their failure.
>
> Site-specific protection areas must be designed as integrated parts of a much wider (regional, national, continental) economic and ecological mandate.

The actual choice of protected areas has been based on existing condition of the habitat. For instance, IUCN decided not to work toward a national park area in the inner delta of the Niger (Mali) because large mammals had been extirpated or drastically reduced. Similarily, the hopes for a national park at Kiang West (Gambia) were dashed because bureaucratic delays allowed encroachment of hunters, fire and cultivators. At this point, should the park become a reality, extensive restoration and species introductions would be necessary.

In West Africa, the value of an area for biodiversity protection cannot rely heavily on its present condition. The maintenance of biodiversity is a long-term goal, just as sustainable water supply and quality and soil fertility are long-term goals. To focus only on what exists, creates an atmosphere of extreme hopelessness within the national governments and the international donor community. This hopelessness has been compounded by the drought's persistence. The long-range view must be stressed: how can a particular area of land and water contribute to the long-term maintenance of biodiversity. This section will emphasize the criteria needed to make realistic, long-term biodiversity choices in the countries visited.

1. Habitat Islands: Size, Scatter and Linkages

Most national parks, faunal reserves or registered national forests are now small habitat islands within a hostile landscape matrix.[1] For instance, the Basse Casamance National Park is so small that its food and water supply cannot support large wildlife during the current drought (see IV.4). Creatures of moist environments such as the African water buffalo and sitatunga are near local extinction. Hippos have left the park and been shot by farmers. The park manager has begged for an emergency importation of fresh water to maintain the watering holes for large mammals within park boundaries. But no emergency ("drought funds") have been available. Small, isolated parks like Basse Casamance (that cannot reasonably expand their boundaries) will require special water/food supplements during periods of environmental crisis such as the Sahelian drought and species re-introductions to maintain population sizes and genetic diversity. Because national parks and refuges are so small, re-introductions will substitute for local extinctions and migrations. Policies for "artificial recolonization" of wildlife have not been addressed in West African park planning with the partial exception of Senegal.

Even the largest habitat "islands" (e.g., Niokolo Koba National Park) are not large enough to accommodate migrations of the largest mammals. Just as the American bison wandered too much to please homestead farmers, the korrigum hartebeest, giraffe and West African elephant now approach extinction because of their wide-ranging habits. To

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[1] The foundation for this approach can be found in "The Fragmented Forest" by Larry Harris. The section focuses on terrestrial habitats. River basin and in-stream fisheries are discussed separately.

maintain these populations, Africa needs to do what North America did not do -- establish safe-passage wildlife corridors.

The distances between the "habitat islands," how they are scattered throughout nations and regions, and how each habitat island is a necessary link (or stepping-stone) in an animal's life-cycle have not been considered in planning for the maintenance of biodiversity. For instance, in Basse Casamance, there were no alternative areas to which the large mammals could migrate and no "wildlife corridors" that would allow safe passage. In Niokolo Koba (see IV.3), the Faleme Hunting Reserve is 60 miles away. The National Park repopulates some of the species hunted within the Faleme reserve. (Hunting permits are the source of substantial revenue to the government). But no corridor has been planned to tie the two "islands" together and no integrated planning with en route farmers exists. In Mali, a whole series of parks and forest reserves (see Table III.B) adjoin each other. Again, no ecological survey of corridors and migration routes between them has been established. These areas include such wide-ranging and rare species as the giant eland and chimpanzee.

The distances between habitat islands, their scatter, and size go beyond simple national biodiversity concerns. They include both intra-African (continental) and inter-continental movements. In West Africa, all the marine turtles, the humpbacked (Sousu) dolphin, the giant eland, the greater flamingo, the fulvous and white-faced tree ducks, the knob-billed goose, many raptors, terns, bee-eaters, orioles, starlings, etc. require more than one African nation to complete their life-cycle. Essentially, all the migrating Palearctic birds travel between habitat islands in Eurasia and habitat islands in West Africa. The size of and distances between each breeding, resting or over-wintering habitat (the "stepping stones") require international cooperation. For Palearctic birds, biodiversity maintenance requires protected areas in both Europe and Africa. The Djoudj (Senegal) and inner Niger delta (Mali) cannot be separated from Sweden and Siberia.

In other words, an "extensive" approach to biodiversity is as necessary as the "intensive" approach characteristic of national parks. The emphasis switches to integrated islands of habitat rather than one exclusive protected area.

The "archipelago" of habitat islands with safe-passage links offers the flexibility required for biodiversity preservation in West Africa. Each habitat island does not necessarily require the total pre-emption of land and water characteristic of national parks. Some habitat islands will be maintained for their total intrinsic diversity and integrity -- as examples of threatened biotic communities. But, other areas may be added to the present geography to serve as seasonally utilized, ecological corridors; managed for specific species rather than total protection; or for genetic diversity within a single species ("biotypes").

In short, there is no analysis available of protected areas in any of the three countries that evaluates protected areas in terms of: actual size; distance between habitat "islands"; and the hostility of the "corridors" or landscape matrix between the habitat islands. Protected areas and the linking corridors in West Africa need to be integrated into development planning. The projected areas must be viewed as part of a larger attempt to

maintain biodiversity throughout the region. Ideal biodiversity planning creates isolated biotypes with limited gene flow between the isolates.

2. Ecotone Contrast, The Attitudes of Local Communities, and Protected Area Effectiveness

The effective protected area cannot be measured just in hectares. Effective size depends as much on cultural attitudes, friendly or antagonistic feelings between the land guardians and the surrounding peoples, and landuse planning that reduces or minimizes the opportunities for access and natural resource use conflicts.

From the NRMS survey, it is clear that the degree of protection and policing required varies with the cultural attitudes, participation, and economic state of the local people. For instance, the trees no more than ten feet outside Basse Casamance National Park are regularly burned by farmers to clear out weaver bird nests but, ten feet inside the park, the nests of this pest species abound. Yet, there is no illegal destruction of nests or trees. In the Basse Casamance, there is a tradition of sacred groves. The park manager relies on this tradition and incorporates it into park management. Even with the "high contrast" boundary or ecotone (cleared fields vs. protected forest) few problems arise. He has created an atmosphere of cooperation -- letting villagers collect "excess" fruit in years when the monkeys cannot consume the total crop and allowing use of the park for religious activities.

On the other hand, Niokolo Koba National Park (Senegal's largest) is plagued with poaching. The local Basari have always been hunters and the Basari have been treated poorly by the park rangers after being expelled from park lands. The Basari have also been tempted by animal parts traffickers, the high price of both ivory and bushmeat, and the availability of automatic weapons from Guinea. At Niokolo Koba, the size of the park or buffer zone is irrelevant. What is needed is a "culture broker" to help resolve differences with the Basari and park management.

In West Africa, little attention has been given to the juxtaposition of ecological communities (the ecotone). High contrast edges (e.g., cleared field farming next to totally protected forest) often create the most difficult management problems for maintaining biodiversity. In general, the greater the contrast between ecological zones (i.e., urban vs. peri-urban vs. rural vs. agroforested vs. forested vs. protected), the greater the policing and protection problems. With greater buffering (gradation of zones), it is more likely that conflicts between humans and biodiversity maintenance can be resolved. In the most difficult cases such as Sine Saloum National Park, there is a village within park boundaries. Fires used to clear fields frequently escape into the park. Cattle wander beyond village boundaries. Protection of the forested area of park has become impossible. There is no buffer zone. Increased policing would only lead to greater conflict, expense and punitive actions. By contrast, Baboon Island (of Gambia River National Park) is surrounded by the Gambia River and, although some violations occur, it is far easier to control access.

The NRMS team felt "buffer zone" planning to reduce high contrast ecotones to a gradation of zones was the most widespread and highest priority need around all protected areas visited (see Section V discussions of Niokolo Koba, Sine Saloum, Djoudj).

As an intellectual (perhaps whimsical) exercise, one can envisage the "ideal" positioning of ecological communities for biodiversity maintenance. In the center would be a biodiversity preserve protected from fire, grazing, hunting, and cutting of forest products. This core reserve would be managed to maintain old growth forest or climax grassland. The immediate area surrounding the biodiversity preserve would allow subsistence hunting, gathering of fruit and dead firewood through limited access and use agreements. Surrounding this hunting/gathering zone would be an area of rotational tree cutting and understory browsing. In turn, this zone of permanent secondary forest would be bordered by a circumference of intercropped agroforestry. Finally, the outermost areas would support cleared field and fallow agriculture with living fences as well as homes and roads. This idealized landscape has many advantages such as minimizing encounters of pest species with crops (see below), and increasing fire and species protection.

In this ecotopian diagram, the relative weight of biodiversity changes from the core to the outermost margins. In the core, native floral and faunal diversity has highest priority. Toward the outer margins, exotics, managed forest species and cultivated crop varieties become more common. Species richness (the number of species in an area) might remain the same. But, the "specialty" species that require intact old-growth forest will find refuge within the core.

In general, three forms of conflict resolution will help maintain biodiversity: (1) Zoning a gradient of land uses from fully protected to multi-use to agriculture; (2) "Culture brokering" by anthropologists, (3) Writing limited access and resource use agreements in the multi-use zones. Access and resource use agreements can be modelled on the exceptional IUCN work in Mali. In the inner Niger delta, IUCN brought together grazers, fishers and land owners that all utilized nesting trees of the few remaining waterbird breeding colonies. By facilitating communication and helping work out difficulties with the national administration, agreements protecting both the birds and national resource use and access have been written (see V.2). All three conflict resolution techniques increase the protected habitat without isolating acreage from reasonable multiple use.

3. Conclusion

The animals, plants and the people require the linking of a constellation of habitat islands and the buffering of each island core. Buffering can be accomplished by land use planning and/or conflict resolution. Conflict resolution may include education on the importance of maintaining biodiversity of specific plants and animals. The linkages and the buffering are the most crucial elements when combining conservation planning with long-term, sustainable economic development.

At this time,

- o most of the classified forests and many of the national parks have no guidelines nor funding that integrates the protected area with the immediately surrounding villages, the region or international biotic communities.

- o much more attention needs to be paid to the purpose of the protected area (its biodiversity components), its distance to other habitat islands, the biological linkages (especially riparian corridors) to other habitat islands, and the "hostility" of the landscape matrix in which each habitat island sits. In order for large mammal, marine turtle, and intra-African and Eurasian bird migrant species to receive adequate protection, this "extensive" approach is crucial.

- o operation and maintenance funds are nowhere near adequate within the national parks. An early warning system and emergency funding plan will be necessary during the drought period in order to maintain waterholes and biomass production to support biodiversity in protection areas.

B. Animal Resources and Biodiversity

Maintaining rats and English sparrows in cities is not a goal of biodiversity. The goal is not larger populations of common species. Controlling locusts with organo-chloride insecticides that harm non-target species is contrary to the goals of biodiversity. The goal of biodiversity is to reduce pest damage without destroying or damaging the food web. Poaching the vulnerable Nile crocodile for its skin is definitely contrary to the goals of biodiversity. Biodiversity has, as a major goal, the preservation of genetic diversity which includes the species that carry the genetic diversity from generation to generation. But, crocodile farms may be an important management tool to help augment the population, even though harvesting skins will occur.

Animal biodiversity is inseparable from the ethics and education of the people, economic development, foreign assistance and international goals. This section will briefly touch on four themes that emerged during the NRMS team surveys: (1) rare, endangered and threatened species; (2) the interplay between agricultural development, disease, pest species and biodiversity: (3) the complex consumptive use of animal meat, parts, and products; (4) the importance of specific animals to the tourist economy.

1. Rare, Endangered and Threatened Animal Species

The rarity of animal species can be judged on a worldwide basis, a national basis or on a village basis. On the worldwide scale, the species is basically listed by the IUCN or the U.S. Fish and Wildlife Department according to its best knowledge of rarity. On the national scale, it is up to the Ministries and, usually, the President of the nation to declare

a species valuable and protected. On the village level, local authorities have a great influence on maintaining a population or letting it decline. The NRMS team did not have enough time to fit the local site-specific populations remaining in the three countries into the larger picture for the species in Africa.

The major animal species of international concern in Mali, Senegal and Gambia are listed in Section III. In Gambia, all wildlife (except for a few "vermin" species like the Gambian rat and warthog) are protected. In Senegal, a long list of protected or partially protected birds and mammals has been authorized. In Mali, a national list was not available to the consultant. The paper protection should not imply effectiveness of protection. While in Mali, the government authorized the killing of one of the last two giraffes in the "Giraffe Reserve." This effectively pushed the giraffe in Mali to extinction. Further discussion of poaching occurs under "Consumptive Uses."

The IUCN has emphasized that the Saharan, Sahelian and Sudanian regions of these nations are of particular concern because of the extremely accelerated loss of large mammals, especially ungulates and diurnal primates. For example, there are no remaining elephants in Gambia; a small herd of about 50 in Senegal and a herd of about 100 in Mali. The chimpanzee has a similar status in all three nations. In Gambia and Senegal, the status of marine turtles and the estuarine, humpbacked dolphin (the Sousu) are completely unknown.

Niokolo Koba National Park contained the greatest number of listed species in the countries visited (three endangered species; one threatened species; four vulnerable species). In addition, it contains over a dozen specially protected mammal species in Senegal (e.g., hippo, aardvark, Cape clawless otter). Surveys of some of the endangered species (e.g., the dwarf crocodile) have not been funded. Niokolo Koba tried to re-introduce the extinct giraffe but the population died of trypanosomes. The park has also tried to obtain funding to maintain the wild hunting dog whose population has precipitiously declined.

Niokolo Koba also has the most intensive commercial poaching, illegal subsistence hunting, difficult terrain, understaffed number of guards and technicians for a park of this size. Its major difficulties revolve around buffer zone management and conflict resolution with surrounding villages. Despite its status as a Man and the Biosphere Reserve, Niokolo Koba has had no help in park planning from the international community in recent years. The park illustrates just a few of the needs for protected areas with endangered animals.

The heart of biodiversity planning are the genetic resources of living creatures. To further this goal, the following actions and interventions are recommended:

a. A site-specific analysis of the top priority rare and endangered animals in West Africa. This analysis can be coordinated with the protected area program. This site-specific location of animals of concern are needed by park managers, the ministries involved, and the donors looking for the most crucial projects. In particular, marine turtle, manatee, cheetah, giant eland, the Sousu, giraffe, and chimpazee site-specific needs have not been addressed.

b. The funding of conflict resolution initiatives along the boundaries of national parks in order to increase protection of endangered species. The conflict resolution should include integration of local human populations into the guardianship as well as the economy of the national parks. The IUCN work in the inner Niger delta provides an excellent model. Suggested interventions have included limited access agreements; crocodile farms to increase tourist encounters and local income; crafts centers for tourist items; village bushmeat hunting permits; employment in park maintenance, fire control, anti-poaching committees, etc.

c. Establishment of an international "Maintenance Revolving Fund" for the national parks of West Africa. At the moment, there are no long-term maintenance funds. The international community has essentially helped set up the various parks and then forgotten them.

d. Funding for the reintroduction of lost species in areas that are truly protected (e.g., Djoudj National Park). Senegal has been attempting reintroduction by itself and deserves credit and assistance in its attempts to locate genetically diverse breeding stock. The difficulties of reintroductions have been greatly underestimated. For example, after eleven years the introduced chimp population in the Gambia River Reserve is still not self--sufficient. Reintroductions of species increase tourist interest and financial solvency of national parks.

e. Establishment of an "Natural Areas Emergency Fund" that can quickly employ finances in crisis situations. For instance, the drought led to the loss of both hippos and sitatungas at Basse Casamance National Park when the water supply dried up.

2. Biodiversity and Pest Species

The biodiversity of West Africa has not been harmed by one dramatic event but by small incremental actions that chipped away at the ecosystem. Pest control -- for agricultural crops or disease or cultural beliefs (e.g., no snakes) -- has slowly eaten away at some species populations. In addition, some control measures have not been targeted at the pest species. They were so generalized that many non-target species have been harmed. This section introduces "pest" management from the point of view of biodiversity.

Pest Management: Waterbirds

The waterbirds considered pests by many farmers and their crops of preference are listed in Table II.A. These birds are not just pests. For instance, the garganey (a small duck) is a source of food and cash for the Bozo in the inner delta of the Niger, Mali. Markets as far as 300 km from place of capture sell Bozo garganey. The Bozo have an interest in maintaining garganey populations as well as exploiting them. Other "pest birds", like the knob-billed goose, can help or hurt, or help and hurt a crop simultaneously. The knob-billed goose helps rice at certain stages by eating young leaves ("pruning") which, in

Table II.A

Waterbird "Pest" Species and Their Favored Foods

Ruff	lodged rice with invertebrates
Black-tailed Godwit	cultivated rice > wild rice, tubers, other seeds
Fulvous Tree Duck	Cultivated rice > Wild grass > wild rice water lily
White-faced Tree Duck	Tubers > rice > water lily > wild grass
Garganey	Wild grass and water lily > all other seeds
Egyptian Goose	
Spur-winged Goose	Standing rice in Senegal
Knob-billed Goose	Prunes young rice. Causes mire and sprout death.
Glossy Ibis	Immature rice

Terrestrial Granivore Birds Considered Pest Species by Farmers

Village Weaver	(Ploceus cuculatus)
Long-tailed Parakeets	(Psittacula krameri)
Black-faced Dioch	(Quelea quelea)
Red-headed Dioch	(Quelea erythrops)
Yellow-crowned Bishop	(Euplectes afer)
Black-headed Weaver	(Ploceus capitalis)
Buffalo Weaver	(Bulbalornis albirostris)
Blue-eared Glossy Starling	(Lamprocolius chalybaeus)

turn, produces a larger rice head. The same species can hurt the rice by paddling and stirring up the paddy water which asphyxiates young shoots.

The waterbird "pest problem" is really just another instance where the balance between species populations and cultivated crops, at times, favors the birds. West Africa receives a mixed message from Western donors: some calling birds an obstacle to food production; others claiming that rice production will lead to the impoverishment or extinction of threatened birdlife. It is a classic problem for wildlife management. The information, research and education aspects require a species specific approach with emphasis on all aspects of the bird's life cycle (e.g., resting sites, breeding sites, yearly molt and migration as well as destructive habits).

For instance, waterbird species that influence rice cultivation have been given much attention, especially by Bernard Treca of ORSTOM (see bibliography). Most damage occurs when the fields have not been well managed or when both humans and birds come under great stress. A few examples illustrate how pest damage and crop management influence each other:

1. In unweeded rice fields, the wild grasses attract waterbirds who may crush rice seedlings or damage stems even when they do not eat the rice;

2. In some rice fields poor levelling causes ponding. In other fields, drainage (at the time of harvest) is poor or impossible. The standing water attracts ducks and godwits who would otherwise avoid the fields;

3. In fields planted late or planted counter-seasonally, the ripening or harvest of the rice coincides with the return of Eurasian winter migrants or African birds returning from breeding. This situation will become worse with Diama and Manatalli dams on the Senegal river, Lake Guiers and Selingue Dam (Niger River) which encourage counter-seasonal rice planting by irrigation; and

4. In drought years, there are fewer and smaller natural ponds. Wild grass growth and seed crops diminish. Humans harvest water lilies for their own use in direct competition with ducks like the garganey. The waterbirds overcome their fear of scarecrows and hunters because they are starving. They consume grain at the same time that yields are lowest. This situation may be particularly intense if a good year (which produces 300 to 400% increases in the waterbird population) is followed by a severe drought year.

The excellent work by Treca has already contributed to a partial success in maintaining rice production and waterbird populations. Extension services and farmer initiative have combined a variety of successful interventions: farmers drain fields as soon as possible; farmers improve levelling and drainage canals; farmers plant the appropriate rice variety which sprouts or matures before the waterbirds return; farmers overseed in areas where ducks appear at the time of sewing; and farmers arrange a series of "frightening and startling" actions at the right times. These successful actions may be one reason that recent losses (in the 1970s and 1980s) have not been as severe as losses reported for the 1950s. Many of these methods capitalize on traditional techniques for native rice varieties

and other crops. Treca gives an excellent review of waterbird and rice crop relations and methods to control grain predation in drought years when crop losses count the most.

Another successful intervention has been Djoudj National Park which attracts and holds many of the "pest" African ducks who prefer the park to the dangers of crop predation and hunters. Roux (1974) felt that the Djoudj reduced rice crop damages. This benefit of a national park -- an artificially controlled wetland -- is similar to the waterfowl preserves throughout North America which have been planted to attract ducks from farmer's fields. Treca also observed that pest management becomes more difficult when the extent of wetlands (natural floodlands) is reduced. When planning for habitat diversity, the importance of natural floodplains as a deterrent to cropland predation should not be forgotten.

The importance of waterbird rice predation has, in general, been exaggerated (Treca, 1985). This has occurred, in part, because local losses can be as high as 50% and these local losses are inaccurately said to be examples of natural losses. There appears to be no need to use pesticides that may effect non-target species in either Senegal or Mali. Nevertheless, more work needs to be continued on a species-specific basis, especially as counter - seasonal rice growing increases and natural wetlands decrease. Locating and gazetting more waterfowl management areas has become a priority for both rice producers and biodiversity maintenance. For example, the recent decline of the black-tailed godwit population may be the result of both drought and lack of floodplain refuges.

Pest Management: The Terrestrial Granivorous Birds

There is prolific literature on the bird granivores that consume rice, millet, sorghum and maize (Ward, 1981). The most annoying in West Africa are listed in Table II.A. The NRMS team discussed the use of long-awn millet in Lamin, Gambia and visited the export houses for granivore birds such as the long-tailed parakeet which are captured for the international pet market. This report cannot summarize the extensive, somewhat unsuccessful work, with terrestrial granivore birds. The following points about pest management and biodiversity bear repeating:

First, any technique that affects the target species exclusively will help both the farmer as well as local biodiversity. Non-targeted pesticides tend to kill other species that help increase production. Destructive techniques such as burning or dynamiting nesting trees have huge harmful side-effects on biodiversity including helpful insectivorous birds. These interventions should not be supported by donors.

Second, some pest management interventions can benefit both the farmer and biodiversity by focussing solely on the pest species. In Senegal, the trapping of the Senegalese long-tailed parakeet is, perhaps, a harsh but nevertheless somewhat successful intervention. Farmers capture the parakeets and sell them to merchants for the international pet bird market. The farmer saves part of his crop and earns a financial reward for focussing on the species. The long-tailed parakeet populations have not been

threatened by the present scale of trapping. This kind of intervention can be improved upon by extension education that re-enforces the benefits of letting other birds escape.

Third, interventions that discourage pest birds biologically are preferable to destructive techniques. Some varieties of corn or millet have special anti-bird genetic structures (such as awns that poke the eyes of probing birds). These cultivars do not harm the overall biodiversity of a region. However, they do require extra labor during harvesting and shucking which makes them less attractive to farmers.

Pest Management: Large and Medium-sized Mammals

The great loss of large carnivores in West Africa can be traced to livestock and improved weapons. As little as fifty years ago, carnivores had sanctuary in thickets and groves of forest within the Sahel, keeping the livestock out. Before rifles, the herds could not enter the thickets and forest, trample seedlings and soil and browse understory. The issuance of rifles to herders killed off most of the Sahel's large carnivores (with the exception of urban adapted hyenas). The penetration of livestock into thickets has resulted in the loss of forest and drought-fallback foods. The trampling and soil compaction has reduced groundwater infiltration rates. It is ironic that these large carnivores were the first antidesertification land stewards. This vignette illustrates the chain of events that leads to the reduction of Sahelian biodiversity.

As in the United States, large carnivores seem to create large emotions. In West Africa, the occasional kill by spotted hyenna, lion, leopard and wild hunting dogs makes news. But, in terms of economic loss, the vegetarian mammals (baboons, warthogs, hippopotamii, elephant, patas monkey, and green vervets) are much more significant. These species have prospered because they are well-adapted to culturally modified landscapes. They greatly benefit from increased farm production. At present they have few or no predators (lion, leopard) and many are taboo food (monkeys, warthog) to the predominantly Muslim population.

In the groundnut areas of Gambia, the warthog is the primary pest followed by monkeys. Birds are minor pests. At times, livestock trespassing hurts crop production. In the maize fields of Gambia and Senegal, patas, baboon and warthog are year-round pests. The vervets appear in the rainy season. In rice fields, birds caused more damage than invading monkeys. Hippos and warthogs are important rice pests in select locations. Other animals perhaps unexpected, include jackal and civet with a strong taste for groundnuts; and civets with a strong taste for maize. Porcupine and small antelopes damage crops in the few areas where they still exist.

The NRMS team could find no summary material on large mammal control methods except the USAID Gambia River Survey (1985). Control methods vary in West Africa from hunting, poisoning with strychnine (hyenas in Gambia), community drives, and scarecrow tactics. Hunting with rifles has become a serious political problem in West Africa and firearms control can cause tense community relations. In areas with poaching and traditional bushmeat hunting, the use of rifles can lead to imprisonment. In Senegal,

sanctioned hunts require a signed document from the President and regulation by the Water and Forest Ministry. In the Gambia, shotgun shells are distributed by the Crop Protection Service or the Police Field Force can be authorized to join warthog hunts. The Gambia also has hunter associations who go to areas that seek help.

Hunting is selective and targeted. If the political situation allows, it is a good form of "vermin" control. When the mammal is rare or endangered (leopard, hippo, lion, wild dog), hunting can send a species to local extinction. The IUCN has submitted a proposal for funding in the Gao region of the inner Niger delta. The last remaining herd of elephants in Mali now raids farms and some conflict resolution is required. Similarly, picket fences or a combination of fences plus moats have been used effectively to exclude hippos from rice fields. The U.S. Ambassador to the Gambia is, at present, funding the restoration work of fencing around rice fields adjacent to the Gambia River National Park. Even though only 50 hippos may remain in the Gambia, shooting "pest hippos" is permitted.

No-hunting methods can be effective. Most are labor intensive such as constant (day/night) vigils. The hunter associations in the Gambia are,at present, experimenting with rotating methods (rattles, dogs, shooting blanks, yelling). Solar powered electric fences have been tried by the Veterinary Services in the Gambia but results are not known.

> In general, no systematic evaluation of the actual damages caused by large mammals nor any assessment of modern techniques for large mammal exclusion or control have been made.

This research could produce new, non-harmful techniques that would greatly aid the maintenance of large mammal populations and increase crop production. The large mammals have suffered most in the last twenty years and are rapidly being lost as part of West Africa's former diverse fauna.

Pest Management: Small Mammals

Throughout West Africa, rodents attack grain and vegetable crops, plantations of tree seedlings. steal from granaries and households; they damage irrigation earthworks by borrowing, chew plastic irrigation pipes, compete with domestic livestock for grasses. There is no desire to keep various rodents (Table II.B) as part of the ecosystem. USAID has spend over $40 million on pest management (focussed on rodents) but the results have not been termed successful.

The biodiversity goals are similar to that of control programs for other pests: single out the species that causes damage without causing secondary, harmful impact to other species. There have been no studies from this point of view. Biological control measures (employing sterilants, parasites, predators, introduction of deleterious genes) have either not been investigated for individual species or have proven ineffective. In East Africa, the cane rat is partially controlled by protecting pythons. This appears to be difficult in West Africa where pythons are unjustly feared and poached for cash. Similarly, in Niger, the cane rat is an important source of protein for humans. In Ghana, over 220,000 kg of cane rat (known as "grasscutter") meat sold at twice the price of beef. However, in Mali, Senegal

Table II.B

RODENT SPECIES CONSIDERED AGROFORESTRY PESTS

African Soft-furred Rats (Mastomys erythroleucus)

Kusu rat or Unstriped Grass Mouse (Arvicanthus abyssinicus)

Small Naked-soled Gerbils (Taterillus pygarus)

Cane rat or the "grasscutter" (Thryonomys swinderianus)

House mouse (Mus musculus)

Black Rat, House Rat (Rattus rattus)

or the Gambia, there is no known education or extension program to encourage the eating of cane rats. The NRMS team observed that the most successful initiatives included well--built grain storage areas with locally-made rat and mouse traps. These storage areas also allowed cooperatives to keep their grains until the market price improved. They had both more grain and received more money for it.

Rodent problems are erratic; they come in bursts of population growth and then subside (e.g., the Kusu rat boom and bust in Senegal in the 1970s). A fruitful research pursuit would be an "early warning system" such as presently exists for locusts. An early warning system could be combined with a village level control program (drive-hunts).

Pest Management: Invertebrates (Insects, Snails, etc.)

The use of pesticides to fight human diseases is widespread in West Africa. Onchoceriasis, malaria, and schistomiasis all can be reduced by applications of chemical and biological controls. In addition, the control of locusts and quelea (diochs) uses strong chemical pesticides applied to rice or other grains. Biodiversity can be affected in two ways: (1) the chemical or bacterial control affects non-target populations; (2) an area, freed from the disease organism, becomes settled by people and the natural habitat destroyed.

For example, WHO has been conducting extensive work on chemical and bacterial pesticides used to control Similum flies (the carrier of onchoceriasis) and, recently, a vaccine to prevent the disease has been announced. The combination of bacterial pesticide and vaccine has reduced disease spread and increased protection of fish species. It has also

opened large forested tracts of land in southern Mali in which some of the best remaining riparian forests of the Sudanian and Congolian/Sudanian transition zone occur. The consequences to these tropical forest need attention if biodiversity requirements of Section 118/119 are to be met.

The subject of pesticides and insects and mollusks was too large for detailed investigation by the NRMS team. But, it should be included in the mission biodiversity reports.

3. Biodiversity and Consumptive Uses

The maintenance of animal biodiversity must take subsistence hunting for food into account, especially as a drought-fallback food source or as part of traditional hunting cultures like the Basari of Senegal. It must consider the commercial hunters who, legally and illegally, hunt for the cash value of meat, hides, ivory and other animal parts. It must consider sport and trophy hunters who come from other countries, importing hard cash, for the privilege of experiencing the pleasures and challenge of hunting as well as the souvenirs (photos, heads, etc.) that can be exported home.

In West Africa, about twenty-five to forty animal species are bushmeat. The choice of bushmeat species varies with (1) cultural group; (2) the enforcement of state hunting regulations; (3) the populations of bushmeat species living within about 10 km of the hunter's village; and (4) access to advanced firearms. In Senegal and Mali, the restrictions on hunting are so severe (and erratically enforced) that hunters do not like to discuss bushmeat. In the Gambia, little large game remains and small game (francolins, guinea fowl, fish) can be hunted without harsh penalties. In the present context, subsistence hunting is equivalent to poaching for almost all mammal and bird species.

During the last twenty years, the rapid loss of large mammals has left a gap between traditional rules of hunting, state enforcement of new rules, and resource management skills. The result has been devastating to game populations and forest regeneration, especially to large seeded legumes which depended on the game animals for seed dispersal and growth stimulation. There have been no attempts to start game ranching even though wild ungulates are more effective users of savanna food niches and produce a greater biomass of meat per hectare than cows.

The "top down" enforcement of hunting regulations has met only partial success and sometimes none at all. From the biodiversity viewpoint, the countries visited are caught in a maelstrom of habitat destruction in which the depletion of game species has resulted in less seed dispersal, increased habitat loss, and lowered carrying capacity of the land.

4. Biodiversity and Non-Consumptive Uses

Non-consumptive uses include photography, birdwatching or general tourism. In East Africa, non-consumptive uses have become a major part of the national economies. Senegal, Mali and the Gambia have not been able to promote non-consumptive uses as well

as East Africa because the wildlife lives in a more forested environment, herds of animals no longer exist, and government budgets, tourist ministries and agencies have not been as deeply committed to wildlife preservation. In addition, the French colonial past promoted attitudes less conducive to wildlife conservation. Nevertheless, before the drought, major bird groups visited Senegal and wildlife tourism remains a part of the Senegalese and Gambian tourist package.

The NRMS team did not have enough information to determine costs, income and multiplier effects for wildlife tourism in the three countries. The exercise might help donors understand what would be required to fruitfully combine economic development and biodiversity maintenance. The economics of wildlife tourism are, in theory, excellent. Nothing is exported and private tour companies do most of the advertising.

C. Biodiversity and Plant Resources

Drought, the congestion of people forced south by the drought, and increased population growth have exacerbated the exploitation of plants to an intensity never before felt in the Sahelian and Sudanian zones. Many plant species have plummeting populations that are so fragmented that pollination has become difficult or impossible. In addition, the drought has forced an increased reliance on plants, especially as forage for goats that have replaced cattle. In certain areas, reduced vegetative cover and water has led to massive die-offs of soil microbes and fungi. The soil has become almost sterile of living matter -- the truest criteria for desertification. The reduction and even extinction of plant species and soil microbes is a major concern of biodiversity.

The biodiversity of plant resources has different focuses in various environments of West Africa -- the protected, the rural, the peri-urban, and the urban areas all have different needs. The NRMS team only brushed the surface of these problems. Four major themes concerning plant resources emerged: (1) status of knowledge of the flora and soil "innoculun;" (2) rare, endangered, threatened and endemic plants; (3) cultivars, seed conservation and innoculum production; and (4) the mix of species within the framework of urban, peri-urban, rural and forested environments.

1. Status of Knowledge of the Flora

The Sahelian and Sudanian zones of Africa support impoverished flora. There are about 2,750 species in the Sudanian zone and 1200 in the Sahelian. However, about one-third of the Sudanian species exist only in this zone. There are no endemic families but endemic genera include Butyrospermum, Haematostonphis and Pseudocedrela (all monotypic). Intact Sudanian or Sahelian woodland, bushland, or grassland is nearly impossible to find because of human influences. Even the national parks encourage burning to either reduce the possibilities of major fire or provide tourists with better viewing. A review of the flora is necessary to pin-point the best locations to preserve rarer species or communities.

2. Rare and Endemic Plants

Local extinctions are well-known in the last sixteen years. In the three countries visited, no species of plant has been singled out as endangered. But, the NRMS team found no conference of botanists and plant ecologists which addressed this question in the Sudanian, Sahelian and Guineo-Congolian transition. There is an obvious need for botanical surveys to identify extinction rates of various plant species.

3. Cultivars, Useful Plants and Seed Conservation

Biodiversity focuses on the need to preserve germplasm of plants that might be of use to human beings, especially as food and medicine. The benefits of germplasm conservation have been widely publicized. The NRMS team did not visit or review the germplasm projects to IRAT. ICRISAT is equally involved, especially with pigeon peas, sorghum, millet and finger millets in Mali. The regional microbiological resources center (MIRCEN) in Bambey, Senegal produces microbial innoculum (rhizobial bacteria, mycorrhizal fungi) for agriculture and environmental restoration. Other organizations involved include UNESCO, ISRA, UNEP. ORSTOM, USDA, the Foundation for Microbiology (New York), Agriculture Canada, NIFTAL project (Hawaii). Despite this list, MIRCEN has much room for expansion to meet the reforestation and agricultural needs of the Sahelian countries.

The team observed the absence of a germplasm bank and a central botanical research center in West Africa. In 1983, the National Research Council suggested establishing these organizations. Since 1983, the need, if anything, to conserve and document seed as well as supply seed to agriculture and forestry needs has increased. The germplasm bank should, of course, work closely with MIRCEN. The NRC also recommended that the Sahel Institute coordinate the collection and dissemination of information concerning species trials and the perfection of varieties suited to West Africa. For trees, the ideal is an attractive, high-yielding, drought-resistant, multipurpose plant. The villages visited were all enthusiastic about fruit trees that fit this ideal.

4. Agroforestry and Biodiversity

Many protected areas including national parks, classified forests, and faunal reserves need restoration with plants that have either died in the drought or were over-exploited. Boucle de Baoule, the Djoudj and Sine Saloum NPs all had clear needs (see Section V) including funding for native plant nurseries. All the classified forests needed assistance.

In rural areas, the enthusiasm for new and more plant species has been emphasized in the introduction. Everywhere the team travelled, there was a desire to learn more about new species and methods for obtaining plants that had disappeared from the drought or over-exploitation. Short-season variety rice spread quickly and enthusiastically along the Gambia River. The desire for nurseries and communal gardens with scarce or special

perennials (henna, medicinal eucalyptus, hibiscus) was widespread. This task occupied all the time of a CIDA volunteer in Senegal.

In rural areas, villagers still resist planting local native shrubs for firewood or browse reserves. There is a fascination with donor-supported exotics, despite full understanding that the native might grow better, be more fire resistant or have multi-purposes. In one case, the gardener simply said: "Nature gives those to us." But, the time seems right for donors and agencies like Eaux et Forets to include a wider species mix of multi-purpose shrubs and trees, especially those that can add to soil restoration as well as serve as living fences, forage, windbreaks and food.

> Just the addition of Sahelian and Sudanian zone native plants to the nurseries could do more for biodiversity than any other single intervention.

The Abuko Nature Reserve on the outside of Banjul (Gambia) was the only peri-urban forest visited by NRMS. It is an excellent biodiversity reserve under extreme pressure from local grazing and urban sprawl. The Park Head wishes to create a "buffer zone" of fruit orchards surrounding the reserve in order to relieve the pressure. This kind of peri-urban agroforestry seems highly promising and deserves funding. The NRMS team did not encounter any biodiversity projects which attempted to increase species richness of natives in gardens, parks or urban woodlots. Botanical gardens within the urban setting would be an educational as well as environmental asset to the major West African cities. They can be tied to sewage plants in order to recycle treated effluent.

Large scale anti-desertification shelter belts remain a problem because of high costs and difficult long-term maintenance. Drought-resistant species for the Sahel/Saharan edge need to include shrubs and grasses, not just trees. Shrubs and grasses may be able to hold soils better than starting with trees. More trial and germplasm selection is required in cooperation with MIRCEN and the Sahel Institute.

D. River Basins and Biodiversity

All three major rivers in this part of West Africa, the Niger, the Gambia and the Senegal, cross international boundaries. In addition, the Sine Saloum and the Basse Casamance are important large drainages within Senegal. These are brackish, sluggish rivers that flow through a large network of tidal flats.

1. The Senegal River

The Senegal River has two dams -- the Manatalli and the Diama. In terms of modification of floodplain rivers (Welcome, 1978), the Senegal has changed from a slightly modified to an extensively modified condition. This present condition requires re-assessments of various aspects of fisheries biodiversity: (1) impacts of load changes, especially sediment, watershed nutrient contributions, fertilizers, and any pesticide residues; (2) increased control over fishing methods by the establishment of tighter rules of access

and catch size; (3) possible year-round aquaculture of fish (e.g., rice/fish culture); and (4) development of a reservoir fisheries.

It is usual for species composition to change (especially the loss of larger species) with extensively modified floodplain rivers but the NRMS team did not have time to review recent information. Fish suited to lentic (lake-like) environments have replaced fish adapted to fluctuating lotic environments. The river's flux used to trigger breeding conditions in some fish and, without the flux, the populations have disappeared. The mitigation proposal for an artificial estuary to increase stocks of species that require estuarine freshwater/salinity gradients has not been acted upon by OMVS. This has probably lead to a permanent loss of fish biodiversity as predicted to by OMVS.

The Senegal River has man-made levees stretching up its southern banks to Richard Toll. However, it still floods on the Mauritanian side. These levees have restricted the amount of floodplain available for the fishery. The increase in the human population using the floodplain has also increased pressure on fish resources. Fish that migrate laterally (onto the floodplain) have smaller breeding grounds and their populations have decreased.

Finally, there is a saltwater barrier dam on the Teway River, the tributary to Lac du Guiers. This barrier prevented salt water intrusion into the lake which has now become part of the Dakar water supply system. With the construction of Diama dam, it has become a watergate which will influence the flood level of the controlled flow in the main channel. The NRMS team did not have time to evaluate how expansion of agriculture along the edge of Lac du Guiers influenced species diversity and populations. A small, experimental aquaculture project exists at the dam on the southern end of the lake. A recent USAID/Peace Corps aquaculture project has been terminated along the river itself.

Another drastic change has been the change of flood level and flood pulse below Manatalli Dam. This change has harmed flood recessional agriculture and will continue to do so until irrigated agriculture can be developed, perhaps in 15 to 20 years. It has reduced the floodplain grassland available for grazing. It will force cultivators into the market economy to purchase fertilizers because the flood no longer supplies nutrients. It harms fish populations dependent on lateral migration into floodplain pools for breeding. At least, in the near future, the livelihoods of people practicing recessional agriculture and the fisheries dependent on the flood pulse will suffer in unison. In addition, the main channel fisheries will become intense and, as indicated, require greater regulation to maintain size and stocks.

The switch to counter-seasonal rice culture will increase the pest problems with waterfowl (see "Themes"). Up to now, the staggering of bird migrations and rice cultivation reduced losses. But, two season rice cultivation will bring migrants and rice growth into close contact. The Djoudj National Park and Mauritanian depressions both serve as sanctuaries to waterfowl and, by attracting and holding the birds, reduce crop losses. Despite the cost-effectiveness of waterbird refugees, the repair of the dikes and watergates at the Djoudj and the expansion of the park has not been given adequate attention.

The NRMS team did not have time to survey the state of floodplain and estuarine plant communities. Riparian forests have been reduced by expansion of agriculture, natural shrinking of the floodplain during the drought, firewood cutting, inundation behind the dams, and flood control levees. It should be noted that no riparian forest (e.g., gonakie forest) is now protected along the main channel of the Senegal river. These riparian communities have been sanctuary for many savanna birds during the drought period and support up to twice the number of species. Not enough attention has been paid to maintaining floodplain forest which are the richest habitats for biodiversity in the Sahelian zone. With the entrapment of some nutrients behind Manatalli Dam, these riparian forests become major contributors of detritus (e.g., dead leaves) which is utilized by many organisms in the food web.

At the mouth of the river, the fate of river navigation, channelization and dredge spoils has not been determined. Marine birds in Langue de Barbarie National Park and birds using floodplains, mudflats, sandbars and riparian forest could suffer serious population losses, especially in the event of an oil spill.

Finally, in the upper watershed, many unknowns exist. On the Faleme River, mining has been proposed within the Faleme Fauna Preserve. The consequences could be devastating to large mammals in the area. In the Bafing tributary, a national park has been proposed. In the Ferlo, another Fauna Preserve exists but apparently without animals. No survey work nor biodiversity evaluation of these three projects could be located by the NRMS team.

In summary, development of the Senegal river basin has had an adverse effect on the diversity of fish species. Increasing human populations along its shores have eliminated most large wildlife (e.g., the Matam elephant population disappeared in 1984). The fate of waterbirds depends on mitigation measures that have yet to be undertaken. These include the repair of waterworks at Djoudj National Park and the protection of wetlands in Mauritania. The riparian forests of the main channel remain outside any protected conservation area. Further losses to bird and, perhaps other species will occur if the navigation channel is built. The protected areas of the upper watershed require conservation planning and administration if biodiversity is to be maintained.

> In general, the cumulative value of sustainable resources (nutrient supply to floodplain; naturally irrigated crops and grassland; estuarine fisheries, etc.) have been underestimated. Their loss may not be balanced by the apparently transitory benefits of capital-intensive activities (e.g., irrigated agriculture with fertilizers, pesticides, pest management, increased waterborne disease and local overgrazing). Long-term economic interests may still be better served by building on local strengths (recessional agriculture and floodplain fisheries and grazing) rather than supplanting them. This direction would also be more compatible with biodiversity maintenance and traditional social controls.

On the north banks of the Senegal River, maintaining recessional agriculture and floodplain breeding grounds for fish is still possible by modifying water release schedules from Manatalli Dam.

2. The Niger River: Inner Delta

The NRMS team spent the least amount of time investigating biodiversity within this basin. Only the inner delta was visited and all comments pertain to the delta only. The material has been extensively summarized by the IUCN umbrella project within the inner delta (IUCN, 1987).

The inner Niger delta has five major floodplain habitats (open water, Vetiveria pools, bourgu, Chloris transition zone, manioc and cultivated fields). In addition, two adjacent habitats are controlled by goundwater levels -- the toguere (palm, millet, fig, woodland) and the Acacia/Cenchrus dunes. The delta supports over 130 species of fish; 350 species of birds; a depauperate mammal fauna. About 2 million migratory birds of 110 species utilize the delta. Approximately 500,000 people depend on the delta for household productivity, including 80,000 involved in fishing.

The level and pulse of the river has major economic effects because very slight increases in the river level inundate disproportionately greater acres of grassland and floodplain agriculture. The drought, one dam (the Selingue) and the major diversion aqueduct (Canal du Sahel) have modified this flood pulse and water level. The drought has drastically shrunk the floodplain grasslands and the river channels available to the West African manatee, the hippo, gazelles and antelopes. Since the beginning of the drought, both loss of habitat and reversion of local people to bushmeat for food have precipated drastic decreases in these populations.

The restoration of large mammal biodiversity can only occur through the reintroduction of locally extinct species and the creation of a protected area. This was not considered feasible by IUCN given the drought and costs. Instead, the IUCN has worked toward integrating various aspects of biodiversity maintenance into a more general program to improve the use of natural resources within the delta. Three of these projects (the Bouna project to protect waterbird nesting areas; Walia, an educational program; and a Village Funds project that researches coordination of economic desires with natural resource needs) are described in detail in Section IV. The preservation of the Gao elephant herd is under consideration. This is the last elephant herd in Mali and methods of reconciliation between farmers and elephants will be needed to keep the herd from extinction.

By Welcome's classification, the Niger has been extensively modified by an upstream dam, diversions and irrigation works, alteration of floodplain timing and duration, modification of the floodplain for agriculture, and intensified use of floodplain native foods and fisheries. The drought has caused many of the delta's problems, but others can be traced to river basin management. For example, the Selingue Dam (1982) has favored upstream production over production in the inner delta. Water releases have favored the Canal du Sahel without any economic analysis of the most cost effective use of the dam's water supply. Similarily, release timing has not been set to maximize flood height, duration and area within the delta. This would increase fish production dramatically.

Economic and ecological damage occur when controlled releases from dams force humans and wildlife into the smaller areas of inundation and concentrate (vs. spread) impacts of grazing, cultivation and fishing. Long-term land degradation; biodiversity losses; intensified land use, over fishing, and access rights conflicts are all common. In other extensively modified river basins (e.g., the Colorado River) dam construction has been accompanied by setting release schedules by "type years" (critical low, low flow, normal, high, critical high). In addition, minimum instream water rights have been established to assure that river reaches like the inner delta can support and maintain fisheries and bourgu grasslands. These instream water rights usually help maintain wildlife populations even if this is not the primary objective.

In summary, IUCN has proposed an examination of river basin management. Their proposal should be funded as a high priority. This is a clear example of biodiversity and economic concerns requiring similar natural resource management guidelines. The proposal should focus on land use goals that can be translated into the schedules and quantities of daily, seasonal and yearly water releases. The inner delta's instream flow should have a higher priority water right over upstream diversions. Flexible operating rules are required to meet emergencies and different type years. For instance, in all arid climates, there is a special set of rules for the year following a critically dry year in order to help speed recovery. Clear attention should be paid to the hydrological model employed, the correlation of LANDSAT and other photos with flood heights, land coverage, economic benefits, and water rights planning.

3. <u>The Gambia River</u>

The Gambia River is, at the moment, a slightly modified floodplain river. The flood is still largely unaltered in timing and duration. In the lower reaches, floodplain depressions have been filled or regulated for cultivation. Many of the riparian forests have been cleared. Fish stocks are largely unaltered, though locally over-exploited. But, OMVG has proposed major waterworks construction for the river -- from one to five dams.

A USAID sponsored study of the Gambia River Basin (1985) and an OMVG Technical Report (1987) recommended against the anti-salinity barrage (the Balingho dam) because of adverse impacts on the lower freshwater and estuary fisheries. Again, both economics and biodiversity concerns led to similar conclusions. The study also warned against harmful side effects of Kekreti Dam, which is, in part, located within Niokolo Koba National Park. The dam permanently opens a protected area to dam workers and reservoir fishermen; it increases conflicts with the Basari people and harms the park's ability to maintain large, endangered mammals.

The NRMS report cannot enter into details. But, maintenance of biodiversity (species richness, species kinds, and population size) will become extremely difficult with Balingho or Kekreti dams. The information of the Guinean dam proposals was not adequate from the point of view of biodiversity. In general, Gambia River Basin development has the advantage of learning from past mistakes of other African River Basin projects. Some of these projects have resulted in lowered standards of living for the population rather than improved quality of life. The evaluation process that is now

occurring should be continued. But, construction funding should not be rushed for any of the dams.

Other proposals in the Gambia River Basin that would maintain biodiversity include (1) a one-mile buffer strip along the river channel to protect gallery forest and floodplain communities where major areas of wildlife remain (see Gambia River National Park Intervention in Section V); (2) the establishment of a national park to protect Gambia's mangroves; (3) an upper watershed protection program (USAID); (4) a park plan and corridor between Niokolo Koba and Faleme Fauna Reserve and Guinea.

III. COUNTRY SPECIFIC BIODIVERSITY

A. Background

This section is an incomplete review of biodiversity concerns in Mali, Senegal and the Gambia. It should be read in conjunction with the general themes and the more detailed interventions (Section IV). Complete country reviews will answer the questions posed in Section V, a biodiversity questionnaire.

Using the UNESCO classification of the Afro-tropical realm, these three countries can be divided into six major biotic communities (Table III.A). In the north, the Saharan desert which has closer affinities to Palearctic. Just south starts the Sahelain transition of Acacia woodland and Acacia deciduous bushland. In the central and southern parts, the Sudanian undifferentiated woodlands can be found. In the extreme south is the Guinean/Congolese transition which, in Senegal, is basically a mosaic of rainforest species with secondary woodlands. In addition, along the southern coast are the most northern of the West African mangrove forests. Smaller communities in the Gambia and Senegal include the coastal sand dune and marine beach biotic community, the "tanne" wetland communities and the coastal islands. All three countries haveriparian zones (riverside communities) of gallery forests. The Gambia and Senegal have saltflats that border the lower reaches of their rivers. These smaller communities are some of the richest in terms of biodiversity.

This classification of biotic communities is, of course, idealized. It is an historical reconstruction of what might have been. A more accurate portrayal of contemporary biotic communities demonstrates why there is an urgent need for conservation of the remnants remaining in a more natural state. The more accurate portrayal can be found in Table III.B. This author could find no detailed survey of these various biotic communities within Senegal, Mali or the Gambia which pinpointed areas that are still in a more natural condition. Some probable areas are listed in the country-specific sections.

B. Biodiversity in the Republic of Mali

1. Background

Mali includes lands from the 10th to 25th latitude -- from the transition zone of the Guinea/Congolese rainforest to the heart of the Sahara. From the point of view of biodiversity, Mali contains one major region of endemism (i.e., center of species richness within Africa). This is the Sudanian Region ("III" in White's classification). The rest of Mali comprises two regional transition zones and mosaics of various regions. These are the Sahel (XVI) and the Sahara (XVII).

TABLE III.A

BIOTIC COMMUNITIES OF COUNTRIES VISITED

SENEGAL	MALI	THE GAMBIA
	Saharan	
Sahelian	Sahelian	Sahelian
Sudanian	Sudanian	Sudanian
Guinean/Congolese Transition	Guinea/Congolese Transition	Guinea/Congolese Transition
Mangrove		Mangrove
Coastal marine		Coastal marine
Open Water	Open Water	Open Water
Wetlands	Wetlands	Wetlands

TABLE III.B

EXISTING PLANT COMMUNITIES IN WEST AFRICA

1. Plantations and artificial regeneration areas.

This community is considered permanent tree and tree-like vegetation that has a structure, but not a species mix similar to natural stands. Species mix ranges widely from gmelina, eucalyptus, fila .shew, cassias, acacias, teak, mesquite, lpil-lpil, kapok, African mahogany, etc.

2. Natural closed or dense forested areas.

Tree, tree-like, and shrub covered areas with a crown closure of more than 50% and trees more than 5 m in height. Most of the plants are deciduous in the dry season. These are the "foret, dense seche" and some of the Congolian/Guinean mosaic. Fire, human use near populated areas for logs and firewood and charcoal and clearing for agriculture have dramatically altered these forests. Uncontrolled fires, set for land clearing, appear to be the major human influence. In Senegal and the Gambia, the scarcity of Parinari excelesea and African mahogany compared to "natural" forests exemplifies the vast and rampant changes that have occurred throughout the Sudanian biotic community.

3. Open, less dense forest and wooded savanna.

Dispersed trees and shrubs with crown cover less than 50%. There is an extensive ground cover of small shrubs, herbaceous and grass vegetation. Vegetation is mostly deciduous in the dry season. This community is usually a degraded form of denser forest that cannot recover from land clearing, fires and/or wood cutting. This is the most extensive area of Senegal and Mali supporting grasses (Andropogon and Paspalum). In some locations, the less, dense woodland includes palms (Borassus and Raphia) used to make many homes.

4. Gallery or Riparian Forest.

Crown closure is greater than 75% and is the best preserved and tallest of the original forest types. This has resulted from the (1) steep and rocky slopes on which the gallery forest remains (the flats have been cleared) which have difficult access and are impossible to cultivate and (2) the high moisture content of the forest that has kept it from burning.

5. Grassland or savanna.

Herbaceous and grassy vegetation with scattered trees and shrubs. The grasses are perennial. It is nearly impossible to separate out the soil-controlled grasslands that suffer natural fires from the grasslands that have resulted from human influences (clearing, fires, grazing). This area is the most important for grazers and has deteriorated most from drought and intensification of burning and grazing.

6. Mangroves.

Mostly round the mouth of the Sine Saloum and Dioumbus rivers, Senegal nurtures the northern most stands of mangrove in West Africa. Species vary. The massive die-off reported recently has not occurred and the parasite has not spread to new groves. Nevertheless, dieback, possibly the result of the drought and/or over-harvesting of oysters (which can cause a local change in pH) is obvious and needs to be monitored closely.

7. Agricultural Areas.

Used annually, bi-annually or semi-permanently, these lands always have vegetation associated with the cultivation/fallow cycle and are only occasionally surrounded by shrub/tree species (e.g. living fences). They may be part of a grazing "system" in which the livestock move into the fields after harvesting. Without going into details, agricultural lands differ if irrigated by rain, by human waterworks or swamp inundation.

8. Urban Areas.

The vegetation of urban or semi-urban areas poses special interest to those concerned with biodiversity. At the moment, the use of trees and other plants, especially ornaments, is limited.

9. Water Bodies.

The open bodies of water of most importance are the Niger, Senegal, Gambia, Sine Saloum rivers and the coastal estuaries.

10. Wetlands.

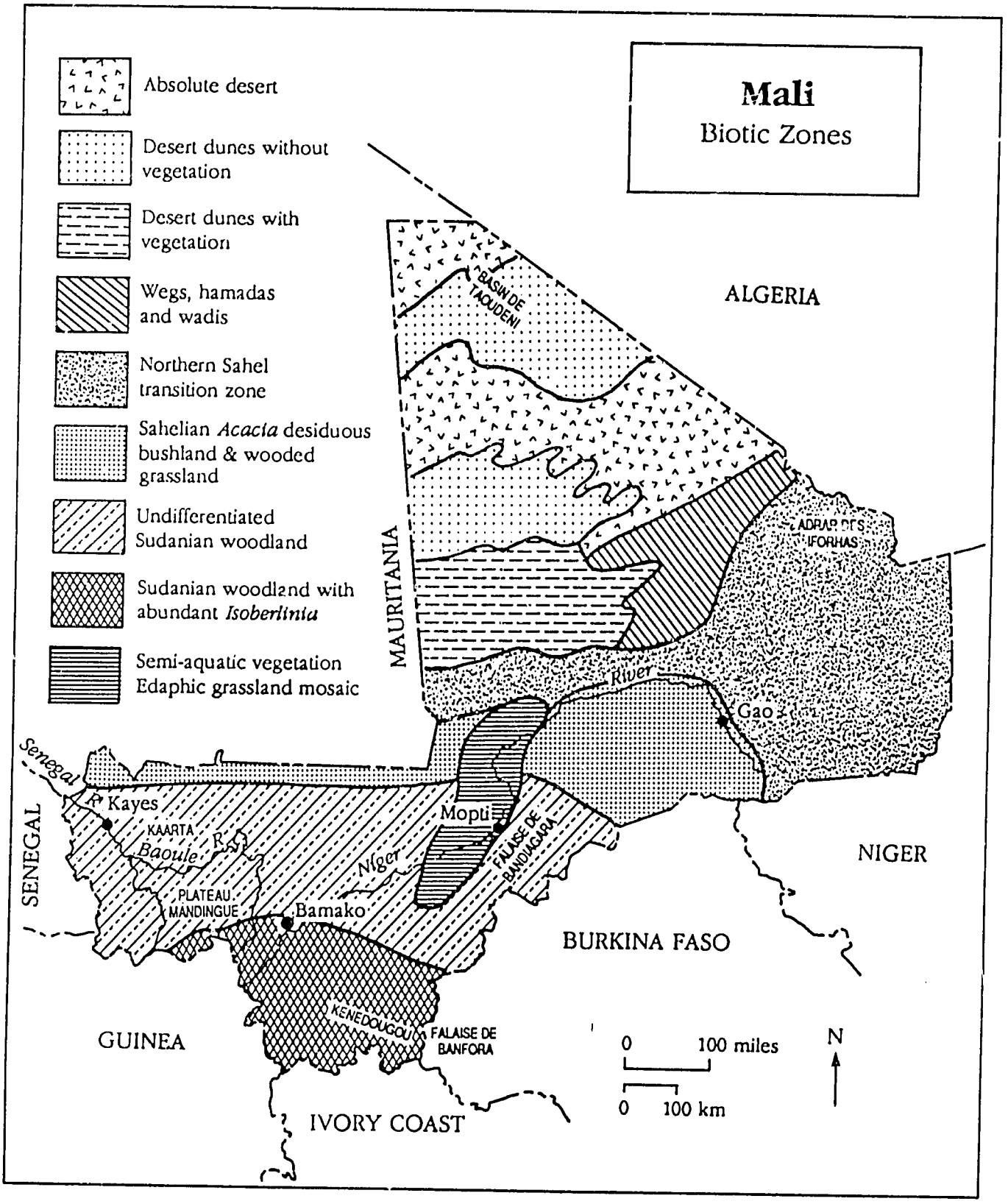
These are seasonally inundated areas with standing water. They range from areas like Lac Guier to the Djoudj. They are important for recessional agriculture, swamp rice, shore birds, fish breeding and various disease organisms. The most important in West Africa is the inner Niger delta of Mali.

11. Barren flats ('tannes').

Areas of little or no vegetation with highly leached, strongly acid, saline and alkaline soils. They occur behind or within swamps. They are important nesting areas for sea turtles and certain pelagic birds (e.g., terns). They are extensive in the Sine Saloum region.

12. Bare lands and rock outcrops.

It is important to distinguish the bare lands caused by the recent combination of human influence and drought (in the north of Senegal and Mali) and the bare lands such as the bowals (laterite flats) in the south. The latter are unique habitats well represented in Niokolo Koba Park, while the bare sandy soils of the Sahel are not. Certain swifts, swallows, raptors as well as baboons and hyrax use bare rocks, rock outcrops and cliffs as a refuge and/or nesting area.


Mali
Biotic Zones
Absolute desert
Desert dunes without vegetation
Desert dunes with vegetation
Wegs, hamadas and wadis
Northern Sahel transition zone
Sahelian Acacia desiduous bushland & wooded grassland
Undifferentiated Sudanian woodland
Sudanian woodland with abundant Isoberlinia
Semi-aquatic vegetation Edaphic grassland mosaic
ALGERIA
BASIN DE TAOUDENI
MAURITANIA
ADRAR DES IFORHAS
River
Gao
Senegal
Kayes
KAARTA
Baoule
PLATEAU MANDINGUE
Bamako
Niger
Mopti
FALAISE DE BANDIAGARA
NIGER
SENEGAL
BURKINA FASO
KENEDOUGOU
FALAISE DE BANFORA
GUINEA
IVORY COAST
0 100 miles
0 100 km
N

The Saharan biotic region of Mali contains (a) regs, hamadas and wadis; (b) desert dunes with perennial vegetation; (c) desert dunes without perennial vegetation; and (d) absolute desert with erratic annual blooms ("ergs").

The Sahelian region contains (a) semidesert grassland and shrubland and (b) Sahel Acacia wooded grassland and deciduous bushland.

The Sudanian biotic region contains (a) Sudanian woodland with Isoberlinia and Sudanian Undifferentiated Woodland (a heavily human influenced woodland). Some small intact relics of the dry evergreen forest (Sudanian dry forest) persist on the sandstone plateaus of Mali in a triangular area formed by Kita, Kayes and Kenieba. The evergreen relics are best represented on rocky areas free from fire and with access to subsurface water. They may have no protection.

Most of the Sudanian region has been highly modified by cultivation and consists of various stages of fallow land and "orchard savanna" in which the original forest has been burned except for useful trees such as karite.

In addition, two special wetland habitats occur: the oases of the Sahara and the edaphic grassland mosaics with semi-aquatic vegetation within the Sahel. The latter is essentially the Inner Niger Delta (see "River Basins" and IV.2).

2. Biodiversity Concerns

a. Protected and Unprotected Areas

1) Protected Areas: Coverage

Table III.C and Figure III.B summarizes national parks, animal and forest reserves in Mali. Note that no part of the Sahara has received attention for protection, even though certain ephemeral water bodies and gorges have importance for the maintenance of bird biodiversity. The two extinct species of antelope were both Sahelian/Saharan dwellers and the bald ibis has only been observed in the Sahara. In addition, the vulnerable addax is a saharan resident.

Two "reserves" exist in the Sahelian zone: the Elephant Reserve which also borders the Niger and the Asongo-Menaka Reserve which is also known as the Giraffe Reserve. Neither have any set protection rules.

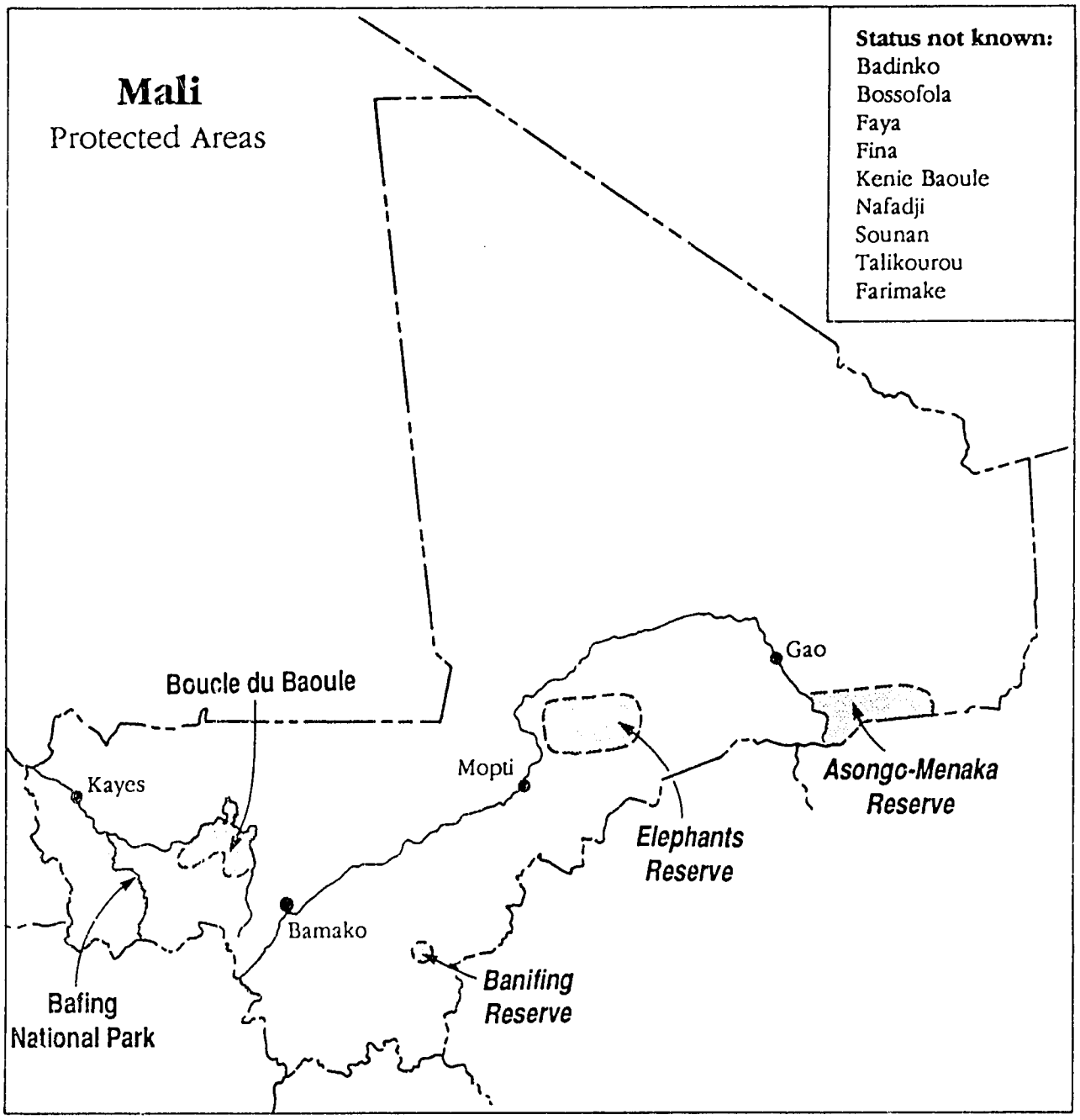
The Sudanian Zone has eleven areas with some form of protection. The Boucle du Boaule National Park; the Fina Fauna Reserve with one of the last two populations of giant eland in Mali; the Bandinko Fauna Reserve and the Kingosombougu Fauna Preserve are all in Sudanian undifferentiated woodland just north and northwest of Bamako. In the Monts Mandinga regions are the Kemebaule Forest Reserve, the Talikourou Forest Reserve, the Nafadju Forest reserve and the Bossofola Forest reserve. The last reserve has giant eland and buffalo. The Fay-Sousan region has two Sudanian-type forest reserves (the

TABLE III.C

TABLE OF PROTECTED AREAS IN MALI

	HA X 10 TOTAL AREA	Vege Classes
Boucle du Baoule (NP)	3500	Sudanian
Bafting (proposed NP)	NA	NA
Reserves:		
Asongo-Menaka (Giraffe)	1,750,0	Sahel
Badinko	1,930	Sudanian
Banifing Baoule	130	Sudanian
Bossofola	120	Sudanian
Elephant	1,200,0	Sudanian/Delta
Faya	800	Sudanian
Fina	1360	Sudanian
Kenie Baoule	675	Sudanian
Nafadji	920	Sudanian
Sounan	430	Sudanian
Talikourou	376	Sudanian
Bafting	NA	NA
Farimake	1,000,0	Delta

FIGURE III.B


Mali
Protected Areas
Status not known:
Badinko
Bossofola
Faya
Fina
Kenie Baoule
Nafadji
Sounan
Talikourou
Farimake
Boucle du Baoule
Kayes
Mopti
Gao
Asongo-Menaka Reserve
Elephants Reserve
Bamako
Banifing Reserve
Bafing National Park

Faya and the Banifing-Bauole) and the Sounsan Reserve. The status of the Bafing National Park, near the Manatalli Dam in the Senegal River Basin, and the Farimake Reserve west of the Niger floodplain, is unknown.

2) Protected Areas: Effectiveness

There are no field-based evaluation reports on the effectiveness of protection for the various protected areas of Mali. A recent IUCN general survey report called the situation in Mali "particularly serious." Previous field work reported loss of forests within the Boucle National Park resulting from Moors killing trees and subsequent encroachment of groundnut farmers. Poaching seems rampant and most animals within the Park are shy - - eliminating its value for tourism. Villages have become established within the Fina Reserve because no overall natural resource management plan or administration exists.

In general, the lack of funds, training, personnel and interest on the part of the Mali government has prevented effective protection. The drought has strained the nation's resources, altered its priorities and reduced any concerns for wildlife and other aspects of biodiversity (see "Consumptive Uses," below).

It is recommended that a conference be held in Bamako of specialists most familiar with the unique aspects of Malian biodiversity and members of the Malian government. Priorities for protection should be set for a limited number of areas, and international funding should be provided for more effective targeted management. The Boucle de Bauole complex, in particular, needs a compete overview plan to determine species locations, habitat islands, connectedness of populations, and multi-use buffer zones (see "Themes").

3) Conservation Needs Outside Protected Areas

The Inner Niger Delta. The Inner Niger delta has no official protection. The Elephant Preserve and the proposed Farimake Reserve would include parts of the delta. But, recent studies by a WWF/IUCN team revealed almost no large mammal wildlife. A reserve would essentially be set aside for a recovery project to restore wildlife. IUCN/WWF have changed their funding strategies away form reserve establishment and wildlife restoration and towards local conflict resolution of natural resource management and wildlife concerns.

The main continuing threat to the delta's richness comes from upstream dams and diversions that lower the flood peak and change the timing of the flooodwave. This change in flood regime has multiple effects on the Malian economy, especially on grazing in the floodplain. Cattle products are a major export commodity, at one time responsible for 16% of all cash income to the nation. Flood management, the cattle and fish enterprises are inseparable.

Overlapping, confusing and conflicting sets of rules and laws (e.g., founding lineage usufruct rights, Fulani rights established in the 1800s, French colonial rights and Malian

State rights) have led to over-use of various portions of the inner delta and these need to be reconciled. These conflicts have led to the degradation of the flooded woodland forests, abuse of the "bourgu" plant association with lowered grazing capacity and the invasion of two less useful plants (Mimosa pigra and Aeschymones). These conflicts have also confused fishing rights and led to over-use of fish resources without adequate management. Until November 1987, there were no regulations of net mesh size. The Niger's waters are over-fished -- threatening the long-term sustainability of this resource.

It is recommended that:

- A careful study of run-of-the-river hydrology be made with the goal of changing the management of storage and release timing (flood pulse) from Selingue dam and diversions to the Canal du Sahel. In addition, minimal in-stream flows should be set for various hydrologic years (see "River Basins"). This can be fruitfully based on work in the Sacremento River Basin of California (Warshall, 1984; IUCN,).

- The IUCN project of conflict resolution of natural resource "commons" within the inner delta be supported (see "Bouna Intervention").

- WALIA be funded and continued in the Fifth Region (see "Walia Intervention") and expansion to other areas of Mali should be considered.

- The IUCN pilot project to restore the "bourgu" by improved local management of grazing and harvest be funded.

- Finally, it should be kept in mind that no strong recovery of aquatic species will be possible until the rains return. What is crucial is the maintenance of "core populations" that can expand with the return of higher riverflow.

Sahara. As mentioned above, no survey or proposed protection now exists in the Sahara zone of Mali. In northern Mali, the Adrar des Iforhas range was reported to have barbary sheep, gazelle, topi and possibly oryx. The possibility of a protected area should be investigated.

Intact Dry Evergreen Forests in Gorges. The areas with endemic birds (the enclosed valleys with intact forest, and the northern fingers of the Guinean/Congolian rainforest near the Ivory Coast/Guinea borders) have no protection. They are in need of better definition. Presently, the only protection is the difficulty of human access.

Sandstone Plateau. Note that the center of endemism of "sahelian" fauna (the Kita, Kayes, triangle) has no reserves and the area that contains the northern most populations of chimpanzees have no protected areas. The proposed Bafining National Park may cover some of this area.

The Manatalli Dam Area. The Manatalli dam will flood 500 sq km of savanna woodland and riparian habitat. The losses were to be mitigated by a rescue operation within the reservoir area and the establishment of a natural park along its borders. No rescue operation appears operative and the protection afforded the proposed park is unknown. OMVS should be responsible for these mitigation measures.

b. Biodiversity and Animal Resources

There are about seventy mid-sized to large mammals in Mali (i.e., excluding mice and bats). Using diurnal primates and ungulates, McKinnon notes that west Mali includes the center of "Sahelian" species richness with 42 species. It is one of eight major centers of ungulate/primate richness in all of Africa.

Table III.D lists mammals of concern in Mali. The oryx and Dorca's gazelle are already extinct and could only be restored to Mali through reintroduction and full protection. Five species are considered by IUCN or CITES to be endangered. Ten species are considered vulnerable on an Africa-wide basis but are clearly endangered within Mali itself.

About 640 species of birds have been recorded in Mali, more species than in all of North America. About 15% of these birds are vagrants or rare, having been seen less than six times. From the point of view of birdlife, four habitats are of particular importance: the inner Niger delta; the gorges and enclosed valleys from Monts Mandigues to Adrar; the numerous cliff faces; and the temporary or perennial ponds within the Sahel. The enclosed valleys are fingers of more southern vegetation that extend north. They are some of the least disturbed forest habitat and some contain Mali endemics. No site specific survey of bird habitat is available for Mali except IUCN data on the inner delta.

The northern bald ibis -- an internationally endangered species that nests in Maroc -- has been seen twice in Mali. The ostrich is vulnerable to extinction in Mali because its eggs are collected for sale.

1) Pest Management

Five major pest management and biodiversity concerns observed in Mali should be considered in a Section 118/119 report. The NRMS team had no time for any detailed observations. General considerations can be found in the themes section. The five major concerns were:

- Waterbirds and Rice
- Quelea, Yellow Canaries and Grains
- Onchoceriasis and Protected Habitats
- Locust Control and Secondary Impacts
- Elephants and Farms

TABLE III.D

MAMMAL SPECIES OF CONCERN IN MALI

Extinct

Scimitar oryx
Dorca's gazelle

Endangered and Threatened

Giant eland
Leopard
Cheetah
Chimpanzee
Dama's gazelle

Vulnerable: Species of Concern

Addax
Roan antelope
Elephant
Giraffe
West Africa manatee
Hippopotamus
Hunting dog
Spotted-neck otter
Cape clawless otter
Lion

The last major herd of Mali's elephants (perhaps 100) travel along the eastside of the Niger delta. The herd is a major research priority for Mali. It is under consideration by IUCN. How to reduce poaching and create travel corridors that do not unduly destroy farmer crops should be the major focus of this research.

2) Non-consumptive Uses

Mali has the potential of combining wildlife tourism with cultural tourism (e.g., trips to the Dogon region). But, wildlife tourism (a non-consumptive use) has deteriorated because of ineffective protection within national parks and the delta region. Biodiversity concerns and cash income concerns of tourism have not been adequately appreciated by the Malian government. They are long-term investments and incentives (such as donor supported park planning and maintenance funds) will be needed in order to interest the Malian government.

3) Consumptive Uses

Mali utilizes wildlife as subsistence bushmeat, commercial bushmeat, cultural commodities, commercial trophy hunting, and protective hunting (pest control). Certain groups like the Bozo combine pest control netting of ducks with market sale. Despite protective laws, hunting of terrestrial and aquatic mammals is not effectively controlled. Poaching for all these uses is widespread. Villagers are reticent and are especially reluctant to provide information about hunting and locations of wildlife (e.g., manatees).

While in Mali, this author heard news of a pair of giraffes, the two remaining members of the species in the Asango-Menaka Reserve and probably all of Mali. (Before the drought, there were 150 to 175 giraffes.) Despite careful protection by two Eaux et Forets guards, a permit was issued to kill one of the two giraffes, thus ensuring the extinction of the giraffe within the "giraffe reserve." Controls on hunting appear to be ineffective throughout the country. The consultant team recorded the following for sale in the Sikasso market: monkey and baboon skins; chimpanzee hands; civet and serval or leopard skins; antelope skins; crocodile, monitor lizard, boa and python skin pieces; two crested crane heads; turtle shells and other reptile parts. Similar markets were noted in Mopti and Bamako. Officially, hunting has been banned since the early 1980's.

There is a conflict between local villagers who are denied permits to hunt vs. urban and privileged hunters who pay large sums to the government and receive permits. This leads to poaching by local people and non-cooperation with Eaux et Forets agents. A series of policy and rule changes as well as local wildlife management agreements will be required to reverse the downward trend in bushmeat and commercial meat populations. In isolated areas where hippo and manatee are eaten, this will be an exceptionally difficult task. Game-ranching has not been considered in Mali.

4) Endangered, Rare and Threatened Species

Table III.D lists mammals of concern in Mali. Preliminary reports on population size and distribution have only been made for the manatee, elephant and chimpanzee. No effort has been made in Mali (vs. Senegal) to reintroduce locally extinct species. Targeted funding of protection and recovery programs in Mali appears minimal, though the NRMS team could have missed some NGO funding because of time constraints. IUCN may begin a project to protect the elephant herd that lives on the border of the Niger Delta. The chimpanzee protection appears ineffective.

c. Biodiversity and Plant Resources

In comparison with the other countries visited, Mali suffers the most of all three countries evaluated from the encroaching desert overtaking the Sahel. All flora biodiversity concerns discussed in the themes section are intensified in Mali.

1) Knowledge of Flora

No survey of Sudanian endemics and rare plants in Mali with mapped areas of endemic or biodiversity richness is available. There are many good botanists of Mali that have never been brought together to plan this type of survey and research. No list of threatened or endangered native flora is available.

2) Cultivars and Seed Conservation

The Sahelian region of Mali was the source of important cultivars of finger millet and sorghum. It also has a wide variety of wild species of rice. The NRMS team did not have time to write a status report on seed conservation, germplasm banks and collection programs in Mali. Similarly, the NRMS team did not have time to survey on-going research into Malian useful, native plants by ICRISAT.

3) Agroforestry

The massive "anti-desertification" campaign which includes "a green belt to stop the desert" should be reviewed carefully. Proposed again and again since 1985, it has been too abstract to be practical. There has not been much success with this type of floral barrier in other parts of Africa. Problems of long-term care for planted seedlings are of special concern.

There is a great need to encourage nurseries to grow native shrubs as well as trees and, along the Sahelian border, even grasses. USAID and other donors are just beginning to encourage multi-species planting. These nurseries should be coordinated with production of innoculum.

d. Education, Government and Religion

1) Biodiversity Data Base

Mali has an excellent series of base maps for the country (TAM, n.d.) which can serve as the foundation for biodiversity and natural resource planning. The best biodiversity reference library is at the IUCN field station in Youvarou. USAID should fund a small grant to straighten out its Bamako library by natural resources and biodiversity and photocopy the IUCN field station material. Groups like the Office of Arid Land Studies (Tucson, Arizona) have helped other organizations with this kind of information organization. The Environmental Report on Mali (University of Arizona, 1980) has been a useful summary document. It deserves updating.

2) Government Organization

A careful summary of agencies, ministries, legislation and rules relating to natural resources management and biodiversity should be prepared for the Section 118/119 report. To encourage biodiversity much more inter-agency coordination will be necessary.

The government has not placed a high priority on any aspects of biodiversity, except perhaps drought-adapted cultivars (research for food security). Indirectly, the government has addressed biodiversity through its goal to restore the environment.

3) Education

Mali has the best environmental education program observed in West Africa. In the 5th region, WALIA magazine and the school follow-ups have already begun to influence thinking among villagers. This program should obviously be supported and expanded.

There is an active program of management training for agricultural extension agents that should be reviewed to insure the inclusion of a biodiversity component.

4) Culture and Religion

More thought should be given to the incorporation of cultural and religious aspects of Malian life into conservation efforts. Various muslim groups have already developed a tree-planting ethic which needs no further "cadeaux-ism" to maintain it.

C. Biodiversity in Senegal

1. Background

Prehistorically, Senegal contained the Sahelian Acacia deciduous bushland and wooded grassland, the undifferentiated Sudanian woodland, and the Guineo-Congolian

lowland rainforest/secondary woodland transition. However, these communities have been greatly modified and only pockets of the original vegetation types exist today. In addition, Senegal has the northern most mangroves with the largest stands at the mouth of the Casamance River. (Figure III.C and III.D)

Senegal also has a series of coastal communities that require special attention. The "niayes" are valleys between semi-stabilized dunes. These have been largely converted into gardens but the few intact niayes are unique communities. Similarly, the dune vegetation itself has been destroyed by overgrazing or replaced by exotics. Pockets of intact dune vegetation have not been mapped. Off the coast, a series of marine islands harbor large populations of pelagic nesting birds.

Senegal also has three major rivers (the Senegal, the SineSaloum and the Casamance) each with remnant closed and open gallery forest, sandbars, open water, sloughs and bolongs. The off-channel Lac Guiers is Senegal's major permanent lake. Within the grasslands, the "marigots" or temporary lakes and pools are important seasonal communities providing support for breeding African ducks, livestock and remaining wild ungulates. The wetland areas are particularly rich habitats.

2. Biodiversity Concerns

a. Protected Areas

1) Protected Areas: Coverage

Senegal has made the most thorough effort to establish national parks for most of its major biotic communities (Table III.E). They have substantially fulfilled their RAMSAR agreements to protect wetlands and migratory birds by establishing Djoudj, Ndial, Isles de Madeleine and Sine-Saloum NP. Niokolo Koba has many small habitats (bamboo forest, bowals, etc.) that are unique aspects of the Sudanian woodlands. The Basse Casamance NP is a unique groundwater fed extension of the Guineo-Congolian rainforest. (Figure III.D)

2) Protected Areas: Effectiveness

The effectiveness of protection varies widely. Niokolo Koba is almost a war zone with poachers pitted against park rangers in certain seasons. The Djoudj is well protected but suffers from water control works that are in poor condition. This has dramatically reduced nesting areas of some species. Sine Saloum National Park has a village within its small forest and has practically no remaining large wildlife. It has no park access to its wetlands or open water habitats. The Basse Casamance National Park is well protected but suffers from drought, isolation from areas that can replenish local extinctions, and smallness.

The classified forests and the faunal reserves have very limited controls according to park heads familiar with them. All Senegal biodiversity areas suffer from isolated habitat "islands" (see "Themes") with inadequate buffering. The connecting wildlife corridor between the Faleme Fauna Reserve, Parc de Badiar (Guinea) and Niokolo Koba NP has

FIGURE III.C

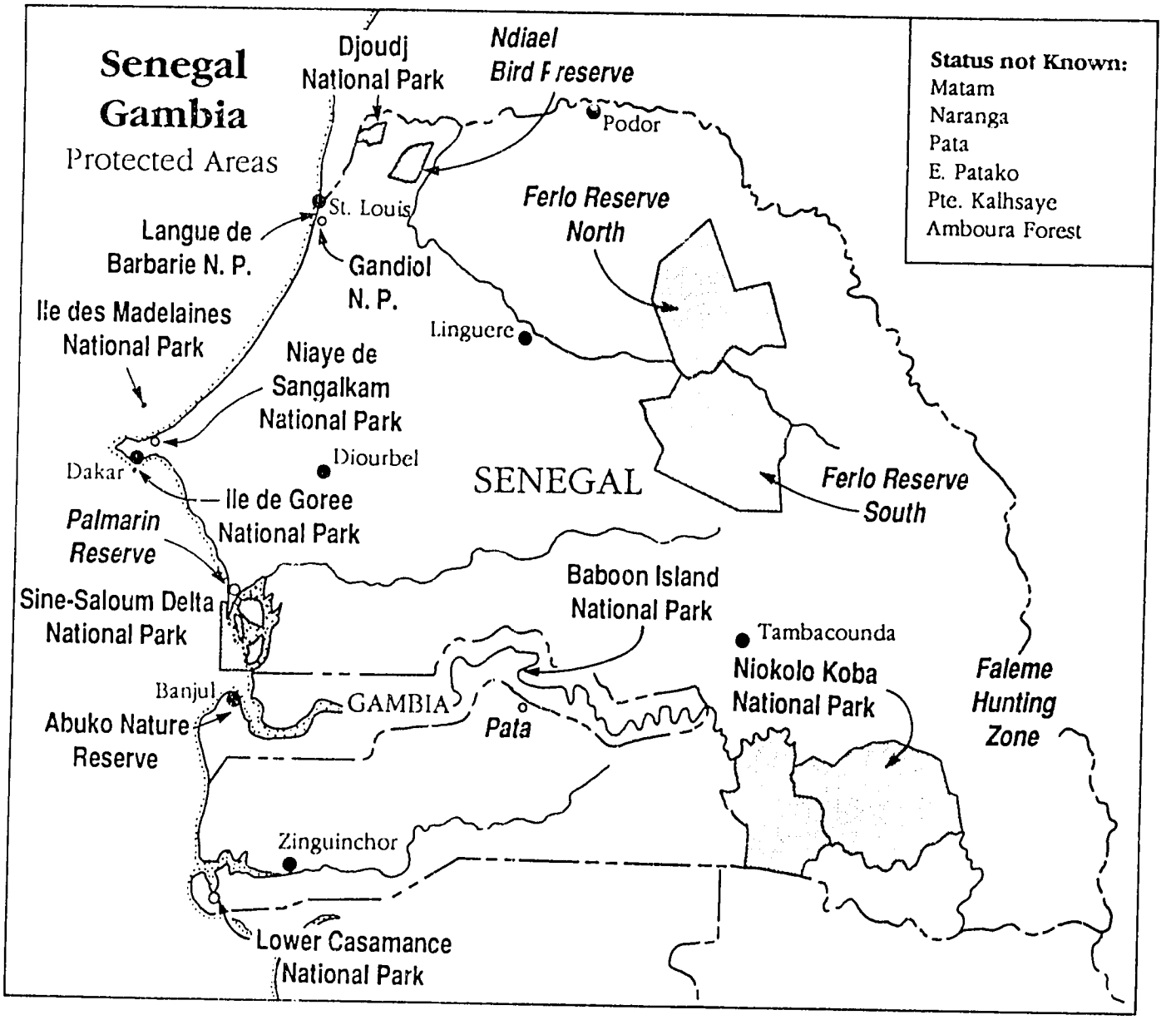

Senegal
Gambia
Protected Areas
Djoudj
National Park
Ndiael
Bird Reserve
Podor
Status not Known:
Matam
Naranga
Pata
E. Patako
Pte. Kalhsaye
Amboura Forest
St. Louis
Langue de
Barbarie N. P.
Gandiol
N. P.
Ferlo Reserve
North
Ile des Madelaines
National Park
Linguere
Niaye de
Sangalkam
National Park
Dakar
Diourbel
SENEGAL
Ferlo Reserve
South
Ile de Goree
National Park
Palmarin
Reserve
Baboon Island
National Park
Sine-Saloum Delta
National Park
Tambacounda
Niokolo Koba
National Park
Faleme
Hunting
Zone
Banjul
GAMBIA
Pata
Abuko Nature
Reserve
Zinguinchor
Lower Casamance
National Park

FIGURE III.D.

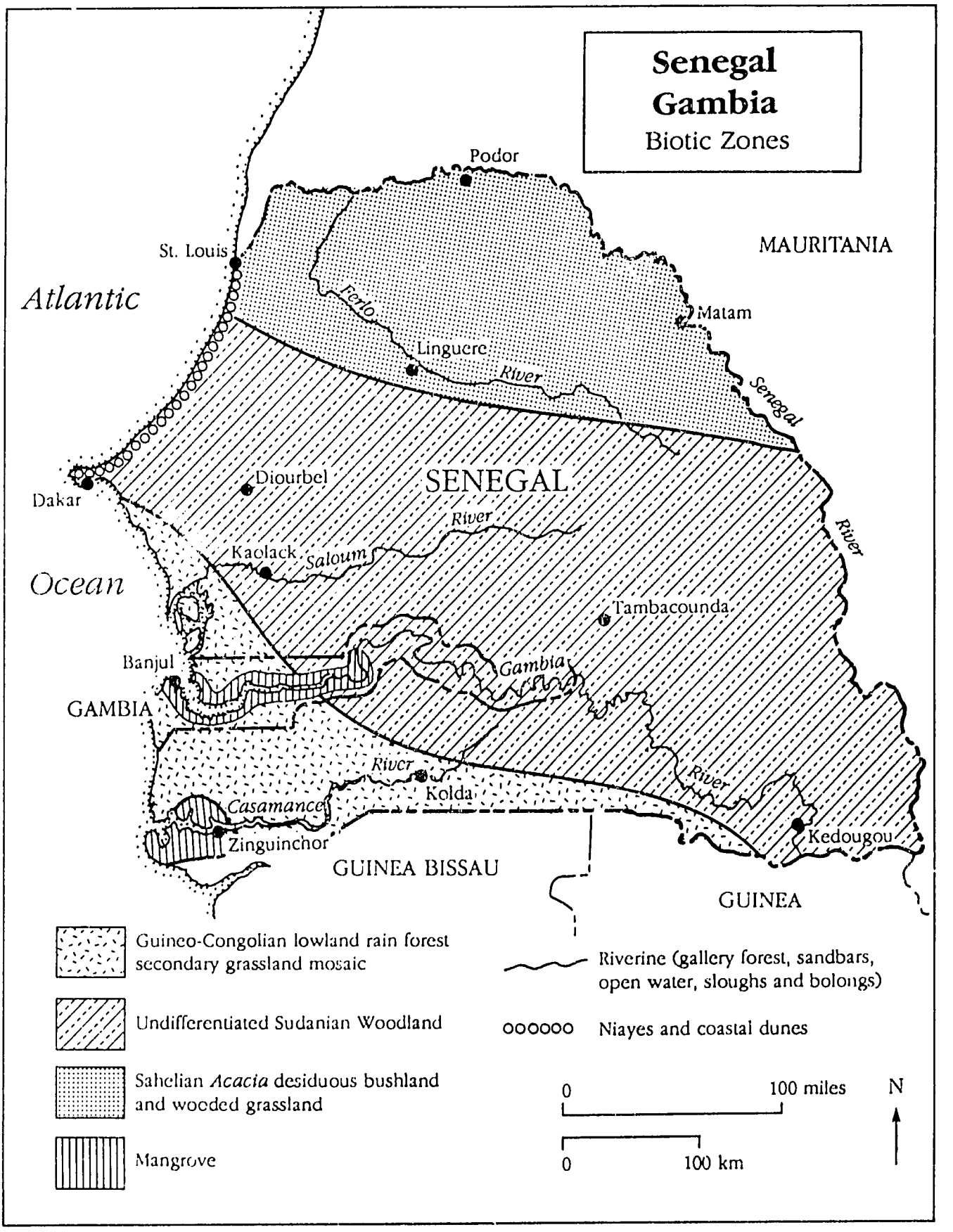

Senegal
Gambia
Biotic Zones
Podor
MAURITANIA
St. Louis
Atlantic
Ferlo
Matam
Linguere
River
Senegal
Dakar
Diourbel
SENEGAL
River
Kaolack
Saloum
River
Ocean
Tambacounda
Banjul
Gambia
GAMBIA
River
River
Kolda
Casamance
Zinguinchor
Kedougou
GUINEA BISSAU
GUINEA
Guineo-Congolian lowland rain forest secondary grassland mosaic
Undifferentiated Sudanian Woodland
Sahelian Acacia desiduous bushland and wooded grassland
Mangrove
Riverine (gallery forest, sandbars, open water, sloughs and bolongs)
oooooo Niayes and coastal dunes
0
100 miles
0
100 km
N

TABLE III.E

SENEGAL'S PROTECTED AREAS

Place		Ha X 100	Ecological Zone	IUCN Priority
Basse-Casamance	NP	50	Sud/Cong	"A"
Sine-Saloum Delta	NP	600	Sud/Cong; marine; coast	"B"
Djoudj N.P.		120	wetland	"B"
Langue de Barbarie	NP	20	coastal	
Isles de Madeleine	NP	4.5	marine	
Niokolo-Koba	NP	9000	Cong/Sud	
Gambel	NP	?	Sud	
Areas With No Administrative Protection in Place:				
Naranga FC		208		
Pata FC		730		
E. Patako FC		16		
Faleme Hunting Zone		1,303,4		
N. Ferlo Fauna Reserve		4870		B
S. Ferlo Fauna Reserve		6630		
Amboura Forest Reserve		25.5		
Ndial Bird Preserve		465.5		B
Palo Marin Bird/Turtle		?		
Pte de Kallisaye		2		Proposed
Niaye de Sangalkam		0.15		Proposed
Matam		?		"B" Proposed

highest priority because of the mutual re-supply of major mammals between these areas. Niokolo Koba has the greatest need for a park plan that incorporates surrounding communities and resolves the conflicts that are the ultimate cause of poaching.

3) Needs Outside Protected Areas

The marigots and the Ferlo area, the riparian gallery forests along the lowland reaches of the Senegal, the niayes (one small park proposed) and a few remaining offshore islands between Gambia and Guinea-Bisseau deserve review and classification within the park system. The Faleme and Ferlo Fauna Reserves need to be integrated into a larger understanding of the biogeography of biodiversity in Senegal.

The Feleme Region lies approximately 100 km to the east of Niokolo Koba National Park. It still contains herds of buffalo, roan and kob antelope, bubale hartebeest, waterbuck and Derby eland. Under the administration of the Senegal Forestry and Wildlife Service, this is the only big game hunting area open in Senegal. The migration routes (if there are any) and the pattern of interchange with Niokolo Koba are not known. The Faleme Faunal Area is the source of the Derby eland and other ungulates in the border area of Guinea. There are plans for mining, the construction of a new road, and increased human habitation within the Faleme Area. There appear to be no Senegalese plans for protecting these large mammals. IUCN did not appear to be involved.

A need for international coordination also exists. The large mammals of Niokolo Koba enter Guinea and vice versa. Senegal has done well in its RAMSAR responsibilities but the constellation of wetland habitats that support waterbirds includes areas within Mauritania. Little is known about the intra-African migrants which nest in other nations or the sea turtles and humpbacked dolphin (the Sousu) who probably migrate into international waters and coastlines.

b. Biodiversity and Animal Resources

1) Pest Management

Senegal's overlap of pest management and biodiversity includes:

- Small mammals, especially rodents and crops;
- Waterbirds, especially around the Senegal River delta;
- Granivorous birds (quelea, parrakeets, weavers, yellow canaries, etc.);
- Disease insects (malaria mosquitos and Simulid flies); and
- Disease molluscs (schistomiasis snails).

Senegal has not experienced major depredations of crops by waterbirds, although localized losses are always reported. The Djoudj National Park is, in part, responsible for minimizing depredation because it draws waterbirds away from cultivated lands. In this sense, Djoudj should be considered a cost-effective tool in pest management which saves

crops and increases cash income. The farmers around the Senegal River lowlands have adapted to waterbird movement patterns by planting when Eurasian migrants and African waterbirds are breeding or have migrated away from fields. The damming of the Senegal and the possibility of counter-seasonal plantings will increase the crop raids by waterbirds. Large harvest losses can be anticipated.

Senegal exports millions of long-tailed parakeets and other granivorous birds that are pest species to farmers. This pest management control should be encouraged to the extent that it targets only the pest birds, treats them humanely, and keeps them alive for Western pet stores. To the extent that rare or useful birds have been trapped and sold, such trade works against the maintenance of biodiversity.

Other problems with pest species of mammals and disease invertebrates are typical of West Africa and have been discussed in the "Themes" section.

2) Non-consumptive Uses

Senegal has a well-developed tourist industry in which wildlife plays a significant role. Essentially, the St. Louis area with the Djoudj NP attracts many birdwatchers and photographers as does the Tambacounda area with Niokolo Koba NP and Basari ceremonies. The Basse Casamance NP and the Cap Skiring beaches are the major locations of wildlife tourism.

Because Senegalese Parks are woodlands, major tourism concentrates around blinds. Only in Niokolo Koba NP does driving to observe elephants, lions, buffalo or, if very lucky, chimpanzees duplicate East African style touring. Niokolo Koba also has giant eland, monkeys, hippos, kob, waterbuck, bushbuck, etc. It is the only park where mammal-watching is a major priority. As such, Niokolo Koba requires special attention.

The drought has depressed the birdwatching industry at Djoudj. This can be partially recovered through repair of the waterworks system.

3) Consumptive Uses

Animal consumption affects biodiversity if the species is over-exploited. In Senegal, subsistence bushmeat, commercial bushmeat, trophy hunting, animal parts for medicinal and cultural practices, and pest control hunting all occur. Virtually all mammals except galagos, chimpanzees and hyena are eaten. Warthogs and other primates are avoided by Muslims, but are preferred by the Basari and Kognagui. Bushmeat hunting is limited only by law enforcement and scarcity.

Commercial hunting for bushmeat was widely reported. It included the sale of large antelope meat at high prices in Tambacounda and the sale of manatee meat along the Senegal River. Poaching for skins and ivory is rampant in Niokolo Koba NP. As elephants decline, the poaching of hippos for ivory has increased.

Senegal has strict laws in place to control the taking of wildlife and, considering the difficulties, has done a reasonable job in applying the laws. For instance, hunting within a national park requires a mandatory jail sentence of one to six months with a maximum penalty of 240.00 CFA and a five year jail sentence. However, many poachers and one guard have been killed in and around Niokolo Koba with no relief on hunting pressure within the park. Senegal animal resources have suffered from the influx of automatic weapons from the Guinean revolution. The conflict between the Basari and Niokolo Koba NP personnel exacerbates the poaching problems.

Senegal also has a profitable sports hunting industry that sold 2,425 permits and garnered $113,000 US in 1983. There are four hunting reserves. Two for small game (warthog, guinea fowl) and two for large game (Faleme and Kayanga). The Faleme area is open at the moment. Game management and populations could not be determined. The Kayanga Reserve has been heavily poached and does not support a significant part of the sports industry. Niokolo Koba probably replenishes both of these reserves with large mammals. The lack of administration and planning for the Faleme Fauna Reserve has allowed increased illegal takes.

Commercial bushmeat poaching and illegal subsistence hunting are not distinguished in Senegalese laws. Making a distinction between permits for traditional hunting and commercial bushmeat hunting might help resolve some of the conflict between Senegalese hunters and their government.

Conflict resolution through written limited access and use agreements between local villagers and the national parks would help ease tensions. Anti-poaching groups that receive some benefits from the park (excess guinea fowl) and less intrusion by park rangers into the private lives of villagers will also help reduce tension. The food-for-information program in which villagers spy on poachers has worked but, ultimately, needs to be replaced by a more viable resolution. Increased aid to the anti-poaching teams, especially radios and vehicles, would be advantageous. Other initiatives to integrate the buffer zone into the park can be found in IV.3.

4) Endangered, Rare and Threatened Species

The threatened and endangered species of Senegal are listed in Table III.F. These species are all fully protected under Senegalese law, except for the lion which can be hunted with special permit from the President. Effective protection within national parks would improve the chances for survival of most of the endangered species of Senegal except the manatee, cheetah, wild hunting dog, giant Derby eland, ostrich, sitatunga, marine turtles and Sousu dolphin. For differing reasons, these species need special attention. Attempts to re-introduce the giraffe and korrigum hartebeest have failed so far. The giraffes were susceptible to trypanosomes.

The last of the Matam (Senegal River) elephants was killed in 1984. The only remaining population is in Niokolo Koba National Park. This population of approximately fifty animals is continually harassed, and any elephant reaching the age at which it grows

TABLE III.F

ANIMALS OF CONCERN IN SENEGAL

Extinct

Giraffe
Korrigum hartebeest

Endangered/Threatened (Red Book)

Chimapanzee
African wild dog
Giant (Derby's) eland
Manatee
White-collared mangabey
Pangolin (scaley anteater)
Sousu (Humpbacked dolphin)
Cheetah
Leopard

African dwarf crocodile
African slender-snouted crocodile
Green sea turtle
Hawksbill sea turtle (Carey)
Kemp's (Atlantic) Ridley
Leatherback sea turtle
Loggerhead sea turtle

Vulnerable (locally endangered) or rare

West African elephant
Western Red Colobus monkey
Black-and-white Colobus monkey
Cape Clawless otter
Aardvark
Pangolins
Red River hog
Ostrich
Nile crocodile
Slender-snouted crocodile
Dwarf crocodile

tusks is eventually poached. The population is therefore underage and has difficulty reproducing. It has lost whatever continuity is provided by inter-generational knowledge (usually migration routes and feeding areas).

c. Education, Government and Religion

1) Biodiversity Data Base

Senegal does not have a large scale and detailed map for vegetation types and soils equivalent to Mali's. OMVS has excellent and exhaustive studies on the Senegal River Basin which can provide much material on biodiversity. In addition, the IFAN library is in Dakar. The USAID library, though small, was extremely well arranged and provided easy reference.

There is a large quantity of material available through ORSTOM but access appeared difficult in Senegal. There is a need to increase access to French and IUCN materials and update the Environmental Report on Senegal prepared by the Office of Arid Lands (University of Arizona). Information on fisheries, cetaceans, and marine turtles needs special attention.

2) Government Organization

The only review of Senegalese government organization and natural resources can be found in the World Bank Report (Gorge, et. al. 1987). Table III.G lists some of the agencies and organizations involved. Their central point was that natural resource management (including biodiversity) has been "pigeon-holed." Agencies which believe food self-sufficiency by agricultural development of cash crops and large-scale farming takes complete precedence over other national goals have relegated natural resources to other departments. Thus, where major land use decisions are being made, the right kind of input is absent.

OMVS has also given biodiversity aspects (the artificial estuary and repair of Djoudj waterworks) a low priority. On the other hand, the government has funded national parks without regard to their money-making abilities, indicating a major commitment to biodiversity maintenance. It has also funded some re-introduction attempts. There is a general need for park management planning and conflict resolution expertise which would probably be welcomed by MPN. Similarly, Eaux et Forets would welcome help increasing tree species diversity in its nurseries.

3) Education

The environmental education sector within Senegal is undeveloped. There were, in Basse Casamance and near Niokolo Koba, groups called "Les Amis de Nature." They had no newspaper equivalent to WALIA in Mali or to East African magazines. There was no donor focussed on coordinating Les Amis or providing additional educational aids. The African Wildlife Foundation (the NGO that started wildlife clubs and magazines in East

TABLE III.G

MAJOR MINISTRIES INVOLVED IN BIODIVERSITY

Ministry of Rural Development (MDR)
- Agricultural Department

Ministry for the Protection of Nature (MPN)
- Intersectoral Group of Nature Protection and the Environment
- Forestry and Hunting (DEFC)
- Soil Conservation and Reforestation (DCSR)
- National parks (DPN)

Ministry of Industrial Development and Energy
- National Energy Commission

State Secretariat for Animal Resources
- Interim Subcommittee Council on Pastoral Water Supplies policy
- Commission on Pastoral Code
- Ad-hoc Interim Council on Livestock Matters
- Ad-hoc Interim Committee on Fresh and Marine Fisheries

Senegal River Basin Organization (OMVS)

Gambia River Basin Organization(OMVG)

Water and Forest

LOCAL ORGANIZATIONS INVOLVED IN BIODIVERSITY

Producers Union (Groupe Des Jeunnes)

GIE (Groupe de Interet Economique)

Brush Fire Control Committees

Borehole Management Committees

Gum Arabic Management Groups

Rural Community Woodstock Production

Africa) had no presence in West Africa. The national parks visited had almost no educational materials. Djoudj had the beginnings of a nature museum. There were no maps available of the park with information of ecology or geology. The maps at Niokolo Koba were incorrect. Senegalese nationals are required to pay "tourist rates" to visit their own parks. Education has been left to local park managers who try to encourage visits from nearby towns and cities. Most of the parks did not have a library of scientific reports written by ex-patriot scientists and few had field guides and/or binoculars to conduct their own field monitoring. Despite these handicaps, the park managers (especially at Djoudj and Basse Casamance) appeared extremely well-informed about ecology and wildlife management.

D. Biodiversity in the Gambia

1. Background

The Gambia is a small nation, smaller than Connecticut. It sits between the 13 and 14 degree north latitude on the lower 470 kilometers of the Gambia River. Its total area is 10,367 square km with 70 km of Atlantic coastline. The Gambia river is tidal throughout the nation. The river is saline up to about 70 km above Banjul. Before the drought, the 250 km point marked the end of saline influence. Mangroves extend 144 km inland. The wet season is five months (June to October) with peak rainfall in August. The closer to the coast, the more rainfall. Before the drought, rainfall varied from 900 to 1400 mm/year. It now averages about 60% of this amount.

According to White (1983), the upper half of the Gambia falls within the Sudanian regional center of endemism and the lower half within the Guinea-Congolia/Sudania transition zone. Strictly speaking, the Gambia is not part of the Sahel. The major feature of the Gambia is, of course, the Gambia river. It is associated with the river flats or banto faros, the gallery forests, and the mangroves (about 32% of the topography). Three topographic forms (the sandstone bluffs, the colluvial slopes and the plateau) abut the banto faros and river. This landscape supports the third major biotic community, the savanna woodlands and dry forest. (Figure III.C and D).

There is probably no acre of the Gambia without some human influence. The savanna/dry forest has been converted into "parkland" in which only trees useful to humans remain; into cattle-disturbed woodland; and into two story woodland in stages between burning and planting.

2. Biodiversity Concerns

a. Protected and Unprotected Areas and Effectiveness

The most intact and the most interesting remaining habitats in the Gambia include: the gallery forests along the middle stretch of the river; some of the islands within the river; some of the coastal communities; and the mangroves along the northwest corner of the

FIGURE III.C

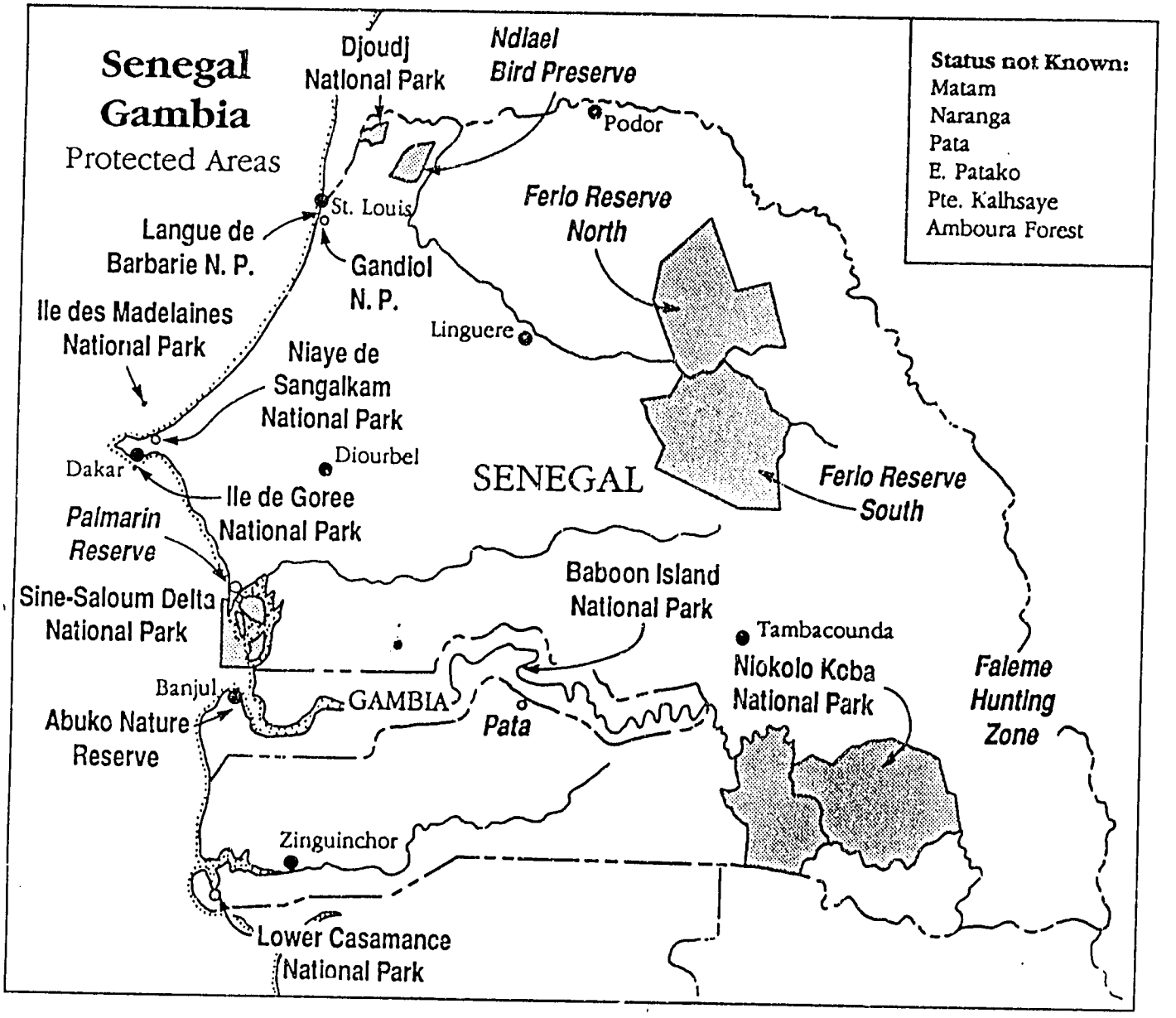
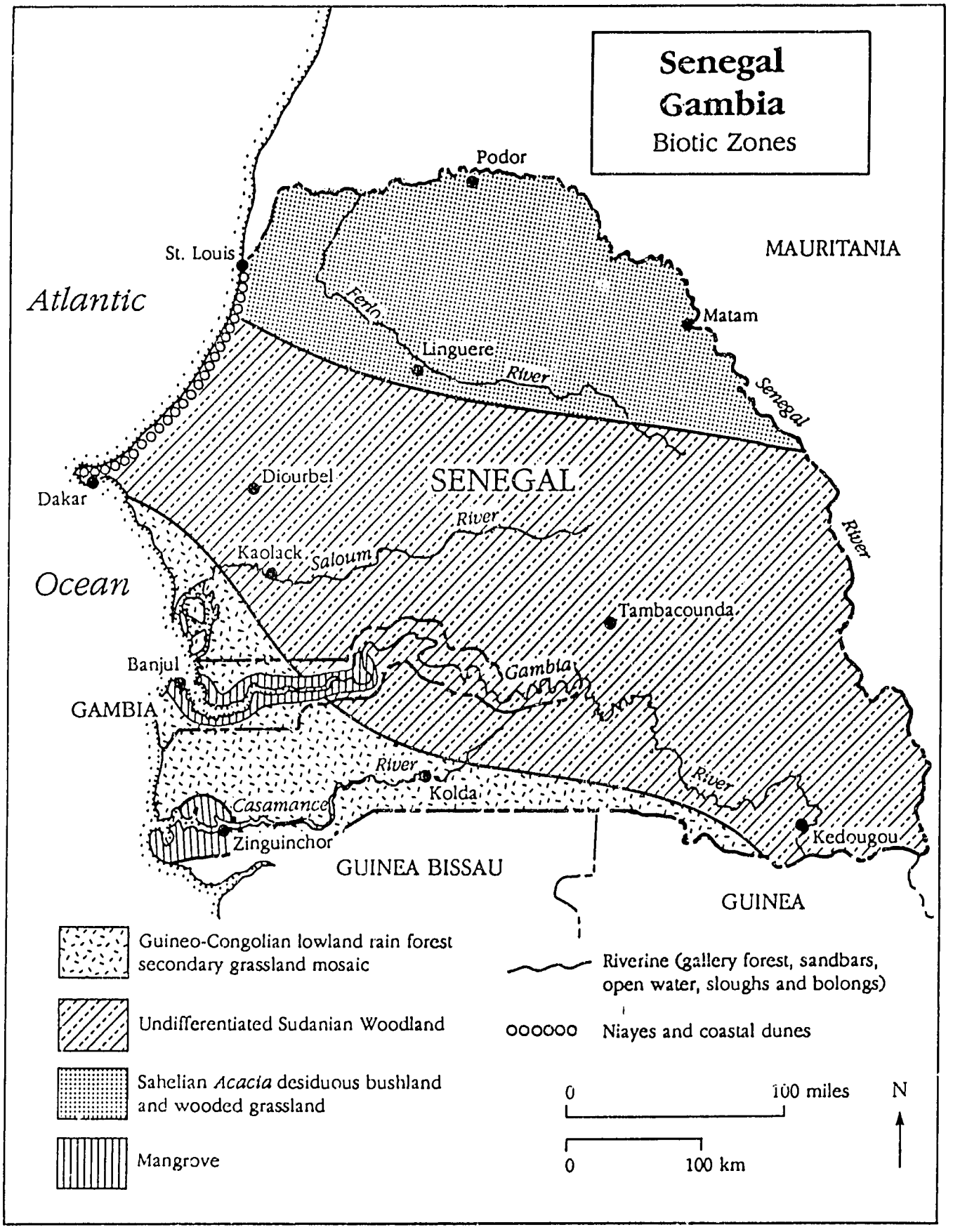

Senegal
Gambia
Protected Areas
Djoudj
National Park
Ndiael
Bird Preserve
Podor
Status not Known:
Matam
Naranga
Pata
E. Patako
Pte. Kalhsaye
Amboura Forest
St. Louis
Langue de
Barbarie N. P.
Gandiol
N. P.
Ferlo Reserve
North
Ile des Madelaines
National Park
Linguere
Niaye de
Sangalkam
National Park
Dakar
Diourbel
SENEGAL
Ferlo Reserve
South
Ile de Goree
National Park
Palmarin
Reserve
Baboon Island
National Park
Sine-Saloum Delta
National Park
Tambacounda
Niokolo Koba
National Park
Faleme
Hunting
Zone
Banjul
GAMBIA
Pata
Abuko Nature
Reserve
Zinguinchor
Lower Casamance
National Park

FIGURE III.D


Senegal
Gambia
Biotic Zones
Podor
St. Louis
MAURITANIA
Atlantic
Ferlo
Matam
Linguere
River
Senegal
Dakar
Diourbel
SENEGAL
River
Kaolack
Saloum
River
Ocean
Tambacounda
Banjul
Gambia
GAMBIA
River
River
Kolda
Casamance
Zinguinchor
Kedougou
GUINEA BISSAU
GUINEA
Guineo-Congolian lowland rain forest secondary grassland mosaic
Undifferentiated Sudanian Woodland
Sahelian Acacia desiduous bushland and wooded grassland
Mangrove
Riverine (gallery forest, sandbars, open water, sloughs and bolongs)
oooooo Niayes and coastal dunes
0
100 miles
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100 km
N

Gambia. The only preserve is the Gambia River National Park (Table III.H and Figure III.C and D). A small nature reserve (the Abuko Reserve) sits within a peri-urban matrix and serves as an excellent bird, snake and small mammal sanctuary. Large mammals are confined to cages.

Increased acreage for protected areas has been proposed for: Gambia River Park, McCarthy Island, Njassang and Kaolong Forest parks, Senegambia Park, Abuko urban park and Kiang West National Park.

With the degradation of Kiang West, there appears to be no woodland area within the Gambia available for a reserve. Only a strong restoration and reintroduction effort at Kiang and a strong desire by the government of the Gambia could make this a high priority. The status of other proposed parks is not known. In general, they would give protection within the Gambia to riverrine forest and mangrove forest. The OMVG report suggested a mile-wide protected strip for the remaining gallery forest along the river's edge. The NRMS team suggests minimally incorporating the bolongs and gallery forest around the existing national park. (See further details in IV.7 and under "River Basins").

One of the most interesting proposals is Eddie Brewer's plan for an orchard buffer zone to surround Abuko Reserve. This is an excellent initiative to improve the effectiveness of a biodiversity reserve without enlarging its boundaries. It would help to protect a reserve now encroached by urban development without enlarging its size.

The major threat to river and gallery habitats comes from the proposed dams, particularly the Balingho Dam. The topic is discussed under "River Basins".

b. Biodiversity and Animal Resources

The Gambia has lost almost all its large mammals. Elephants were last reported in 1913. Of the sixty-seven large mammals once recorded in the Gambia, ten are extinct. Four more are extinct or very endangered. The last wild chimpanzees were recorded in the 1930s. There is a group of introduced chimpanzees on Baboon Island. The Abuko Nature Preserve has lions in cages which are popular with the urban and tourist public. The status of the humpbacked dolphin and the West African manatee are unknown in the Gambia. The number of hippos left in the Gambia may be on the order of 50 animals that are protected, in theory, at the Gambia River National Park.

About 550 bird species have been recorded in the Gambia. 150 Palearctic migrants winter in the Gambia but there have been noticeable declines in species frequency with habitat destruction. The Gambia Ornithological Society is very active. No known endemic or endangered birds of worldwide concern live in the Gambia.

There are approximately ten species of toads and frogs; a half dozen freshwater turtles and tortoises; three crocodiles; more than 15 species of lizards and 30 species of snakes. None of the reptiles and amphibians are endemic to the Gambia. All the marine turtles are endangered but their nesting grounds in the Gambia are not recorded. The Nile

TABLE III.H

PROTECTED AREAS OF THE GAMBIA

Gambia River NP	
Abuko Nature Reserve	73 ha
McCarthy Island (Njassang & Kaolong Forest park)	5000+ ha Proposed
Kiang West NP	1800 ha Proposed
Senegambia NP	Proposed
Suggested by NRMS:	
Gallery Forest Extension at Gambia River Park	
Forest parks:	
12 rhum palm forests	618 ha
14 timber forests	4104 ha
6 bamboo	7068 ha
34 "protected"	22,239 ha

crocodile is also threatened by hunting. The snake populations are disappearing into the skin trade.

Given habitat destruction and human settlement patterns, there is probably no way to reintroduce the extinct large mammals of the Gambia (Table III.I) Kiang West was the major hope for re-introductions. Major efforts should be made to maintain existing mammals such as the hippo herd.

In the Gambia, no mammal species is authorized for sport hunting. Warthogs, the Gambian rat and household rodents are considered vermin and can be killed. A small commercial operation in warthog meat exists in the Basse. Trafficking in wild animal occasionally killed. Manatees are poached. Hippos are usually shot as pest control. products is completely prohibited. Only small amounts of illegal ivory and skins can be purchased according to the University of Michigan study (1985b). Manatees and hippos are

Wildlife tourist opportunities are very limited in the Gambia. Roadside viewing of monkeys, Abuko Reserve, and boat trips to see hippos and monkeys provide the greatest opportunities. Birdwatching is the major non-consumptive use of wildlife and generates the largest income derived from biodiversity tourism.

c. Plant Resources and Biodiversity

The NRMS team was not aware of any listing of rare, endemic or threatened species of plants. A list should be compiled.

The SCF project in Lamin which has introduced a new form of short season swamp rice was one of the best extension services seen by the team. This kind of work should be encouraged and connected to MIRCEN and a botanical research station in Senegal (see "Themes").

The problem of water hyacinth encroachment up the river has been mentioned. No details were available.

There is a massive die-off of mangroves. This may result from the drought or a combination of the drought plus other physical factors. The consequences could be severe in terms of detritus for the fisheries and increased sedimentation (the mangrove roots hold the soil). The die-off raises the priority for the Senegambia Park which includes mangrove swamps.

d. Education, Government and Religion

The NRMS Team did not have time to meet with any government ministry officials except the head of the Wildlife Conservation Department. Laws protecting natural resources can be found in the Office of Arid Lands Environmental Report (1980). The Section 118/119 report should carefully review laws relating to forest parks and suggest better methods of rotational cutting and multi-species plantings and biodiversity maintenance.

TABLE III.I

GAMBIAN ANIMALS OF CONCERN

Extinct

Bubal hartebeest
African buffalo
Buffon's kob
Chimpanzee (re-introduced)
Elephant
Waterbuck
korrigum hartebeest
Roan antelope
Giant eland
Giraffe
Wild dog
Tiang
Lion

Probably extinct

Pied Colobus
Yellow-backed duiker

Species of Concern in the Gambia

West African manatee
Sousu (humpbacked dolphin)
Hippopotamus
Oribi
Leopard
Serval
Caracal
African wild cat
Nile crocodile
Pygmy crocodile
Slender-snouted crocodile
Rock python
All species of marine turtle

The most influential organization involved with biodiversity is the OMVG. USAID is helping fund studies for OMVG's future plans. These studies have been extremely worthwhile for data collection and for analysis of alternatives.

There are no wildlife clubs in the Gambia. Environmental education centers around Abuko which is the best West African outdoor education program near an urban center. There is no wildlife magazine. The school curricula were not reviewed. IUCN was becoming involved in environmental education but details are not known.

III. APPENDIX

FIGURE III.E

NIGER BIOTIC ZONES

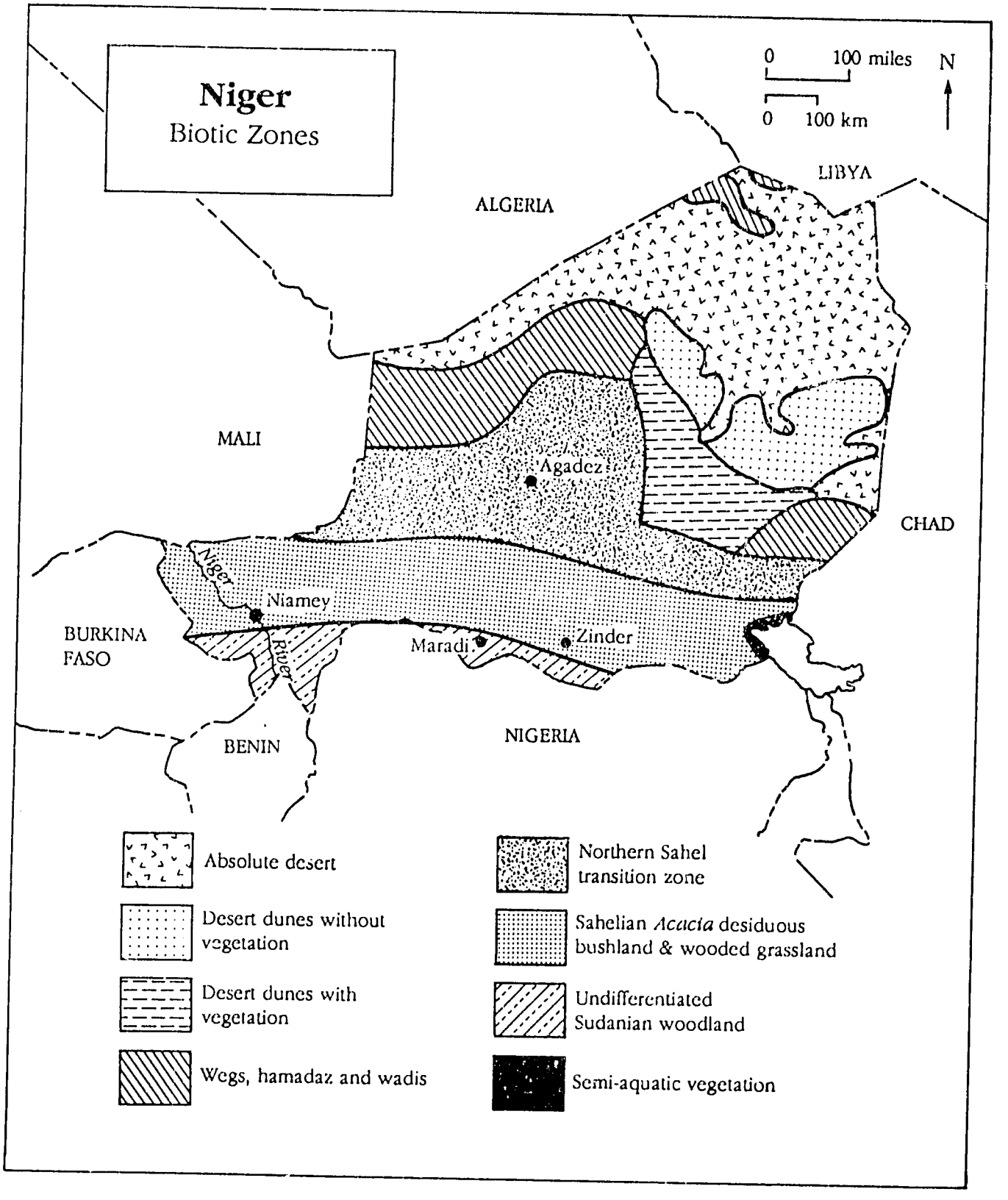
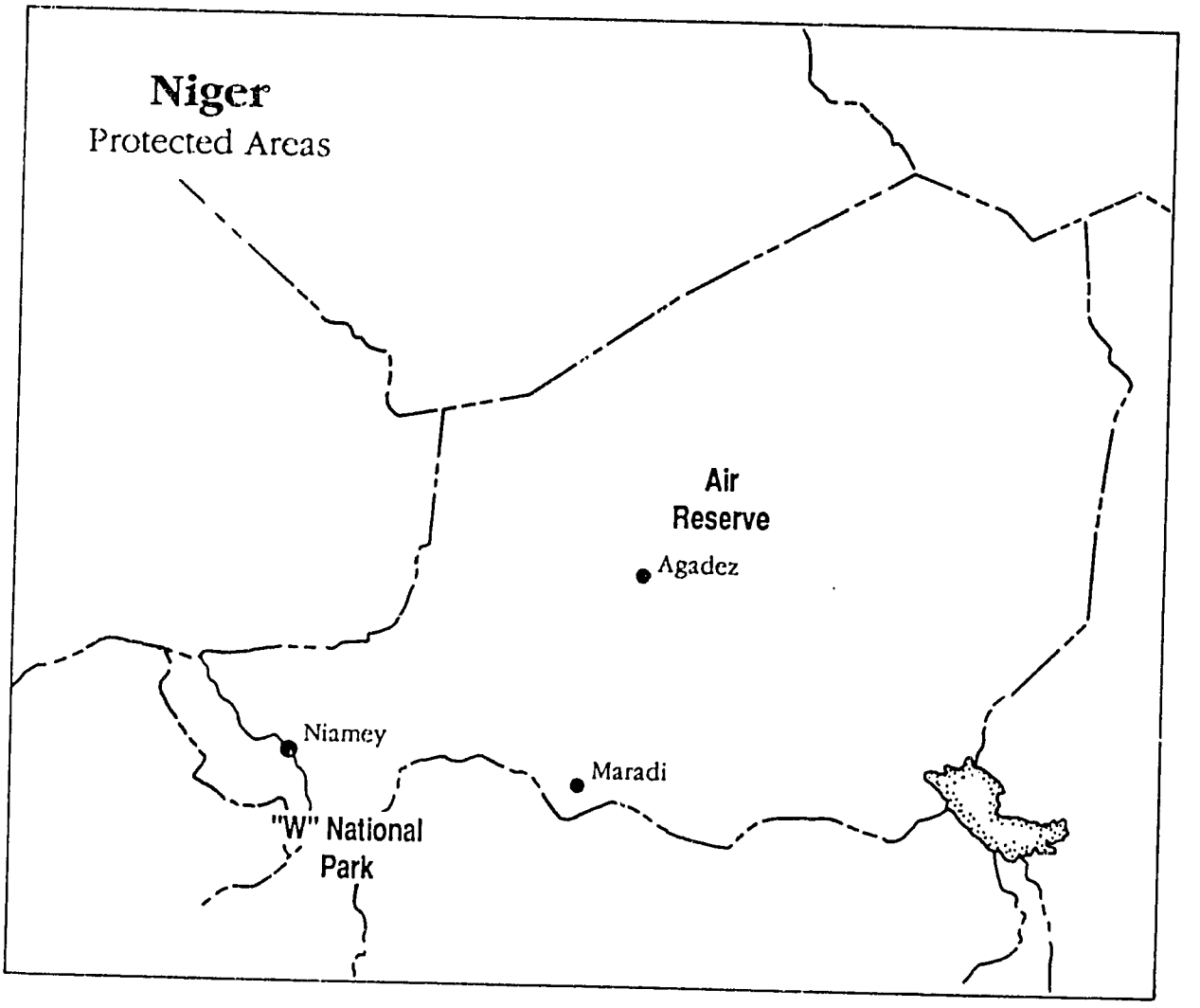


FIGURE III.F

NIGER PROTECTED AREAS



IV. BIODIVERSITY INTERVENTIONS

The following eight "vignettes" summarize fieldwork done by the NRMS team in 1987 and 1988. They each follow the identical format of background, description of the project or initiative, and a discussion of observations and conversations. The vignettes in this chapter center on biodiversity. Volume II "Case Descriptions" contains other projects in which biodiversity was a component but not a major theme (e.g. agroforestry).

A. WALIA

BASIC INFORMATION

Nature of the Initiative

IUCN's goals include natural resources management (reconciling short-term gains with long-term sustenance) as well as harmonizing rural development with conservation concerns. Walia is a magazine for school children that teaches local geography, ecology, wildlife, traditional stories concerning wildlife, environmental awareness and concerns. The Walia group follows up each issue by visiting the school in which it is used and giving a special class to the students.

Natural Resources Involved

Human energy and how it is used, can be conserved and better applied and integrated to land, water, plants, and animals.

Location

The headquarters of Walia is in Mopti. The distribution and education program occurs throughout the 5th Region. The region is 78,000 sq km.

Major Characteristics of the Place

The 5th Region is the region of Mali including the inner delta of the Niger and the dry lands surrounding the delta. The inner delta has the most complex of all human ecologies in Mali because of the seasonal floods of the Niger River. Over nine ethnic or language groups occur in the area. At least six different labor strategies can be broadly defined; agro-pastoralists; agro-fishermen; transhumant herders; transhumant fisherman; wage laborers; semi-sedentary agro-forest-traders. Many groups supplement these labors with wild food collecting, hunting. The people of the 5th region grow rice, millet, fish and livestock (cattle, sheep, donkeys and goats). In general, large wildlife has disappeared from

over-exploitation, open access rules or unenforceable limited access rules. The agroforestry, fish and wildlife situation has been greatly damaged by the drought.

People present:
NRMS team: Peter Warshall
Monique Trudet, IUCN Coordinator

DESCRIPTION OF THE INITIATIVE

Walia is published three times a year. Monique Trudet and an assistant/translator travel to 25 schools in the 5th region. They visit each twice a year. About 4,000 students receive the magazine and experience the visits. Because of distances, it takes three months to cover all 25 schools. Monique spends two days at each school. But, this underestimates greatly the circulation of Walia. It goes to many lycee libraries. It is used by bureaucrats and teachers outside the 25 school circuit. A conservative estimate of 10,000 readers throughout Mali and even other parts of West Africa more accurately reflects its influence.

The school children are predominantly between the seventh and ninth grade -- 14 to 20 years of age. The magazine is not part of the required curriculum which Monique felt was a better place for it. It meant that the magazine took on a life of its own outside the formal school system. Nevertheless, many teachers use it in their geography class.

Technical Measures

Walia is printed on a mimeograph which limits the number of copies that can be made. The artwork is done by local artists without pay. The distribution system is the most difficult part of the project as there is no regular mail service to many of the villages. IUCN provides one cranky vehicle for use.

Social Organization

The project is organized under an umbrella of IUCN projects connected to the inner delta. This "umbrella" has led to extensive communication between projects which appear to help enthusiasm and knowledge and the great interest of the publication. The project is under the direction of INEF and DREF -- Direction Nationale et Regionale des Eaux et Forets. CECI (Centre canadien d'Etudes et de Cooperation Internationale, Mopti) supplies volunteers. CARE-MALI, an agroforestry project in Koro, also helps fund publication. The Ministry of Education is not involved. It is solely a regional project.

Socio-Economic Data

IUCN spends $40,000 per year to support Walia. Other contributions are not known. This includes running the office, vehicles, publication and trips to the schools. The funding

is hopefully in five-year increments which gives the project some stability. Long-term education cannot be calculated in economic terms. But, the difficulty of cost/benefit analysis should not be used to minimize the long-term effect on natural resources within a country.

DISCUSSION OF THE INITIATIVE

The program of magazine and school visits was the most successful project seen by this consultant in the Sahel. By standards such as inter-generational exchange of information; feedback from students and teachers; increased demand for materials; integration into the school curricula; initiation of environmentally based school projects and increased sensitivity to local natural resource concerns, Walia has been very effective.

B. IUCN IN THE NIGER DELTA: BOUNA PROJECT (MALI)

BASIC INFORMATION

Nature of the Initiative

The overall goals is to improve natural resource management. The specific goal is conflict resolution of overlapping "common" property rules by reciprocal access agreements and the formation of management committees composed of all local interest-groups. These groups will manage the common property and are dedicated to the regeneration and conservation of each specific areas' local natural resource. The conflict resolved in the site visited, Bouna, was the result of overlapping uses of an Acacia kirkii forest by fisherman, wood harvesters, herdsmen, and nesting water birds. The goal is regeneration of the forests, protection of the waterbird nesting grounds and creation of viable natural resource management organizations.

Natural Resources Affected

The immediate natural resources of concern are Acacia trees, fish and biodiversity (herons, egrets, comorants). The human uses are young birds which are eaten; fish; cattle egrets which are a major form of locus control in the millet fields; dry season forage for herders and branches for thorn enclosures.

Number of Hectares Affected

The hectares are not known. The project is designed around a series of seven heronries. The most accomplished, in terms of reciprocal access agreements, is at Bouna.

Location and Region

The seven herories are within the inner Niger Delta. The forest of Timisobo at Bouna is a flooded woodland in Kona arrondissement. It is easy access by boat from Youvarou. It is within the Cercle de Mopti. The heronries are within the 5th region, Mali.

Characteristics of the Place

The heronry is a seasonally-flooded woodland. The major tree is Acacia kirkii. The forest is young (less than 15 years) but is growing well. Surrounding the grove is a flooded area with Mimosa priga (a drought invader), Echinochloa stagina ("bourgu"), Polygynum, two species of water lilies (Nenuphars), Vetaria nigriciana, Vossia, Oryza longistrama and

Aeschynomenes crassicaulis. Seasonally, the woodland community dries out and allows access to goats who use the trees for forage. While in flood, some branches are cut for fish barriers. In dry season, branches are cut for thorn enclosures.

The flooded woodland provides protection for nesting birds from predators (who are now scarce). The birds include cattle egrets (26,700), long-tailed shag (595), great white egrets (190), black heron (90), squacco herons (200), little egrets (380); grey herons, and yellow-billed egrets (70). Other birds (ibis) use trees for resting. In turn, the guano from the nesting birds falls into the water, increases algal growth and fish populations. The numbers of birds vary greatly each year depending on floods and fish production.

Traditional Land Use Practices

As stated, for five or six months of the dry season the goat herders use the Acacia for forage and thorn enclosures. In the wet season, fishermen use the branches for fish barriers and eat the nestlings. Fishermen (predominantly Bozo) traditionally used the wood for firewood and house construction. The fishermen fully understand the relation of guano, algal production and fish production. Older people associate the presence of large numbers of birds with large quantities of fish and think of the birds as a sign of prosperity. In the wet season, fishing was traditionally common near the woodlands. Traditional use rights are well defined and even respected by both fishermen and herders. Dioros (traditional land "owners" and managers) are still influential -- though their authority has been clouded by more recent events (see below). There are three dioros from three villages involved in the Bouna forest. Traditionally, the dioros herded only cattle and did not have much concern over the state of the forest which did not influence cattle grazing. Their concern for the forest focussed on revenue obtained from seasonal goat herders.

Present:

NRMS Team: Peter Warshall
Accompanied by: Richard Moorehead, IUCN; Mousa Kaute, Arisike Coulibaly and Kasoum Konta.

DESCRIPTION OF THE INITIATIVES

Two-thirds of the colonies of waterbirds in the inner Niger delta have disappeared because of recent changes in the ecology of the river, rainfall and the economy of the surrounding peoples. Of twenty sites, seven still had bird colonies; six were no longer in use because the drought had prevented flooding and seven had been destroyed by forest cutting. The loss of nesting sites reduced access to waterbird feeding grounds by about 2,000 km2 since birds cannot travel more than 35 km c. ly.

With the drought, the fishermen of Bouna want the forest completely protected. They have stopped cutting wood. But, they realize that it is also necessary to limit the goat herders. Goat herding is replacing cattle and "outsiders" from the north are requesting or

taking access to browse in January. Some have permits from Eaux et Forets in Konna that they feel supercede any requirement or limitation in cutting branches that the dioros might require. This situation resulted in conflicts with Eaux et Forets as well as the herders. In short, rules that prevented over-use or abuse of these forests have become clouded by rapid historical changes. These are: the rights of founding lineages; the Fulani Dina sets of administrative rules; the French colonial changes to Dina rules; and post-independence nationalization of natural resources. The traditional resource controls have been effectively undermined by a more distant "technical/administrative" control. The Bouna project has begun the integration of transhumant herders with the management of the forests -- a difficult problem within the Sahel.

In 1985, the project started with discussions in the three villages that each held claim to the woodland as well as a habitat survey of the remaining forests. This was, in part, an educational campaign to increase concern for and awareness of forest degradation and the importance of maintaining forest regeneration. By April 1986, an oral agreement had been reached with the herders and Eaux et Forets that gave the village more control over the woodland and reduced the cutting of wood. These oral agreements need to be signed by the Cantonnement Forestier and the Cercle de Mopti to become official agreements. IUCN staff, in part, try to coordinate, encourage and deliver the various documents to all the participants to formalize the agreement.

The conflict resolution (called the "Bouna Agreement") includes: (1) establishing rights of forest ownership to traditional villages; (2) placing the power of local management into the hands of the dioros and chef du village as these are the traditional managers; (3) formalizing fishing rights that already exist; (4) prohibiting cutting of trees for enclosures or browse; (5) restricting entry of herds; (6) forbidding harvesting of nestlings for two years; and (8) obtaining backing for the agreement from the various administrative entities of the Malian government.

The incentives include avoiding forestry permits and fines; increased fish outtake from increased guano; protected cattle egret nesting as a form of locust control; increased browse that can be utilized without cutting lower branches, and clarity about common property payments for browse use. The enclosures are part of a project to promote living-fences or the use of Mimosa priga.

The "players" in this agreement are the dioros from three villages, Ministry of Natural Resources, gendarmarie, Eaux et Forets and Malian administrative framework. Agreement is needed by all these parties as well as local fishermen and herders. At the moment, the situation has Eaux et Forets playing a punitive and alienating role. There are fines for cutting trees or making enclosures without a permit. Twenty-five percent of the fine goes to the field agent and 75% to the National Forestry Fund. If a tree is cut, everyone in the village is responsible for the fine, even if innocent or ignorant of the culprit. The fines are set at capricious levels. There are no internal controls among goat herders.

The agreement of the Malian government is important because the agreement gives control of the natural resources back to the local and traditional managers (dioros). This is contrary to the nationalization of natural resources practiced by the government. It is

also contrary to the trend in Mali of allowing open access to all natural resources which has led to the privatization of the "commons" and the further marginalization of the poor. It has also meant that income gained by a resource (especially fish) was in the hands of outsiders who did not reinvest within the community. While Eaux et Forets and the Mali government remain the ultimate power in natural resource management, the Bouna agreement returns some part of natural resource control to local and traditional users. Local control of a natural resource can be more effective because of the continuous presence of the controllers, their greater ability to monitor conditions, and "internal" vs. external methods of policing. There is no doubt that getting out from under the Eaux et Forets fines is one incentive spurring the Bouna agreement to completion.

The Malian government has also signed the RAMSAR agreement to protect wetlands. The establishment of the seven nesting sites will be a big step towards fulfilling this agreement. RAMSAR is administrated in Mali through Eaux et Forets, Division Pour La Faune. The Bouna agreement, in effect, can become part of the RAMSAR agreement.

Jamie Stevens (who was unfortunately not present at the time of the visit) and Richard Moorehead have been the coordinators of the waterbird conservation and natural resource management agreements. The interventions used include: (1) information networking to all interest- groups: (2) conflict resolution in areas of disagreement; (3) natural resource surveys to determine status of flooded woodlands. In addition, a local singer has made a cassette that is sold in Mopti that sings praise to the forests and their need to protection.

The cost of this project was not available because of Mr. Stevens absence. The project is part of the umbrella of inner Niger delta projects funded by WWF and BMZ/IUCN is the implementor of the project. The overall funding has been $712,000 U.S. from BMZ spread over four annual payments. WWF has contributed $85,700 with a supplement of Sfr. 105,00 in 1987. This covers many more projects than the henronry project.

The "cost/benefit" of preserving waterbird nesting grounds is probably unquantifiable in any case. The benefits in natural resource management are long-term (increased fish size and production, locust control, reduced overgrazing) and could not be estimated without Mr. Steven's help. Perhaps the greatest achievement -- a social organization that has synthesized and formalized many levels of clouded rules -- is equally difficult to quantify economically.

DISCUSSION OF THE INITIATIVE

This project is unique in its intimacy with the socio-political framework in which natural resource management occurs. In general, we can note that:

- This initiative is non-technological. It attempts to resolve the conflicts between overlapping layers of rules, the humans that enforce these

rules and, as part of the conflict resolution process, incorporate rules to protect biodiversity (i.e., fish and waterbirds).

- Accelerated, accurate diffusion of information to all concerned parties is a significant intervention in area of natural resource abuse.

- The role of a PVO with no international interest in the resources themselves allows for a more successful intervention. It was also clear that equal access to information can switch the nature of political power from more urban trader/merchants to the less informed local dioros.

- The mirco- and macro-aspects of natural resource management are inseparable. This is obvious is the Bouna agreement and is equally true in natural resource management involving river basins, tax collecting related to resource use, cattle and/or fish marketing.

- The IUCN representatives are basically what Americans call "facilitators." IUCN representatives also act as a "neutral" monitoring system or quality control on the effectiveness of the agreement. They have been able to define local "wants" better than most project interventions because of their long-term commitment. Outsider views of the "needs" are one of the major mistakes that lead to project failure. IUCN long-term commitment and intimate knowledge of the social fabric has also meant that any financial contribution by donors is better targeted with less risk of wasted funding.

C. PARC NATIONAL DE BASSE CASAMANCE (SENEGAL)

BASIC INFORMATION

Location: Right outside Ziguinchor, Senegal

Region: Casamance

Present:

NRMS Team: Peter Warshall and Eric Arnould

Accompanied by: Christophe Sagna, Conservator of the Park.

Met during visit by: Sassy Ndiaye, Agent Technique and Assistant to the Conservator and M. Fall; and a guard.

Major Characteristics of Location

The Parc National du Basse-Casamance is located about 45 kilometers southeast of Ziguinchor close to the Guinea-Bisseau border and a point of West Africa that extends into the Atlantic called Cap Roxo.

Number of Hectares Affected

The park itself is 5,000 hectares and is tightly surrounded by village gardens that literally stop just at the Park's boundary.

Special Characteristics of the Case

The "rainforest" of the Guineo-Congolian biotic zone extends far beyond the usual climatic limit of the rainforest into the Basse-Casamance. Basse-Casamance is the northern limit of forests with close ties to the Congolese rainforest. Normally, it should not be found here because only 1500 to 1800 mm of rain per year falls, and it falls in five months rather than nine. The dry season is too long and too severe to permit the development of true rainforest.

Until recently, the Basse-Casamance was more or less flooded during the rainy season and the water-table remained close to the surface during the dry season. This groundwater supply enables some of the Guineo-Congolian rainforest species to survive in an otherwise inhospitable climatic area.

The Park is a unique and exciting forest from the biodiversity point of view. It is given top priority by the IUCN as an area that should be protected. Parts of the forest are

18 to 20 m tall with large trees that branch close to the ground with leaning boles and very wide crowns. Only Khaya senegalensis appears to have straight trunks. Lianas of all sizes are abundant. In short, although similar forest still exists within the drier areas of the Guineo- congolian area, the Basse-Casamance forest is structurally, floristically, and hydrologically unique.

The important digneous species in this forest include: Parinara excelsa, Erythrophleum suaveolens, Detarium senegalese, Afzelia africana and Khaya senegalensis. Rarer associates include Albizia adianthifolia, A. ferruginea, A. zygia, Antiaris toxicaria, Chlorophora regia, Cola cardifolia, Daniella ogea, Dialium guineense, Morus mesozygia, Schrebera arborea and Sterculia tragacantha. Various acacias and sahelian plants are also found.

Other Important Aspects of the Park

In the dense forest, the Park supports populations of butterflies that are unique to the Basse-Casamance. There are five species of primates (the vervet or green monkey, the red colobus, galago, patas, and the endemic Campell's Mona monkey).

Within the grassland and open forest transitions to mangrove estuary swamps, African buffaloes of the forest-type that are immune to trypansomes, and the sitatunga can be found. The sitatunga seems to have disappeared and the buffalo are cut off from essential breeding populations in Guinea-Bisseau. Within the waters of the Park, hippos were found until the recent drought. The endangered manatee, the vulnerable Nile crocodile and the Sousu, (the humpbacked dolphin) have been seen here.

About 373 species of birds have been recorded in the Basse-Casamance area and, at least, 278 seen within the park itself. The nest of the tiger bittern -- close to, if not its most northerly breeding station -- has been recorded within the Park. This bird is characteristic of the streams of the Guineo-Congolian forest and extends into the shaded mangroves of Senegal.

Human Ecology

Most of the natural vegetation of the Basse-Casamance has been replaced by rice fields or peanut fields and dense groves of Elaensis guineensis (oil palm). When the park was created in 1970, there was, at first, some difficulty in preventing human intrusions. But a combination of factors makes the integration of this park with the surrounding population, the most successful seen by the team.

First, the local people (mostly Diuola) have a tradition of sacred forest protection, which values they seem to have transferred to the Park. No bush fires are ever reported and no poaching occurs. Other sacred forests exist nearby which are used for traditional ceremonial activities, and to harbor village discussions and decision making activities. Some of the sacred groves nearby are large enough to support leopards. These are, unfortunately, not connected to the Park.

Second, the closeness of the Park to major tourist locations (Cap Skirring) has meant greater use of the Park (about 30,000 visitors per year). This has had secondary economic impacts on the local villages which are much appreciated. There is a folkdance group that performs regularly for tourists. Some small hotels have been involved with tourism. But, Park conservator has been unable to interest the Club Med in Cap Skirring in Park activities. Only a few tourists were in fact seen. The Conservator, however, is concerned to limit traffic to less than 100 persons per day.

Third, the Park service personnel have made special effort to cooperate with the surrounding population. The present park chief is Dioula (from Bignona) which surely helps facilitate communication with surrounding villages. The team has noted throughout Senegal that park directors and other agents trained by Andre Dupuy have exceptional commitment to and knowledge of ecology of their parks. A typical example: in years of exceptional fruit crop production, when even the monkeys cannot eat all the fruit, villagers are allowed into the forest to collect surpluses.

Fourth, the young people in Gussoye have organized a chapter of Les Amies de la Nature Clubs. Annual field trips bring school children into the Park. The park director also has a slide show which can be used for presentations in nearby schools. A chapter of Les Amies also exists in Ziguinchor. This chapter built the current Command Post office. He felt this initiative had greatly enhanced respect for the park.

Fifth, charcoal collecting has been prohibited in the department of the Basse-Casamance on local initiative. Traditional local respect for forests, plus this legal backing has meant that no "wood poaching" occurs. In fact, charcoal sellers brought in through a government program were run out of the area and beaten for trying to skirt local mores. The degree of popular integration, the humidity and presence of surrounding waters and farmland has meant that brushfires are not a major threat to biodiversity as found in other parks. There was, in fact, much dead wood on the ground; nesting sites for the yellow-casqued hornbill -- a rainforest species that needs large, hollow snags to nest -- were available.

In summary, the situation is in stark contrast to Niokolo-Koba. The main effects of humans on this Park have been the constriction of the park to a very small size to support large mammals and the impossibility of park expansion.

Nature of the Initiative

The initiative was the creation of the Park in 1970. The present initiatives relate to protection of the Park.

DESCRIPTION OF INITIATIVE

The initiative is not threatened but is going through an extremely difficult period. The drought has lasted sixteen years. The area around Ziguinchor has affected the largest average drop in rainfall recorded in the Sahel -- about 400mm per year. The watertable

on which this relic rainforest relies has dropped 25 meters (75 feet) in places. Whole groves of trees (Ceiba petandra) have died. The lowered watertable has allowed saltwater intrusion that has threatened some of the palm groves.

Many water adapted mammal species are disappearing in the Park. The hippos were forced by salt intrusion to migrate south and were shot by farmers in Guinea Bisseau. They are now extinct in the Park. There are probably only two forest water buffalo remaining. Sitatunga may have already disappeared.

Faced with this situation, the main priority of the Park has become to reinforce local water supply. The conservator wants to try to import water -- by pipeline from nearby, inland wells -- to maintain watering holes until the drought breaks. It is estimated that ten years of good rainfall would be enough to restore the water tables but there is no certainty that such will occur. There has been no international or national help to help cope with this drought crisis situation. Minimal financial costs would be involved in piping water from the town 9 kms away.

Other needed initiatives are basically educational. Throughout Senegal, Les Amies de Nature Clubs needed better support as part of the education on environmental problems of natural resource management and national heritage of wildlife. This will be discussed under themes. Included in this (and stressed heavily by the Park director) was the need for more school trips into the park.

GENERAL DISCUSSION OF INITIATIVE

The Basse-Casamance is a small gem of a park like the small national monuments of the United States. It is an example of what happens to species when the park size is too small. The Basse- Casamance has suffered from fragmentation of the surrounding forests, human intrusions into the wildlife corridors that connect forest fragments and, most important, no sources for population replenishment after local extinctions occur. In this case, the cause of local extinction was not directly human. It was the persistent drought. The park will now be reduced in biological diversity. This has occurred in many United States parks. The only way to restore this diversity will be to re-introduce species after the drought has broken. The Senegalese DPN is more advanced than any other Sahelian country in re-introductions (see Djoudj National Park, for example). Janice Carter re-introduced patas to the Basse- Casamance and is famous for installing chimps in Gambia. Given the relic nature of the forest and its present isolation, the Basse- Casamance is a true biogeographic island. A park plan for long-term preservation of germplasm of trees and populations of animals by reintroduction will be necessary to retain biodiversity.

D. NIOKOLO-KOBA NATIONAL PARK (Senegal)

BASIC INFORMATION

Location

Niokolo-Koba National Park, 100 km SE of Tambacounda.

Region: Region du Senegal Oriental

Present

NRMS Team: Peter Warshall, Eric Arnould, and Idrissa Samba.

Met during site visit: Souleye Ndiaye, Conservator of the Park; and Ibrahima Seck, Chef de Poste at Badi.

Accompanied by a guard from one of the outlying posts.

Major Characteristics of Location

The Niokolo-Koba National Park is a major location for the protection of biological diversity -- both habitats and species. It is situated at 13 North latitude and 13 West longitude. It has a five month rainy season and a seven month dry season. Before the drought (before 1968), the average rainfall varied between 1,100 and 1,300 mm. This has been drastically reduced in the last 16 years and has lead to the loss of wetland habitat and tree species in need of high water tables.

In contrast with the vast sedimentary basin of Senegal, the Park sits on older and more folded terrains with Senegal's tallest peaks (for example, mt. Assirik, 311 m). The Park is crossed by the elegant meanders of the Gambia River and its immediate tributaries. Although classified as the Sudanian Zone, the Park has a much more diverse number of habitats than this classification indicates. The river derived and wetland habitats include the open water, the banks, the ephemeral ponds and marshes, and the former alluvial sands. The plains and valleys include dry forests, palm (Borassus aethiopium) forests, bamboo forests and shrub savannas. In addition, the ravines with their exceptional liana vegetation and the special "bowal" openings all have plants not found in other Park habitats.

The park's size and these habitats create one of the few locations for large mammals in West Africa. They will be described below. About 350 bird species and more than 70 species of mammals live within the Park.

Number of Hectares Affected

The park is 913,000 ha (8,130 km2) in size. Ecologically, the park forms a land bridge between the Faleme Valley hunting preserve (approximately 100 kms northeast) and the Guinean Park (its legal status is currently unclear). As a source of recolonization due to local extinction, a source of renewed genetic diversity, as well as a migration route for larger mammals, the park affects a much wider area. The importance of the park as a freshwater fish source to the lower reaches of the river (which are badly damaged by the drought and over-fishing) is unknown.

Special Characteristics of the Case

The Niokolo-Koba National Park is Senegal's largest, with importance locally, nationally and internationally. It is a Man and the Biosphere Preserve under UNESCO auspices. IUCN has designated Niokolo-Koba as a top priority Park and reference biome for the Sudanian Zone. This understates the importance of the Gambia River in the creation of habitat diversity.

With the reported elimination of the elephants near Matam (1984), Niokolo Koba remains the only location west of the Senegal River with interior elephants. It also harbors the northernmost natural population of chimpanzees within a protected area. The chimpanzee is recoginized by IUCN and the USFWS as an endangered species. These two species alone have great tourist value as well as biological importance.

The Park also harbors remnant populations of other rare, threatened and endangered species. The Giant Eland is clearly endangered, with the largest known population (about 500 individuals) within the Park. The "vulnerable" leopard is almost common in the park with perhaps 100 individuals (1975 estimate). The Wild Hunting Dog, a threatened species, is declining rapidly within the park and elsewhere. The park's conservator reported only a few scattered sightings. In 1970, there were about 100. The endangered Slender-snouted crocodile, the endangered dwarf crocodile and the vulnerable Nile crocodile can be found in the tributaries and/or main channel of the Gambia River within the park.

Other species of both tourist and biological importance within the Park include lions, Cape Clawless Otters, Aardvarks, pangolins, Red River Hog and hippopotami.

Traditional Land Use Practices

Traditionally the area was used for agriculture by a small number of villagers (less than 10,000). However, Bassari and other hunters ranged widely over the area in search of game.

Nature of Initiative

Biological diversity was preserved through the formation of the national park in 1962. Subsequent initiatives taken to reinforce the effectiveness of conservation within this internationally designated biological area are discussed below.

DESCRIPTION OF INITIATIVE

The initiatives taken to maintain biological diversity can be roughly divided into ecologically-oriented initiatives and socially-oriented initiatives. There is obvious overlap between them.

The ecological initiatives include: (1) control burns for tourist viewing, to prevent catastrophic fires and to replace the opening of the forest that was traditionally done by elephants; and (2) reintroduction of some vanished species.

The social initiatives include: (1) active struggle with the poachers by creation of more guards, more posts, better equipment; (2) passive struggle by education in schools and local villages, compensating informers, forming anti-fire and anti-poaching committees within the villages; (3) trying to intergrate park and village communities by helping with brush fire control committees; (4) finding employment for villagers in park maintenance; (5) plans to involve locals in the tourist industry through the creation of tourist villages; and (6) sharing "excess" wildlife such as guinea fowl with the villagers for commercial exploitation.

It should be noted that none of these social initiatives appeared to be very successful as they were underfinanced, understaffed and without adequate specialized personnel responsible for implementation of particular initiatives. Vehicles and all other logistical material was in short supply, repair costs are high because of the terrain, and rough field conditions. Food and medical supply to the posts is difficult because of the road conditions and distances. The team served as a taxi service for a park guard because he had no other means of transportation.

Technical Measures Taken

This section will not describe the technical aspects of Park Management in detail. An extensive system of dirt tracks exists, but the bridges are in disrepair. Tourist facilities can be found at Sintaba and Niokolo, which are likewise in disrepair. A network of guard posts exists throughout the park, but facilities and logistical support are rudimentary.

It is recommended that another mission specializing in park management be sent to Niokolo-Koba to determine more precisely needs for fire control, poaching, improving communication between outposts, access, poaching equipment, telemetry to follow elephants and, perhaps, chimpanzees. In addition, a study of wild dog population decline, proposed by IUCN, is needed.

Social Organization of Initiative

Currently, the park is organized on a paramilitary basis with extremely limited villager participation. A few local men act as guides. Otherwise villagers are encouraged to stay out of the park.

The following initiatives have been suggested by the Park Head and appear to be important. Again, funding and a plan for integration of neighboring villages into park programs must be a high priority.

(1) Increased educational efforts in the schools to describe what is important about the park and why the park should be protected. These might include audio-visual presentations in the Pulaar, Mandinga and Wolof languages. Programs to establish "Friends of Nature" chapters, as in the Ziguinchor areas, should be considered.

(2) Financing for formation of a guinea fowl collection for Women's Groups in seven villages to allow them to fatten guinea fowl for sale.

(3) Discontinuing fees for Senegalese entering the park. The current fee structure has discouraged citizen understanding of the park. Organize package tours through Senegalese companies. Expand the program of granting park tours as prizes to honor school students.

(4) Further cooperation between the park and local villagers for brush fire control and anti-poaching committees. Find alternative economic resources for villagers. Funding for tours into the park for villagers should be part of this project.

There are 173 guards trying to police 913,000 hectares. They do not live with their families, and have only four days each month to travel from the park to be with them. Food is difficult to obtain because of the distances to the nearest markets and lack of vehicles. The post housing is not protected against mosquitoes. Emergency first aid does not exist. This worries many guards because of the violence involved with confronting or tracking poachers. The poachers are definitely better armed than the guards. Many of the guards use 1936 French carbines or American Winchesters.

Economic Incentive System

Economic incentives affect the owners of the limited tourist infrastructure installed in the park and the handfull of guides and local organizers of excursions into the park from Tamabacounda or the Gambia. The only positive economic incentives for villagers are the occasional hand-outs of food they may receive for spotting fires or informing on poachers.

Socio-economic Data

The park receives only 4,000 to 5,000 visitors per year. Less than 300 are Senegalese. Visitation has recently decreased because of a dispute between Air Senegal

and private airplane tour guides. This dispute depressed the number of visits by, at least, 1,000 visitors per year.

The park earns directly about 12,000,000 CFA each year which does not cover expenses of 30,000,000 CFA. However, if the average tourist visits the Tambarounda region for 4 days and spends about 200,000 CFA, then the park may be generating an additional 20,000,000 CFA in indirect benefits each year.

The park has many indirect effects on Senegalese income which could not be defined. These include the obvious tourist income to hotels and local guides. For example, four entrepreneurs in Tambacounda currently mount low cost tours through the park for low budget tourists using Pugeot 404 trucks. The National Park is also a source for hunted animals outside the Park, especially in the Faleme. Many hunting expeditions were located in Tambacounda. Ultimately, many of the permits rely on resupply of game species from the park. No studies are available to quantify these indirect effects.

GENERAL DISCUSSION OF INITIATIVE

Human Ecology

The park has so far provided sanctuary for many large mammals of West Africa. But, large mammals with migration needs and large mammals with commodity value such as elephant ivory or, more recently, hippo teeth are extinct or rapidly disappearing. Both the giraffe and korrigum hartebeest are extinct within the Park and throughout Senegal. (They are extinct or heavily threatened in all Sahelian countries). The elephant population is in extreme jeopardy from poaching. There are probably fewer than 75 animals and most of these are not of reproductive age.

The human ecology and history with the National Park has been complex. Many conflicts have not been resolved. These include:

(1) Lion, leopard, and hyena attacks on cattle and other livestock, especially during the dry season when livestock roam more freely because there is little fear of livestock eating agricultural crops.

(2) Poaching for bushmeat with, according to the park head, an increasing market in Tambacounda. The bushmeat focusses on roan antelope, bubal hartebeest, buffalo and waterbuck. Smaller animals include warthog, duikers and bushbuck. Villagers with strong hunting traditions also prefer to raise livestock for sale and hunt bushmeat for local consumption.

(3) Poaching for trophies. The species affected by poaching for skins and horns include leopard, lion, otter, crocodile, roan antelope, bubal hartebeest, waterbuck, buffalo, reedbuck and eland.

(4) Poaching for ivory which focusses on elephants. Hippo and warthog serve as secondary species. There is virtually a war in Niokolo-Koba over the few remaining elephants. The poachers have Uli and Kalishnikov semi-automatic weapons and are organized for international sales. Even the smallest tusks lead to elephant kills. In 1984, a Park guard was killed by poachers and less tragic incidents are common.

(5) Police tactics, searches, and man-handling of villagers by park guards. Because of the intensification of poachers vs. guards, guards have been reported to enter border villages and enter homes illegally and force information from villagers.

Although the team could not carefully reconstruct the past history of human resettlement from the Park, there were strong indications that resettlement had not promoted goodwill between the park personnel and the local population. Very little has been done to provide positive economic incentives for villagers to protect park resources. It is apparent that past history and limited economic incentives contribute to poaching problems.

Recent OMVG plans to construct a dam either within the park boundaries (the Kekreti Dam), or upstream in Guinea are the focus of a great historical moment. The dam would include a transmission line through the Park; influx of humans involved with construction and operations of the dam; flooding of riparian areas and loss of the flood pulse; possible increased illegal hunting by workers and new residents; new roads and borrow pits; and partial blockage of migration movements across the river; increased contact between livestock and ungulates which can increase transmissible diseases; etc.

Cooperation between park officials and the OMVG has been tense and minimal. Officials in each organization have tended to view the others as competitors rather than allies in a common cause. The impact on the park of proposed mitigation measures such as insured flood pulse and in-stream water rights for the park have neither been discussed nor evaluated by a joint committee. Mitigation funding is uncertain.

Flooding will cause some villages adjacent to the park to be moved. Between 4,000 and 8,400 people are involved and, if equivalent quality land is to be found, then between 6,500 and 13,500 ha will be required. This may require sacrificing further land within present park boundaries.

Niokolo-Koba is an extremely important protected area for biological diversity that is in the greatest need of assistance of all protected areas visited in Senegal. The international community (UNESCO, USAID or private NGOs) could greatly aid Niokolo-Koba with a special mission to evaluate Park management, and possibilities for better integration of the Park with neighboring villages.

The conservator is interested in the possibilities of reintroducing vanished species and trying to negotiate the opening of migration cooridors to Guinea. More study is needed to determine whether habitats are suitable to do this.

The park is in need of a plan for development in order to bring tourists in contact with major attractions (chimps, elephants, lions). Given the park's status as an international preserve, aid to park management appeared minimal. Tourist values of the park were not coordinated with "package" tours, such as the coastal tourism. The wilderness values of the Park (vs. the developed game parks of East Africa) have not been emphasized. The experience of the Gambia river, a forested park (vs. Savanna) and special topographic features (waterfalls) are virtually undeveloped. Few arts and crafts activities have been coordinated with the park to benefit local craftspersons and park guides. An accurate park map was unavailable. Research workers do not contribute to park financing and rarely send their reports to the park. Information on park ecology was not accumulating locally.

This short summary cannot do justice to the importance of Niokolo-Koba. The book Le Niokolo-Koba by Andre Depuy and Ecologie du Parc National du Niokolo-Koba by Jacques Verschuren provide further information concerning the richness of this park.

E. DJOUDJ NATIONAL PARK, SENEGAL

BASIC INFORMATION

Nature of the Initiative

Djoudj National Park was created to protect the breeding and wintering grounds of Eurasian migrant, intra-African migrant and resident waterbirds. The Djoudj, the sudd swamps of Sudan, Lake Tchad and the inner delta of the Niger River are the four most important wetlands remaining in the Sahel and northern Afro-tropical zones. The park helps insure waterbirds and other plant and animal biodiversity in the face of massive agricultural development in the Senegal River Basin.

Natural Resources Affected

Since the Djoudj is a national park, the resources affected include water and water quality (especially seasonal freshwater supplies and natural flood pulses), soils, air quality (eolian sand reduction), and biodiversity of plants (natural wetland vegetation and habitats) and animals (especially waterbirds but also vulnerable and endangered mammals and reptitles).

Number of Hectares Affected

The park itself is 16,000 hectares. But, the area affected is far greater since many of the birds are Eurasian migrants. The park affects biodiversity from Belgium to Siberia. The flight paths of the intra-African migrants are less well known. But, the park may affect biodiversity throughout the Sahel and south below the equator.

Location and Region

The Djoudj National Park is 60 km NE of St. Louis, Senegal in the Region de Fleuve.

Characteristics of the Location and Case

The park is located in the Djoudj depression in the channel of the Senegal River. It became a waterbird haven in 1963 when agricultural dikes prevented the flooding of many of the river's islands, eliminating these habitats as waterbird roosting, feeding and nesting areas. This agricultural development was designed to retain water for longer periods within the Djoudj depression to partially compensate for losses.

The Djoudj is part of an integrated complex of wetlands including Lac de Guiers, shortlines of the Senegal delta, and the delta lands of Mauritania (the Diaouling depression, the Tianbrank depression and the shoreline of Keur Massene lagoon). If one area dries up, the waterbirds depend on the other areas. Nearby, the 7,000 ha Delta see area (Ross-Bothio) has also been set aside for waterbirds. This whole complex of wetlands is, in turn, integrated with the Eurasian breeding grounds of many of the ducks and the ponds and pool breeding grounds of the African ducks. Preservation of biodiversity cannot be viewed narrowly with 69 species of palearctic waterbirds and over 20 species of African residents and migrants.

By mid-winter each year, the Djoudj contains 90% of all the waterbirds wintering the delta. The garganey population has varied between 23 and 143,000; pintail duck between 3 and 110,000; while-faced tree ducks between 4,300 and 43,000. The major part of the West African white pelican population winters at Djoudj. In good years, more than one million birds, including 200,000 palearctic ducks can be found at the Djoudj. Many of Senegal's protected birds (white storks, egrets, flamingos, crowned crane) find refugee here.

The Djoudj also provides sanctuary for the Nile crocodile (considered a threatened species) and the West African manatee (considered endangered). Recent re-introductions of formerly extinct gazelles have taken place and appear to be successful.

The vegetation of the Djoudj contains: (1) valley formations (gonakie) of Acacia nilotica/A. seyal, Salvadora persica, and Oryza barthie/Salsolo baryoosma; (2) tannes (a steppe-like formation) of A. nilotica, Balanities aegyptica, Tamarix senegalensis, S. persica/ Schoenfeldia, Chloris prier/S. baryoosma; and (4) Phragmites/Tamarix along the floodplain edge. Open water, lily pond areas, emergent grass and other vegetation are the most important habitats for waterfowl. The gonakie is a rapidly disappearing riparian habitat because of riverside agricultural development.

The soils are littoral and deltaic with depressions of halomorphic acidic soils. Salinization is heavy to slight.

Traditional Land Use Practices and Recent History

The Djoudj depression has only one small area that allows agriculture. They were two villages when the park was created. One village has been relocated. The other is immediately adjacent to the park. Herders can be a problem in the dry season. There are feral donkeys. Almost all large mammalian wildlife disappeared from hunting.

The Djoudj water regime is artificial because of the agricultural development of the early sixties and the construction of the Diama salt-barrier dam just downstream and the Manatalli Dam upstream in Mali. In addition, as more freshwater is diverted for perimeter irrigation, the flows will change. Essentially, the effectiveness of the Djoudj depends on the maintenance of a series of dikes, tailgates and locks as well as proper management of the in-coming and out-going flows.

The park is under the Ministry of Nature Conservation (Ministere pour la Protection de la Nature). It is more immediately under the National Parks Department (DPN). There are 24 employees within the park who have four days off each month to see their families. They live in open quarters without mosquito protection. They all gathered about to discuss with the NRMS team in a knowledgeable and concerned manner, the ecological problems of Djoudj.

Present

NRMS Team: Peter Warshall, Joe Tabor, Kjell Christophersen

Accompanied by: Moussa Fall, E&F. Met during site visit: Kara Sane, Agent Technique au Parc Nationaux des Disaeux du Djoudj (Adjoint Technique Conservateur du Parc).

DESCRIPTION OF THE INITIATIVE

The National Park is an official Man and the Biosphere Preserve under the United Nations. The park compensates for wetlands lost to agricultural development and insures sanctuary for waterbirds and mitigates the degradation of the Senegal River Delta complex. Initiatives described here are those needed to maintain or improve biodiversity. The park is, at the moment, a partial success but greatly worthwhile.

Dike and Tailgate Repair: The dikes and tailgates are only partially operative. The breeding grounds of white-backed, pink pelicans and greater flamingos had been inundated because of the inability to control waterflows. There was no breeding during he NRMS team visit. The situation has become worse because of the flooding caused by the Diama dam. There is the threat that the flooded grasslands will be over-flooded. Not only will duck and geese populations find less food, but they may fly to nearby agricultural projects to find grain. Other affected species include crowned cranes, while storks, European spoonbills, Osprey, West African River Eagle, Marsh harrier, Montagu's harrier. These are all officially protected species in Senegal. The maintenance of biodiversity in this Man and the Biosphere reserve with Eurasian migrants is the highest priority for donors in Senegal. In addition, effective control of waterflows would help increase populations of rarer waterbirds such as Pochard, Ferruginous duck, Egyptian goose, and Comb Duck.

The total costs of this project have been estimated at 460 million CFA. The OMVS was instructed to repair these dikes and tailgates or construct new dikes as part of the Diama dam and Manatalli dam project. ("Nonimplementation of mitigating measures is an unsatisfactory alternative," OMVS, no date). OMVS, donors, UNEP have, so far, not fulfilled these mitigation requirements. Part of this program should include a waterfowl consultant familiar with management of waterflows and levels for maximum grass, fish and nesting production.

The Djoudj is a cost-effective intervention to keep migrant birds away from cultivated fields and safe from hunting. It helps economic profits by reducing grain losses.

Maintenance, Unkeep and Personnel: The park has an inadequate maintenance and unkeep budget for waterworks, tourist facilities and personnel. The tourist blinds have rotted posts. The living quarters for park workers have no mosquito nets or doors. See themes for a more general discussion of maintenance needs for biodiversity reserves in West Africa.

Artificial Estuary: The mitigation measures suggested for Manatalli and Diama dams included an artificial estuary to maintain the diversity of fish species, salinity gradient, piscivore bird food supply, and manatee and estuarine fish migration routes. OMVS has not acted on this proposal though both dams are complete.

Rationalization of Park Boundaries: Both OMVS and the park have suggested enlarging Djoudj so that the northern and/or eastern boundaries include the gonakie forests and shorelines along the river itself. This extension would impact about 500 people in three villages as well as some agricultural land. The extension would bring the park to Mauritania's borders. The park technician said this extension should be based on finding equal or better lands for the 500 Senegalese within the proposed area.

Biodiversity Restoration: Djoudj is already involved in a reintroduction program for two extinct gazelles and patas monkeys. They have a well established program with a breeding reserve (Gambel) south of St. Louis. Part of this reintroduction program includes the elimination of feral donkeys. The park needs funds for reforestation and control of fluvial sediments and eolian sands that are filling in wetland habitat.

Education: The surrounding towns and villages could well profit from an environmental education program and the improvement of the Djoudj museum. See "themes" discussion and Walia intervention.

Conflict Resolution: There are relatively few conflicts with the surrounding peoples. Access by cattle herders to the park is the major violation of park boundaries. See conflict resolution in themes section.

Socio-economics

Annual visit fees in 1987 amounted to 7 to 8 million CFA, below anticipated levels of about 1 million. But, this does not include the multiplier effect (hotel expenditures, food travel, etc.) that increased income ten fold. The more species within the park, in the greater numbers, the greater the visitation. The assurance of "glamor" species such as flamingos and fish eagles within the park will help increase visitation. Biodiversity works, in this case, for labor-intensive economic development. Research workers have been conspicuous in NOT contributing equipment or aid to park infrastructure.

DISCUSSION OF THE INITIATIVE

The Djoudj is among the most successful parks in Senegal in terms of wildlife administration and improvement of biodiversity as well as visitation rates. Its Afro-tropical and Eurasian importance gives it a special place among Senegalese and West African parks. Its problems are those of other biodiversity preserves: infrastructure maintenance, river basin management, education, conflict resolution, and boundary locations. It suffers particularly from similar river basin development schemes in North America -- promises of mitigation measures (dike and watergate maintenance, artificial estuary, technical wildlife management assistance) that have not materialized.

F. SINE SALOUM NATIONAL PARK (SENEGAL)

BASIC INFORMATION

Nature of the Initiative

The park was created to protect the northern most mangroves, a series of off-shore and on-shore bird breeding areas, sea turtle egg-laying habitat, estuary habitats and a small dry forest with some Guinean species. The initiative was to protect samples of biological diversity (habitats and species) for future generations.

Natural Resources Affected

The park maintains soils, water and water quality, as well as specific habitats and animal and plant species from extinction or harm.

Number of Hectares Affected

The park is variously described as 60,000 or 73,000 hectares. Mr. Coly states that 73,000 is correct at this time. This includes the 400 ha Fathala Forest, sometimes listed as 600 hectares. It is not known if the village and its dedicated lands are included within these estimates. The variation in overall acreage may involve inclusions or exclusions of open water and estuary (vs. land) within the estimate. Some estimates may wrongly include the Palomarin area.

Location and Region

Road access is to the west from the main road between Banjul and Kaolack. But, most of the park is accessible only by boat either from a small fishing town (Missirat) or from coastal hotels further north. The park is in the Sine Saloum Region, Senegal.

Characteristics of Location and Case

The National park surrounds the mouth of the Diombos estuary and Bandiala estuary, its bolons, and wet season freshwater floodplains. It contains the northern most large stands of mangrove in West Africa. Off-shore are a series of protected islands known for their bird nesting grounds. Along the coast are sandy beaches used by turtles and terns for nesting. Within the mangrove are small "forested" islands (e.g., Betenti) that also contain or contained turtle nesting areas and saltflats. Between the Bandiala estuary and the main road is a small dry forest (the Fathala forest) with some Guinean tree species. The villages of Bakadaji, a tourist hotel and park headquarters are located inside this forest

and within Park boundaries. The village's fields and livestock were seen within the park and the forest had been burned surrounding the tourist hotel.

An area known as the Palomarin Reserve at the northwestern end of the park (north of the Saloum River) is independent of the park. No one is allowed to live within this reserve. It contains fossil mangroves and migratory bird wintering areas.

The park has suffered from the sixteen-year drought. More tropical, high rainfall species are dying within the park. The park headquarters itself is without an operable well.

The park is poor in land mammals. There are spotted hyenas, one or two pairs of leopards, warthogs, green monkeys, patas, red colobus and galagos, Grimms' duiker, kob and oribi. The large antelopes such as the roan are extinct. While aquatic mammals have been reported, they appear scarce. Only the common dolphin is frequently seen. The endangered West African Manatee and the endangered humpbacked dolphin (Sousa teuszii) are difficult to locate.

The status of park reptiles is not well known. According to Mr. Coly, snakes appear to have disappeared. The Nile crocodile is present in unknown numbers and is hunted within the estuaries of the national park. The sea turtles (Green, loggerhead, leatherback) cannot be monitored because the Sangomar sand spit has been isolated from the guard post by a channel of saltwater where the ocean overtopped the spit. Poaching is suspected. Turtle shells are easily available for purchase.

The bird populations on the offshore islands have been more closely monitored. Bird Islands and Terene Island have nesting Caspian terns, common terns (50 pairs), sooty terns (2 pairs), slender-billed qulls (1,500), and Larus dominicanus (4 pairs) Franklin's gull and white-faced tree ducks have been reported as non-breeders. On the Sand Islands, the breeders include Caspian terns (2 to 2,500), grey-headed gulls (2,000 pairs) and Royal terns (6 to 7,000).

Fishing is allowed within the lagoons and near shore areas of the Park, including the islands.

Human Ecology of the Site

In 1935, two villages and groups of humans lived within the park boundaries. They were the Koumberg and Bakadaji villages -- both Mandinga. The Koumberg have left the park area. Bakadaji village (with over 100 villagers) remains a strong influence in the Fathala forest. By law, the villagers have a right to maintain their lands within the Park and there are no suggestions or discussions of removing the village from the park. Though limits of village cultivation and wood-gathering are supposedly in place, the team found village influence throughout the forest. Charcoal bags were seen near Park headquarters. Cattle wandered without herders or fences. The hotel owner complained that the forest had been so severly burned near the hotel that wildlife had moved. Fields of gourds,

millet, cutting of Andropogan for fencing, etc. gave the forest area of the Park a feeling of an active village.

The Park appears to have been established about 1976 with recent additions. At the beginning, World Wildlife Fund donated a boat and some vehicles for the park. The Park is heavily influenced by the major road between Banjul and Kaolack which abuts the forest edge. Road kills, human instrusions that lead to brushfires or poaching, and a past history of charcoal gathering and gathering Daniella for incense all influence the park's ecology. Honey gatherers as well as carelessness have been the cause of brushfires. As stated above, very few rules apply to the access to waters that comprise the park. Fishing is allowed and birds are regularly caught within the mesh of fishing nets. Although it is forbidden for fisherman to land on the bird islands, they do land occasionally. Even slight disturbance of island nesters can lead to egg and nesting losses by gull predation. There are no controls on turtle, Sousa, manatee and dolphin hunting. Crocodile hunting is not a problem because of the scarcity of crocodiles. Because the local people are Islamic, neither monkeys nor warthogs are killed. But, with the increase pressure for warthog "ivory", poaching without use of the meat may be on the increase.

Within the Palomarin preserve, women are allowed to collect salt.

Researchers do visit the park, especially the coastal region. ORSTOM and BIROA have done recent surveys. None of their reports have been forwarded to the park and no financial or equipment has been given to the park because of their research.

Socio-economic Additions

The Park is formed and financed under the Ministry for the Protection of Nature. There are 27 guards and technical assistants as well as the park director. During a year's time, about 50 temporary workers are hired for special jobs. There are almost no visitors to the forested part of the park. In 1987, 545 visitors paid to enter the park. Twelve were Senegalese. The actual booth for payment is not at the entrance from the main road so additional "visitors" may have used the road without registering. There is no map for the park, no list of bird, plant or tree species that can be seen in the park and no pamphlet describing the special terrain and tourist features of the park. No educational material on the area is available at the park.

Visitors to the aquatic areas of the park and its shorelines do not enter through the park and do not contribute any revenue to the park. They visit the bird islands and the lagoons from nearby resorts or the town of Missirat. There are about two to three boat trips each day. At Missirat, a good price (negotiated) is between 10 and 11,000 CFA. Each trip lasts about four hours. The park has no real docking facilities for leasing to boat operators. Some visitors come to the park expecting access to the coastal and island waters. They must then return to Missirat or other locations.

The team could discover no financial arrangements between the Park and the village or the Park and the Hotel.

Present:

NRMS Team: Peter Warshall, Idrissa Samba. Met during site visit: Bertin Coly, Park Director

Description of the Initiative

This section will list some of the major priorities and areas of interest (social, economic, technical) that confront Sine Saloum National Park.

Water: Because of the drought, both the guard compound and the waterholes for animals have dried up. Mr. Coly considered this the Park's immediate highest priority. Without water in the watering holes, the few mammals left in the park have begun to leave and reintroduction of antelopes cannot begin. Tourism (which in forest habitats centers around waterholes) cannot be promoted. The necessity of water for the compound is obvious.

Protective Fencing: In order to help confine the animals within the park and to prevent further roadkills, there is a need for a fence along highway N.5. This highway will also discourage charcoal and animal poaching and give the park managers a better handle on village use of the park. The fence would require a parallel or pre-project education of the surrounding villagers in order to limit fence destruction and accommodate their needs for walking. There are about 10 km of park/highway boundary. An additional 20 km would prevent poaching from Gambia which parallels the park boundary in the south.

Brushfire Control and Reforestation: Mr. Coly reported great interest from the women of Bakadaji and 18 surrounding villages for the reforestation of trees lost to charcoal makers and the drought. Mr. Coly and the women listed boabab, cashew, tamarind, dimb, Detalium, Pterocarpus, and Parkia biglobosa as trees they would like to plant. There are no nurseries associated with the park. The park would need to receive help from Eaux et Forets or an outside donor. Nineteen committees are in the process of forming that will respond to brushfires as well as become anti-poaching committees. They may also form the basis for reforestation groups. This initiative was considered the third highest priority by Mr. Coly.

Reintroductions: It is clear that the forest area of the park has few attractions for tourists and is, at this time, difficult to manage as a preserve for biodiversity. Senegal has taken a lead in reintroducing large mammals lost in other parks. Mr. Coly would like to introduce the roan antelope and the red-fronted kob. This would be a second stage after the waterholes are restored and the fence is in place.

Crocodile Farms: In order to make the park more attractive to tourists, Mr. Coly has proposed an integrated tourist/crocodile farm in the bolongs (salt water alcoves or tributaries) of the Saloum and Bandiala. This project would reduce the conflict between

fishermen and crocodiles as it now exists. He hopes to employ younger men and boys to fence in parts of the bolongs as crocodile semi-wild pens. He feels that this is a five year project before tourist income will help pay the costs. Income will be shared between the park and crocodile farmers.

A Senegambia Park: Of more interest to the international community than Senegal or the Gambia, this park was proposed in 1984. It would essentially add Gambian tributaries of the Karenti Bolon (e.g., Massarinko Bolon) as well as Gambia mangrove and coastal habitats to the Park. The status of the proposal could not be determined.

DISCUSSION OF THE INITIATIVE

After Niokolo Koba, Sine Saloum (plus Palomarin?) was considered to have the most tourist potential of all Senegal's National Parks. It is closest to major cities and has a combination of beach resort/wildlife attractions.

Of all the parks in Senegal, this one might be considered too well integrated with the population. There is a need to develop and fund a long-term park plan to address impacts from the through road, the internal and external villages, and tourism. At the moment, the forested part of the park has no real attractions and the result has been the slow spread of the village into the park lands. Mr. Coly understands the need for integrated park/village management. How to tailor human access and use of park resources to the specific needs to maintain biodiversity needs more thought.

G. ABUKO NATURE RESERVE (THE GAMBIA)

BASIC INFORMATION

Location: Abuko, Gambia

Region: Kombo North District

Present: NRMS Team: Peter Warshall

Met during site visit: Eddie Brewer, Director of the Wildlife Conservation Department.

Major Characteristics of Location

Riverrine gallery forest and tall grass savanna. Pathways for humans to walk around; caged animals; watering holes; a food stand; bird blinds.

Number of Hectares Affected

Seventy-three hectares surrounded by fence. One side contains Banjuls old water supply pumping station and another side includes Banjul reservoir.

Special Characteristics of the Case

In 1913, this land became the original Abuko Management Area and a pumping station was installed. Over the last thirty years, the pool and stream in the area have dried out from the drought, urban and industrial development and, perhaps, overpumping. The Abuko Nature Reserve remains the only forested area in the vicinity.

The reserve is a major educational asset to Gambia. It is the only major nature reserve within close distance of a major West African city in which citizens and tourists can see wildlife. The area is an excellent bird sanctuary. Large mammals are necessarily enclosed in cages. Many of the large mammals are in the zoo provisionally as a step toward rehabilitation in the wild. Some have no obvious place to be relocated.

Human Ecology and Socio-Economic Data

The park is the only park visited by the NRMS team to make enough money to support itself. The exact number of employees was unavailable but appeared to be about ten. They guarded the animals and fed them on schedule. Much of the food for the carnivores comes from scraps provided by a nearby abattoir. Over 10,000 visitors came to the park each year, plus a large number of local children who do not pay. The park, according to Eddie Brewer, earns 20,000 to 30,000 Dalasis over costs annually.

Nature of Initiative

The initiative aimed (1) to create a Nature reserve on a remnant forest; (2) stock it with species that need rehabilitation; and, (3) maintain a habitat for wild birds, monkies and a few of the smaller indigenous mammals and reptiles.

The reserve has been the way station for chimpanzees that now inhabit the Gambia River reserve on Baboon Island.

DESCRIPTION OF INITIATIVE

The initiative seeks to maintain the biological diversity, especially of birds and small mammals, within the reserve; to continue as a rehabilitation center for larger mammals before they are returned to the wild; to increase environmental education; and work with the local villages and industries to protect the park.

The most creative initiative being pursued by the Park Reserve and the head of the Wildlife Conservation Department is a buffer zone, agroforestry project. The central intervention would be the establishment of a mango orchard in cooperation with the villagers surrounding the nature reserve. This would halt environmental degradation that occurs immediately adjacent to the reserve from livestock grazing and sub-urban sprawl. The project would have high visibility (being so close to Banjul), and could easily be combined with local canning of damaged fruit as well as export of high-grade mangos. It could serve as a model for maintaining greenbelt orchards near the city. Forests have beneficial effects on air pollution from dust and cars.

The project needs money for fencing and a social anthropologist to work out land tenure and the division of responsibilities and benefits with neighboring residents.

GENERAL DISCUSSION OF INITIATIVE

The Reserve has served as a source of monkeys for other reserves. At the moment, a mountain gorilla is waiting for relocation in the Cameroons but an appropriate area has yet to be found. The gorilla, now becoming a teenager, is coming to an age that may prohibit reintroduction.

The Abuko Nature Reserve is important as an example of urban-oriented biodiversity projects. The only equivalent known to this consultant is Nairobi Game Park in Kenya. Because it is geared toward maintaining natural habitat, it should not be confused with a "zoo" -- although elements of the park are zoo-like. The use of blinds to watch wildlife is a crucial aspect of the park experience. Inclusion of the reserve in a program of primary and secondary school science and ecology education, and donation of binoculars for school groups would add to this experience.

H. GAMBIA RIVER NATIONAL PARK

BASIC INFORMATION

Location: Between Kuntaur and Sapu on the Gambia River. Access by fourteen kilometers of dirt track to the south bank camp of the Chimp project.

Region: Niamina East District

Present:
- o NRMS Team: Peter Warshall
- o Accompanied by: Janice Carter, head of the Chimpanzee Rehabilitation Project

Met during site visit: Jill Watt, volunteer under Stella Brewer for the Chimpanzee Rehabilitation Project. Staff members Bruno Boubane and Samba Waro.

Major Characteristics of Location

The Gambia River National Park consists of five islands within the main channel of the Gambia River. The islands are in the stretch of river known as the "lower freshwater zone". There is freshwater all year long, but tidal mixing occurs. The floodwaters control the chemistry of the river. This stretch of river was found to be exceptional within the Gambia River basin for its unusally high July phytoplankton production. While the main channel is relatively unproductive, the side channels and bolongs are very productive. One of the few remaining hippo populations in the lower Gambia River basin, as well as the endangered manatee, the vulnerable Nile crocodile and Cape clawless otter live among the islands.

The islands and adjacent shores contain some of the best gallery or riparian forest in Gambia. The mostly evergreen forest was as tall as 20 to 25 meters with a "cathedral" effect reported by Janice Carter. Lianas are lush. The major island forest supports populations of pangolin, bushbuck, serval, warthog, banded mongeese, baboons, vervets, red colobus, possibly leopard, and the introduced chimpanzees. Because of the dangerous nature of the chimps and because human presence would injure the rehabilitation project (see below), no humans are allowed on the islands.

There are two new islands forming within the area. These will be part of the park. These islands are used by local bird populations for roosting, and for feeding during the tidal changes. They greatly add to the diversity of birds found along the shores. Hundreds of white-faced tree ducks, Senegal thicknees, knob-billed geese, garganey and teal were seen.

The shoreline is not included in the national park. But, it deserves mention as it contains fine stands of riverrine forest equivalent to Baboon Island. Some of the forest is

"protected" by the ironpan cliff faces that jutt up just back from the shoreline. Some of the forest is being cleared for rice fields.

In addition, the shoreline has at least one "intact" bolong (dubbed "Little Africa"), where raphhia palm and phragmites dominate. This habitat is very rare in this part of Africa and provides another fine habitat for birds.

Number of Hectares Affected

The immediate terrestrial habitat consists of five islands. The largest is 1100 acres and harbors ten chimpanzees (Baboon Island). The next is 293 acres with 21 chimps. The third is 143 acres with 3 chimps. The fourth is an all grass habitat, with Andropogon sp predominant. The fifth island floods during high tides. The land area thus totals about 1500 acres, not counting the two, newly forming mud islands.

The aquatic habitat associated with the park was not assessed. Officially, all the waters south of the main shipping channel, and all the waters south of the main islands are off limits and part of the park.

Nature of Initiative

The park was created to protect a series of riparian forests within the Gambia River as well as reintroduce chimpanzees.

DESCRIPTION OF INITIATIVE

The most significant human presence is the chimpanzee rehabilitation project under the guidance and financing of Janice Carter and Stella Brewer. The project has spent eleven years trying to acclimate chimps that were in medical institutions, included in psychology experiments, or illegally traded, etc., to the wild. The full story is complex and long. At the moment, there are 34 chimps living on three islands. The chimps still receive some extra food from the project once every two days, especially during the winter when, like humans near the river, they are subject to pneumonia and other respiratory problems. However, they are now largely independent of the project staff.

GENERAL DISCUSSION OF INITIATIVE

Historically, the park area was used for hunting, cutting raphia palms. It was essentially uninhabited because of tsetse, mosquitoes, other health problems and the presence of spirts in certain areas. At the moment, there is no real pressure on the land in the park. Many of the local inhabitants from Guinea have returned to Guinea with the change in regime there. The human population along the shores appears to be declining.

The villagers are on generally good terms with the chimp project which is virtually the only human presence within the park area (see below). They have benefited from local

purchases by the rehabilitation project and an attempt to construct a hippo fence to help keep hippos from their rice fields. When asked if they received any benefits from the park, in a recent survey, they answered "no". There is no tourism by land and tourism by boat comes from other towns. Tourism is actively discouraged because of its effects on the chimps. Other costs to some villagers include restrictions on fishable waters, prohibitions against cutting rapphia, and the hippo problem.

No chimps ever lived on the islands in historical memory (chimps cannot swim), but chimps had been reported as far north as Basse, Gambia. They were hunted to extinction by the 1930s within Gambia. The carrying capacity of the island for chimpanzees is not known but, at the moment, researchers believe the chimps could exist with no supplemental feeding when fully rehabilitated. The chimps have attacked humans (one wounding occurred during my visit) and one chimp may have been poached. The chimps are heard, but rarely seen, from the surrounding waters.

The presence of the Chimp Project has been the only protection given to the park. The Wildlife Department can afford one ranger who does not live by the river, and only receives about 280 D per month in salary. At the moment, the chimp project staff includes three trained workers, who also patrol during their feeding and maintenance duties, as well as one Scottish volunteer who watches over chimp health and behavior. Janice Carter visits when possible. Stella Brewer now lives in Asia. They both use personal funds to finance the project, supporting village/Park integration and operations. The financial situation is not known in detail, but the project appears to operate on a "shoestring." World Wildlife Fund originally donated boats and motors. The motors have long since deteriorated and are now supplied by the project participants.

The Chimp Project is viewed by locals and many outsiders as the reason for the park, and the staff is confused for Wildlife Department personnel. This is a natural result of their supplying all the petrol for the patrol boats, acting as guardians, guiding official tourists and consultants, and mediating with fisherman and rice growers.

Finally, it is not the Wildlife Department but the Port Authority that controls the main channel on the northern side of the river. Relations between the Port Authority and the park appear agreeable with relatively few violations of the navigable waters boundary.

Other Socio-economic Data

The park makes no money because of the need to keep tourists from disturbing the rehabilitation project. Nevertheless, boat operators are increasingly taking tourists up to the island and violating park rules. The amount of money made and the number of boats in not known.

Future plans center around further protection of the park; its possible expansion; and a new project to incorporate rice grower concerns (hippo damage) into park management practices.

The park needs a full time ranger who speaks English. The ranger needs to know how to run a boat and manage petrol supplies. Petrol needs to be supplied from government or private donor funds rather than one specific research project. Thought needs to be given to long range funding and goals of the park consistent with the policies of the Gambian government and concerns of international conservation groups.

V. A BIODIVERSITY QUESTIONNAIRE

This chapter is basically the questionnaire used by the author to explore biodiversity concerns in West Africa. It is included here as a helpful tool for other workers in natural resource management.

A. Protected Areas

1. Status of Knowledge About Special Habitats and Ecological Communities

List from general to specific the kinds of biotic communities within the country. Using White's (1983) classification to start with, it is necessary to greatly refine analysis for particular countries. The appropriate level will depend on the purpose of protection. For instance, the "niayes" of Senegal costal dunes are unique communities, although any individual species may not be threatened.

It is important to avoid being too general. For instance, wetlands can be subdivided in closed and open gallery forest, mangroves, emergent vegetation, tannes, open water, sandbars, flooded grasslands, etc. The importance of a protected area cannot just be "wetlands" or Sudanian or Sahelian but must include a more specific sense of tree, grass and shrub dominants or special plant or animal species within the community. For instance, the Isle de Madeleine National Park is a rocky, coastal, marine island that supports the red-billed tropic bird.

2. Coverage of Protected Communities

Given the existing "paper" protected areas, what ecological communities, special habitats and special species (endemics, rare, unique combinations) do they cover?

3. Effectiveness of Protection

Is protection fulfilling requirements of existing laws? Is protection level sufficient to maintain biodiversity goals? What are conflicts between protection, access and use of natural resources? Should protective status be changed (up or downgraded)? Does protected area need a buffer zone? Is protected area connected to other habitat islands? Is protected area large enough for species of concern? Does protected area need restoration or reintroductions?

4. Conservation Needs Outside Protected Areas

What areas with special habitats have not received protection? What areas need protection as corridors between habitat islands? What international agreements are necessary to protect local biodiversity? River basins which act as both habitat for residents and corridors between habitat islands require special attention. What major rivers require

water management plans to insure instream flows, flood pulses and long enough duration of floods to maintain biodiversity?

B. Biodiversity and Animal Resources

1. Status of Knowledge

Is there a complete list of mammals, birds, reptiles, and amphibians? How complete is the knowledge of insects? What is known of locations and population sizes of animals of concern? Are some subpopulations so isolated that gene flow can no longer occur between them? Have endemic animals been given special attention? Is it known where animals that cross international boundaries go? Does the nation have any special subspecies or races that require attention?

2. Endangered, Threatened and Rare Animals

Which animals have IUCN Redbook or US Endangered Species Act status? Which animals have special status nationally? Which animals have special status (cultural/religious/legal) locally? Which species are the highest priority concerns internationally and nationally? Has a complete population and location survey been done? Are they in protected areas? Are there national and international funds to help maintain their populations? Are the involved species in illegal international trafficking? What is the status of the nation's commitment to protecting the species? Have reintroductions occurred?

3. Pest Management

Which of the following are problems within the nation: (1) Waterbird consumption of crops? (2) Terrestrial bird consumption of grains? (3) Large vegetarian mammals such as elephants and farms? or hippos and rice? (4) Large carnivorous or omnivorous mammals such as lion and livestock? or civet cats and groundnuts? (5) Small mammals and crops such as grasscutter rats and grains? or house mice and stored food? (6) Disease control and secondary impacts to fish such as insecticide impacts to control malaria? or onchoceriasis control and habitat clearing? locusts?

4. Consumptive Uses

What are the species hunted for subsistence and drought fall-back food? What are the species killed for local cultural purposes (talisman, medicines)? What are the species hunted for legal bushmeat and other animal products (skins)? What are the species hunted illegally (poached for bushmeat or animal products, i.e. ivory, horn, skins)? What are the species hunted by ex-pat hunters for trophies? Are any of the species over-exploited or threatened by local extinction?

5. Non-Consumptive Uses

What are the species of major attraction to tourism? birdwatchers? Where are they located? Are they in protected areas?

C. Biodiversity and Plant Resources

1. Knowledge of the Flora

Is there a flora for the nation? Is the flora an adequate guide to the geographical distribution of species? Is there a botany department in the university? Are type specimens of various species indexed? What nations hold the largest collections of the flora? What institutions and individuals are actively involved in studying the plantlife of the nation?

2. Endemic, Rare and Endangered Flora

What endemic species can be found in the nation? Are they in protected areas? What species have small local populations or small widely scattered populations? What species are considered rare by international or local standards? Are they found in protected areas?

3. Cultivars, Useful Natives and Seed Conservation

What are the most interesting native plants and cultivars for the nation (trees, grain crops, medicinal plants, etc.)? What institutions are surveying native cultivars? Where are specimens kept? If seed is being collected or produced, who does it? Is seed re-distributed back to the population? Who certifies varietals? Where are the agricultural research stations involved in extension work with varietals? Is there any collection or production of innoculum taking place? Who are the export institutions and individuals involved? What needs to be done?

4. Agroforestry Concerns: Exotics and Natives

In urban areas, are there any projects to increase biodiversity in home gardens or city parks? Is there a botanical gardens with a large variety of native species? Are there urban woodlots?

In the peri-urban areas, are there greenbelt woodlots or forests with many species? In the rural area, are windbreaks, living fences, gardens, shade trees making adequate use of natives or multipurpose trees? Does the village have its own garden for specialty plants for medicines, cosmetics, etc.?

In agricultural areas, are multipurpose trees for firewood, forage, soil restoration, etc. being employed? Is there a nursery for natives as well as exotics? How long is the fallow period? Are there browse reserves? Is there a nearby classified forest? Does its

rotational system take age - stands, native species, and support of non-human species into account?

Do agencies and farmers have access to innoculum, mychorhizal fungi or other aids to restorestation?

D. Biodiversity and Its Social Context

1. Government and Laws: A Review

What ministries and agencies have influence over any of the above biodiversity concerns? What local, village groups have any influence over any of the above biodiversity concerns? What extension agents (locust control, crop management) can influence biodiversity maintenance? Are they aware of biodiversity needs? Are they incorporated into planning, policies and implementation? What is the general understanding and attitude of high level officials and policy makers towards biodiversity?

What laws exist that influence biodiversity? In particular, what laws cover protected areas, hunting, trade in animals, instream water rights, release scheduling from dams, etc.?

2. Education: Clubs, Media, Schools, Extension

What is the state of environmental education in the primary, secondary and college or university? Is there a zoological park, botanical park or national park within easy access of the urban public? Is there a national program of natural resource conservation (e.g., firewood, water)? Is there a magazine on wildlife and environmental concerns within the country? Are there radio and TV programs concerning the environment and wildlife? Are there "nature clubs?" Are there local organizations for reforestation, anti-fire or anti-poaching that have access to educational material? Do the national parks have any educational material at park headquarters? Is there a book on the environment and the wildlife of the nation in the spoken language(s)? What is the Ministry of Education's attitudes and needs for a program that would include biodiversity and natural resource management? Is there cooperation between local villages and the extension program?

3. Religion and Culture

What religions and cultures have any ethics that incorporate biodiversity (e.g., sacred forests, taboos against killing certain species, species that are national symbols)? Are there cultural attitudes that can be incorporated into an environmental ethic?

4. Donors and International Aid

List donors and projects involved with environmental manipulation that could effect biodiversity concerns. Are these projects aware of biodiversity concerns? What can be done to change USAID projects by addition or correction to more fully incorporate biodiversity? What can be done in projects in which the United States is a participant

donor (e.g., the World Bank)? What projects can be funded to help increase sensitivity and incorporation of biodiversity?

E. Conclusions and Recommendations

What existing projects have highest priority? Can additions be made to existing projects to take biodiversity into account? What new projects have highest priority? What policy changes are required by U.S. government donors? How can the Peace Corps play a role in any of these projects? What policy changes should the nation involved be encouraged to make?

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OPPORTUNITIES FOR SUSTAINED DEVELOPMENT

Successful Natural Resources Management in the Sahel

Summary

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Summary

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Preface

In February 1987, the Africa Bureau approved the Plan for Supporting Natural Resources Management in Sub-Saharan Africa (PNRM). The focus of the PNRM is achieving sustainable increases in agriculture and rural income where agriculture includes production of food and export crops, livestock and wood. The PNRM grew out of A.I.D. experience indicating that sustainable production is directly linked to the long-term condition of soils and vegetation and to the maintenance of habitats that harbor genetically-diverse flora and fauna. Under the PNRM, agricultural development is necessarily considered a sub-set of natural resources management (NRM). The PNRM reflects growing congressional and public concern about investing for sustainable impacts in Africa. Under the Development Fund for Africa, (DFA) the African Bureau is expected to target 10% of the development budget towards natural resources management activities.

The Sahel Sub-Regional Natural Resources Management Assessment Report (SSRA), including an executive summary, is one of the essential steps in implementing the PNRM. It is the result of several months of Africa Bureau-sponsored field research designed to address an important aspect of the problem of development sustainability.

The SSRA was conducted in the Gambia, Mali, Niger, and Senegal. The scope of work for the SSRA team called for its members to examine first-hand those farmer-based initiatives that were having enduring impacts and to describe the conditions under which the impacts were occurring. Sustainable development, because of its cross-cutting nature, requires us to know more about agriculture, economics, the environment, national institutions and their policies and the socio-cultural milieu under which small producers conduct business. Sustainable development also requires us to have a sound analytical understanding of the relationships among the elements of a production system in order to understand the system's resiliency and ability to withstand shock and stress, both externally and internally imposed.

This report focuses on a host of on-farm agricultural production practices that show promise for sustainable agricultural growth in the four Sahelian countries studied. It was prepared by a team of experts assembled by Energy/Development International under the coordination of Michael McGahuey, Agroforester, Natural Resources Branch, Agriculture and Natural Resources Division, Office of Technical Resources, Bureau for Africa. Volume One provides an overview and findings of the assessment and presents the recommendations.

Volume Two provides an in-depth description and analysis of each of the seventy initiatives studied. The Financial Analysis Annex (Volume III) provides a menu of potential interventions and a cost and benefit analysis. The Biological Diversity Annex (Volume IV) reports on how interventions affected biological diversity of an area and the potential for integrating biodiversity concerns into future programs.

Compilation of this report would not have been possible without the inputs of many people. Mission personnel in each country contributed countless hours in preparing for the team's visit, facilitating their work in-country, and reviewing their findings. Special gratitude is extended to officials of the government of the Gambia, Mali, Niger and Senegal who provided the team with basic information and guidance. A large number of professionals, inside and outside of A.I.D., also reviewed the draft reports and made substantive contributions.

We intend this report to be the beginning of a process rather than an end product. The wealth of information presented in this four volume report provides a number of lessons for strengthening country action programs for sustainable agriculture. It also should assist the Africa Bureau in its long-term strategic planning and donor coordination efforts. Most importantly, it should be noted that the seventy interventions described represent but a portion of the management strategies being used by innovators who could serve as models for host country and donor investments that help farmers to help themselves.

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10/19/88

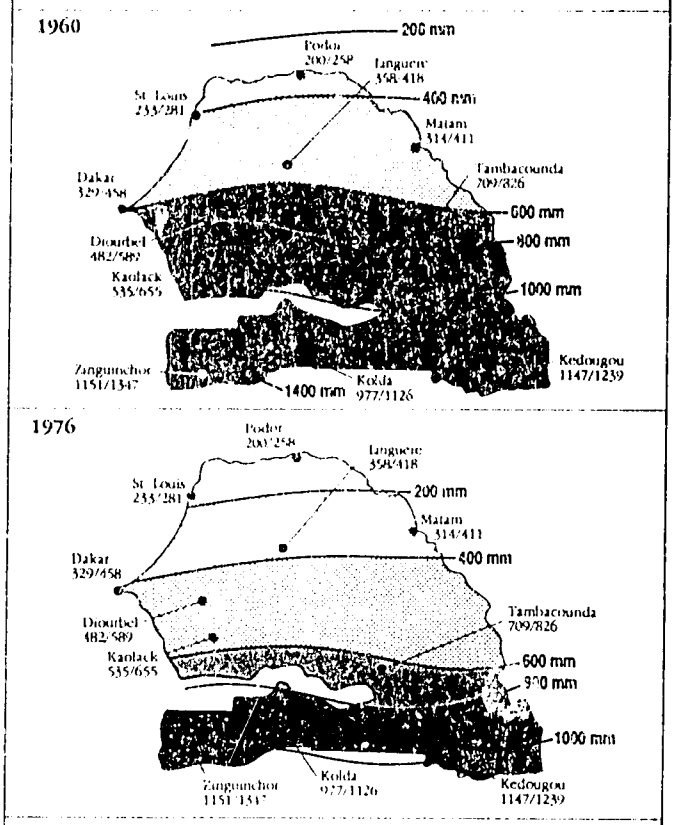
1

The Rapidly Changing Context

Natural resources are the long-term capital on which a nation builds and grows. Every nation starts with a specific endowment of water, soils, minerals, plants and animal life. It must manage this endowment well in order to improve the livelihood of its human population, including its terms of trade with other nations. The management of natural resources -- of the nation's ecology -- is inseparable from the nation's economy. When the ecology is stressed by drought and rapid population growth, natural resources management becomes increasingly difficult. Reaping short term benefits may sacrifice the long term quality and quantity of the nation's natural capital. This is the situation in the West African Sahel today.

The basic parameters of economic development are no longer the same as in the pre-drought period. For the last sixteen years, rainfall has remained about 60% of pre-drought levels. The Niger, Senegal and Gambia rivers have shrunk drastically. Saltwaters have moved inland into the groundwater. Wells have dropped as much as 75 feet. Forests and grasslands have become increasingly fragmented. Some productive trees, grasses and other valuable species have completely disappeared. Brush fires have become harder to control. Reduced numbers of pollinators and greater distances between plants have reduced production; seed dispersal has been reduced. Traditional fallback foods can no longer be found in quantities sufficient to harvest. The Sahel's natural bank account has been depleted. In some areas, this depletion is so severe that ecological knowledge has been lost between the last generation and today's children.

Sixteen Years of Climatic Change in Senegal



Isohyets of mean annual rainfall in 1960 and 1976 showing southward migration of drought by 113 km. Each city shows the mean amount of rainfall for the last 16 and the last 30 years. The last 16 years show reduced mean rainfall at all stations.

The decline in rainfall has lasted long enough to kill off some native vegetation and block certain agricultural practices. The rainy season has shrunk, preventing crops from growing to full maturity. The Sahara Desert has effectively moved south, undermining prevailing land use practices. Development projects which assume pre-drought norms have doomed themselves to failure.

. the rural economies of the Sahel, this profound change in the resource base has wrought permanent changes in agriculture, herding, fishing and, more generally, the uses of land, labor and natural capital. Drought has intensified resource conflicts between human populations and between humans and wildlife. At the same time, the situation is now more open to innovation to deal with increased pressure. Everywhere we saw people substituting their own imagination, technical skills and energy for what were once naturally occurring gifts of rain, dependable crop yields, grazing pastures, forests, rivers and groundwater. In looking at the Sahelian struggle, we saw a cup half full, not half empty.

Biodiversity
The Neglected Natural Resource

In simplest terms, biodiversity is what natural resource scientists call "germplasm". Most people know germplasm as packages of genetic materials called animals and plants -- everything from rice to elephants, mushrooms to aardvarks. But biodiversity means more than just species. It includes the maintenance of these species in quantities sufficient to ensure their survival in the future. Maintenance of biodiversity is easiest and safest by maintaining the community of species which supports it and which it helps support. In West Africa, this includes five major biotic communities: the Sahara Desert, the Sahelian shrub/tree drylands; the Sudanian dry forest; the coastal estuaries and near-shore islands; and the freshwater rivers. Within each of these communities are finer distinctions of unique complexes of self-supporting germplasm.

The best known focus of biodiversity is threatened and endangered species. This illustrates the two-pronged focus of biodiversity. On the one hand, there is a need to maintain species that may not have an immediate or well understood human use. In West Africa, this list might include animals like the wild dog, pygmy kingfisher or ground hornbill. These species may continue to exist only in protected areas, where the immediate goal of biodiversity is a sanctuary, as a reference biotic community (to understand the changes wrought by humans) and as an educational setting.

On the other hand, there is a great need to maintain diverse species which have human uses. These include animal species such as the endangered manatee which is sacred within many local religions and a drought fallback food; plants such as disappearing millet varieties resistant to disease, drought or bird predation; amd trees endangered by the drought or over-exploitation such as kouf, which has a long tradition of medicinal and religious uses.

For purposes of this assessment, biodiversity addresses the maintenance of variety in both the natural and human environments. It can be contrasted with activities which reduce species richness and population abundance. Its three broad concerns are: habitat types, species and crop varieties (germplasm). In reality, it is impossible to separate the human and natural environments in the Sahel. In most cases, the human ecology of biodiversity is crucial for both conversation and sustainable development.

2

Successful Initiatives in the Sahel

Criteria for Defining Success

Fundamental to our approach was the idea that success cannot be attributed to technical measures alone. Incentives -- social, economic, policy -- play an equally important role. We saw many examples of potentially excellent technical measures which failed for lack of workable incentives systems, and of even marginal technologies which had a positive impact because policy and incentive signals fostered innovative solutions. Extension and training have successfully complemented economic reorganization as well as the transfer of technical skills. Often the underlying socioeconomic changes took years to mature, but sharply accelerated technical change once they took hold. There is widespread evidence of misjudgment by donors and host governments who have neglected the necessary socioeconomic restructuring, and abandoned valuable efforts because they did not achieve short term technical results.

Has Anything Worked?

The simple answer is yes. The team visited 70 promising natural resource management initiatives in the four countries. We saw some striking successes which had visible impacts, sometimes on large populations. We include in this category the A.I.D. sponsored Guesselbodi Natural Forest Management project, the Maggia Valley Windbreaks and the Mali mud stoves program. Typically the large scale successes involved many things happening at once: technical interventions, new socioeconomic incentives, policy change and a changing economic and natural context. We also saw dramatic examples of private initiative which have proven that there are strategies for intensified land management which rely primarily on labor input and which improve soil and water conservation and soil fertility, diversify production and reduce the risks of rainfed agriculture -- in short, strategies which are replicable.

Successful Initiatives Seen

Soil and Water Conservation

Mini check dams
Gully check dams
Dune stabilization
Water retention dikes
Microcatchments
Sheet erosion reclamation
Living hedges
Water retention dams
Contour ridges
Channel protection

Forestry and Agroforestry

Pole plantations
Intercropping
Private nurseries
Water harvesting for trees
Private woodlots
Windbreaks
Sacred woodlots
Forest management
In-field protection
Forest reserves
Living hedges

Socioeconomic and Biodiversity

Direct payment for forest management
Direct payment for tree planting
Upgrading village infrastructure
Free seedlings, equipment, TA
Farmer visits to "model" sites
Long term NGO commitment
Food-for-work
Extension-supported diffusion
Conflict resolution
Organization of cooperatives
Market incentives
Productivity sustaining incentives
Reinforcement of local institutions
Alignment with core values
Environmental education
Prizes in kind for performance
Public awards and honors
Sanctuaries and protected areas

Policy and income improvement

Exemptions from local permit fees
Exemptions from forest service fines
Renegotiating resource management rules
Permitting new local organizations
Increasing forest products prices
Providing local tree tenure
Law requiring improved stoves
Rising relative resource costs
Enlisting local values in resource management

Successful Initiatives

- **Water Conservation:** Recently introduced water conservation techniques seen during the assessment included: water retention dams; water harvesting catchments; channel protection dams; contour plowing; vegetative strips; tied ridges; and windbreaks. Interviews in Mali, Niger and The Gambia suggest that even efforts which exceed local technical, financial and organizational capabilities may prompt further local action with the help of outside assistance.

- **Soil Conservation and Fertility Improvement:** Contour ridges, comprehensive watershed management techniques, dikes, protection dams and contour berms are examples of successful (i.e., low cost, widely used and simple) soil conservation interventions. Windbreaks, check dams, diversion bunds, channel protection dams and water harvesting are becoming more widely adopted. Even where soil conservation and fertility improvement measures have been successfully introduced, the team noted a need for greater skills and authority transfer from project staff to the farmers themselves.

- **Forestry and Agroforestry Initiatives:** Forestry interventions in the Sahel are remarkably diverse -- the traditional coexisting with the modern. Overall, comparison of the experiences of large reforestation projects suggests that where the market exists, fire and construction timber can be produced economically on a decentralized basis using native species and selected exotic species. Multipurpose forestry and land use interventions are promising successors to industrial plantations involving monocropping of exotic species, which have failed throughout the Sahel.

- **Biodiversity Initiatives:** Maintaining biodiversity is not a high government priority, but is sometimes valued by local farmers. Few farmers, however, work actively to maintain species diversity, as the notion of successful intervention is still relatively novel. In virtually all cases where biodiversity was threatened, so too was food sustenance and/or income generation. The most successful biodiversity sustaining or improving initiatives were those which integrated economic incentives with biodiversity themes.

- **Socioeconomic Incentives:** Where cash returns are available, technical assistance and other outside inputs are required primarily as "trigger mechanisms" to overcome initial technological or organizational constraints. The high cash value of poles, for example, constitutes a strong market incentive for farmers, as macroeconomic conditions and market demand provide an income opportunity which can be realized through investment in the land. While direct payments raise many questions regarding sustainability and the creation of potential dependency relationships, they have attained visible, successful results. Food for work incentives have been successfully used as a bridging mechanism to help local populations initiate more sustained resource management. Direct employment of villagers has successfully stimulated an initial active participation by villagers in resource management. After this initial paid effort, the upgraded land is then turned over to the village cooperative, which is provided with technical skills and advice to ensure continued profitable management. Visits to model sites by villagers, subsidized self development and training, and awards have also helped ensure success. Also, collective projects with shared or rotated benefits have reinforced moral incentives to participation.

- **Policy and Income Enhancing Incentives:** Perhaps the most valuable policy changes allow local communities the freedom to organize natural resources management systems within general resource-sustaining guidelines. Crucial to policy is sound research, e.g. land planning maps and forest classification maps, which provide strong foundations for future programs.

Discussion Of Initiatives

Cultural Ecologies: Site visits encompassed the major cultural groups represented in the four countries. The most successful extension and outreach approaches have been adapted to cultural differences in these groups, and in subgroups within them. We also observed, however, a tendency towards the breakdown of historical patterns of specialization in land use management by different ethnic groups, primarily in response to economic and environmental changes. This homogenization of ecosystem management approaches by groups which historically occupied distinct "econiches" has increased resource competition and made the environment more vulnerable to further climatic and economic stress.

Scale, Intensity and Timeframe: The team saw successful initiatives which varied tremendously in geographic scale, extension intensity and timeframe of impact. The most successful initiatives included privately-initiated, single farmer efforts as well as huge, arrondissement-wide public projects. In most instances, however, resolution of local constraints and responsiveness to locally-occurring opportunities stood out as distinguishing characteristics. With respect to timeframe, we found that the time lag between when a population was introduced to new techniques and when it began adopting them was at least as important as the time it took for a given technical approach to bear fruit once it was adopted.

Types of Technical Assistance: All kinds of technical assistance have proven successful in NRMS interventions. Paternalistic extension methods and extension of themes which conflict with local knowledge and economic incentive systems are less successful than interactive approaches to extension. Typing personnel evaluation more tightly to favorable natural resource management outcomes might improve technical assistance performance generally.

Source of the Initiative: Top down, bottom up, policy to field, and field to policy have all proved successful. Regardless of the source of the initiative, some sort of external "facilitator", "culture broker" or technical assistance lobby usually intervenes to motivate interested parties to change the status quo in resource management practices.

Conclusions

At one level, the diversity of the successes we have seen suggests that many things can potentially work. The process of extracting useful conclusions from such a diverse set of observations is based primarily on judgment and partially on analysis.

Attributing Success: Initiatives have had the greatest impact when they have broadened the definition of what constitutes a natural resources management intervention: that is, when approaches have resolved the problems of the populations involved rather than of the environment per se. Creating opportunities for income generation from natural resource management has been as much a successful intervention as the introduction of specific technologies.

Defining Objectives: Attributing success to an intervention also depends upon how objectives are defined. While a specific intervention may be successful in a given area and replicable in many others, the context of a given areas must be taken into consideration before replication is chosen.

Timeframe: In general, a minimum ten year time frame is required for natural resource management initiatives to mature. The time needed to achieve visible impacts appears to increase with the novelty of the techniques, competition for resources, and inexperience of technical assistance. Time requirements have been shorter in the presence of market incentives and supportive values, policies and social structure.

The Importance of Process: Projects which sometimes offer little tangible product, but in which a process of mutual accommodation and adaptation of techniques and extension methods between implementing agencies and participants is permitted to occur over time, often seem to be the most promising. Simply put, "doing something right" is as important as "doing the right thing".

Using Local Values: Values play a critical role in sustained success and are critical to replicability. An intervention which is an indisputable success in one culture may have to be significantly altered before it will be adopted by another cultural group.

3
Financial Analyses

The financial analyses presented in Chapter 4, Volume 1 and in much greater detail in Volume III of this report were made from the farmers' perspective -- the investment decisions they will have to make in order to improve the productivity of their land. What would entice farmers to forego alternative uses of their time during the off-season, or work harder during the peak planting season, in order to undertake land improvement interventions? The common denominator for nearly all of the interventions described in the study was that they made financial sense to the farmers.

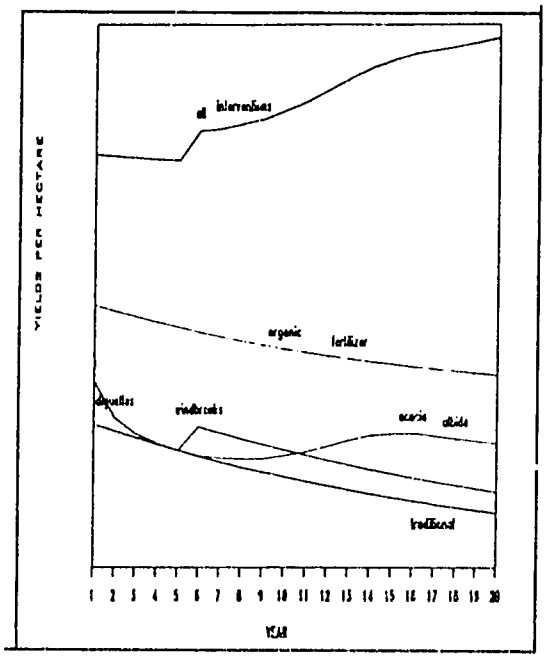
The analytical approach taken was simple. It was assumed (and documented as accurately as possible in the field) that land productivity declines over time in the absence of any land improvement interventions, and that productivity is fractionally and/or fully restored as appropriate interventions are applied. The difference between the presence or absence of interventions measures the extent to which the farmers benefit. The analyses weigh these differences against the costs the farmers would have to incur in order to obtain the crop yield increases as measured. If the present value of the increased crop yields exceeds the present value of the costs, given a relatively high discount rate to reflect a Sahelian farmer's typical aversion to risk, the intervention would be judged financially feasible.

A break-even approach to determine feasibility was used where the information on benefits (or the extent to which crop yields increase in response to an intervention such as contour ridges) was not available. This approach estimated how many additional kilos of crop yield the farmer would have to produce in order to recover his investments of time and/or money in the interventions. For example, if an additional 30 kilos of millet would have to be produced per hectare per year for the farmer to break even on his investments of time and money, and if agronomists familiar with the site estimate that the intervention will increase production by at least 100 kilos, then one can safely conclude that the intervention would be financially attractive to the farmer.

The results of the financial analyses were encouraging. Given the realistic assumptions used, the interventions described in the study should be financially attractive to farmers. The major blockage to large scale replicability is diffusion of the technologies in areas where they are appropriate and with the site-specific adaptations that will be required to reflect differences in socio-economic and ethnic backgrounds, the resource base and markets. Interventions that are most financially attractive should require no direct financial incentive to attract farmer participation. Where interventions are less financially attractive, some form of cash or in-kind direct incentives may be necessary in order to attract the desired level of farmer participation.

The summary graph below illustrates the anticipated impacts on crop yields of several interventions. The bottom line (traditional farming) illustrates how crop yields will gradually decline over time in the absence of any land improvement interventions. The other curves show the timing, level and duration of estimated yield increases for each individual intervention, and for major combinations of interventions. The most significant observation that can be made is that all of the interventions buy the farmer additional time before the land has to return to fallow. Where the traditional farming (base case) curve and intervention curves diverge, however, land productivity is improving over time, which means that return to fallow can be postponed indefinitely. This is a significant environmental benefit since the pressure to clear additional land to replace recently fallowed land will be lessened. As this pressure is reduced, land not in cultivation can remain in fallow longer, thereby further increasing the fertility of the soil. This land will be more productive when it is eventually brought back into production.

Impact of Interventions



A Case Example
Private Initiative for Intensified Resource Management

In the village of Pelesoko, near Mopti (the 5th Region of Mali), Angel Togo has four hectares of millet fields. In recent years, rainfall has declined, with some years of severe drought. This is a major transhumance area. Land is scarce, as is competition for resources between farmers and herders. Fallow periods have decreased and in some cases agricultural land is kept in continuous production. Land degradation is widely evident.

Angel Togo had served in the French Army, travelling to Indochina and elsewhere. Through military pay and retirement benefits, he has had access to some cash income in his later life. When he retired from the army in 1982, he obtained free eucalyptus seedlings from the Forest Service. His motivation was economic, aesthetic and "cultural". He specifically mentioned the desire to break out of the cycle of diminishing millet yields, to lower the workload in his old age and to have something more than barren fields to pass on to his sons.

Since 1982, Togo has planted 3000 eucalyptus trees on his four hectares. He began with a few dozen seedlings obtained from Eaux et Forets, and has increased plantings every year since. The trees are planted in windbreaks, as borders around the fields and in other locations as he saw fit. He uses nearby streams to water seedlings during establishment, and has recently dug a well. In addition to eucalyptus, he has planted guava, tamarind and other species for products which can be marketed. He has a variety of garden crops and also grows millet to meet the needs of this small family. For new species and initiatives, he receives both advice and free seedlings from forestry agents.

In areas used for millet, he has both planted and protected the natural regeneration of Acacia albida. His millet yields appeared substantially better than surrounding fields, and several of his neighbors present commented that his yields were better than most. Mr. Togo has planted live fencing around many of his garden crops, which he said were for protection and to hold the soil.

By tradition, the land is his, but he has no legal title. His improvements to the site have increased his sense of property ownership. By law, in order to harvest wood from the trees, he still requires a "free permit" from Eaux et Forets, which he has always been able to obtain. He does not require one for each cutting, but either seasonally or on a one time basis.

Mr. Togo's land has attracted a great deal of attention from neighbors and from visitors, the interest of each tending to reinforce that of the others. His fields stand apart from the relatively barren surrounding landscape. Mr. Togo's immediate neighbor, Abdulahi Traore, was present at the interview and said after seeing the eucalyptus growing he obtained seedlings from Angel Togo and planted them three years ago. He pointed to his fields where several hundred trees of about 7-10 meters each were visible. In the last three years, farmers from four villages have come to ask Togo for eucalyptus seedlings. When he has them, he gives them for free. He has provided approximately one hundred farmers with 5-15 seedlings each to date.

Within the next few years, he plans to build plantings to a total of 5000 eucalyptus, and to increase his already substantial Acacia albida, live fencing, garden crops and other tree species. It is noteworthy that through his eucalyptus plantings to date, he has created a standing volume of poles with a market value of 3,600,000 CFA francs. If he achieves his goal of 5,000 eucalyptus, and with expected increases in the real price of poles, he will have formed new capital in the order of 5 to 7 million francs ($16,000 to $23,000) from the eucalyptus alone. The value of windbreaks, garden crops, a well, in-field plantings of Acacia albida and other improvements, could well increase that figure by 50%.

Based on a brief visit and interviews, and given the background knowledge on the soils and environment, the team believes that this example has increased sustainability of productive land-use and water management, nutrient cycling, biological diversity and economic activity. If Angel Togo can serve as a "model", it is on a localized basis. Critical is the access to water, and the soil conditions under which the first trees took root and flourished. That he is a local model is already established. The team estimates that between 5,000-10,000 farmers may reasonably draw from his specific technical interventions. The socio-economic ground he has broken has wider applicability, and innovative farmers in other zones are already breaking similar ground with wholly different technical approaches more suited to their environment. Few farmers are likely to duplicate that absolute level of success he has achieved, however.

4
Principal Findings

1. Intensive application of human energy has regenerated degraded land and created productive microenvironments

The Potential: Natural regeneration, planting of windbreaks and use of water catchment dams are among the principal methods being applied to create protected microenvironments. A number of farmers have gone the next step to diversify their activities, providing new fallback mechanisms and creating opportunities for some cash income.

Issues Requiring Attention: The absence of land tenure rights stands as a major impediment to farmer initiative. Successful initiatives have either negotiated specific exemptions to existing resource tenure legislation or have succeeded in spite of that legislation. Improved training of technical agents to reorient them from a policing to an outreach orientation is an important issue to be addressed.

2. Successful "farmer-innovators" have provided powerful role models

The Potential: Innovators are set apart by their prior exposure to new and different cultural influences, often combined with some previous access to cash income. Initial ventures were often treated with skepticism and sometimes ridiculed by other farmers, but their success has subsequently been copied.

Issues Requiring Attention: An effective approach has been that of taking ordinary farmers from a project area to visit the farmers who have implemented new techniques, rather that utilizing outside experts to educate farmers. This approach, used in concert with national publicity campaigns, use of mass media and organization of village councils and women's groups, has contributed to achieving widespread participation at relatively low cost.

3. Public policy changes have increased incentives for more rational natural resource management by small farmers

The Potential: In the Guesselbodi project, the empowerment of village cooperatives to manage local resources and the exemption from taxation as commercial enterprises have created income generation potential and mobilized village participation. In the Mali Village Reforestation Project, removal of the policing role of forestry agents has increased villagers' receptivity to extension services. In Mali, years of field extension and training, mobilization of local organizations, national publicity campaigns, and direct political mobilization through the Party have culminated in dramatic success in the campaign to spread the use of more efficient earthen woodstoves.

Issues Requiring Attention: Conflict resolution remains under emphasized and under funded as conflicts resulting from a worsening environmental crisis and heightened competition for resources increase. Environmental crisis has created the need to invest in private land to protect it from degradation. Insecurity of tenure has reduced the incentive to make such investments. Lack of land tenure was a constraint to replication of successful initiatives in every country visited. Failure to address legislative obstacles to private initiative can raise the cost and lower the success rate of all future natural resource management efforts in the region.

4. Successful resource management initiatives have improved the climate for subsequent efforts

The Potential: Access to a "capital reserve" generated by an initial natural resources management activity has allowed many small farmers more freedom to try soil protection measures which they view as intrinsically more risky because they directly affect their agricultural plots.

Issues Requiring Attention: Environmental benefits of different initiatives must be judged in terms of their microeconomic impacts, <u>and</u> in terms of their effect in relieving pressure on the overall environment.

5. Successful natural resources initiatives involved both technical interventions and socioeconomic incentives

The Potential: The right socioeconomic incentives have allowed marginal techniques to succeed, and their absence has caused excellent technical approaches to fail. No single technical approach is likely to be sufficient to stabilize the Sahelian environment. The pattern of adoption of selected initiatives will follow local incentives rather than global priorities.

Issues Requiring Attention: The rational first choice in resource management options for farmers will not always be the measure which maximizes long term returns. Rather, it may be the one which increases the short term margins for risk taking. Offering and demonstrating a range of viable options increases the "surface area" through which technology transfer can occur.

6. Sustainable initiatives which provide immediate benefits have brought about smallholder participation

The Potential: Actions to be taken by smallholders must offer sufficient incentive to mobilize widespread participation. At the same time, the recurrent budgetary costs of providing incentives must be low enough that government can afford to replicate them widely.

Issues Requiring Attention: Assuring financial benefits to participants has proven to be a successful approach to eliciting smallholder participation. "Buying" participation may, however, foster, sustain and reinforce the impression that better resource management is in "someone else's" interest and must therefore be paid for. One successful approach effectively combats this attitude by limiting its subsidy to the startup phase, after which the village initiative responds to market incentives. In many cases, the discrepancy between individual and social rates of return for resource protection may, in fact, warrant some initial subsidy, since farmers may be receptive to improved resource management but lack the margins of survival to adopt them.

7. It will take twenty years or more before impacts from successful programs become visible on a large scale

The Potential: Long-term commitment, the willingness to learn from mistakes and try new approaches and the flexibiity to adapt goals to new opportunities as they arise are important contributors to success.

Issues Requiring Attention: The obstacle is more the time needed to bring about participation than the time needed to realize benefits once a technology has been implemented. It is the human, rather than the technological, dimension which takes time. Adaptation of technologies and incentive systems to spread them has often been a slow process, and the minimum time horizon is commonly estimated to be twenty years in the Sahel.

8. Providing increased economic opportunity to local populations has played an important role in successful efforts to maintain biological diversity

The Potential: Relieving local economic pressure and creating new income-generation opportunities, though slow and arduous, has had greater success than the attempt to simply protect resources which local populations have little choice but to exploit.

Issues Requiring Attention: It is extremely difficult for governments to prevent encroachment on protected areas unless the surrounding populations are given a positive stake in their preservation. Because local economic and environmental pressures necessarily vary from one location to another, alleviating them may require relatively long lead times and patient work at the "micro" level. Because of its long term nature, environmental education can contribute to increasing the understanding of the importance of environmental protection and of the potential solutions to resource competition conflicts.

Strategy Guidelines

From the major findings of the assessment, and from the themes which recur across the initiatives we observed, we have drawn the following strategy guidelines:

Provide clear, consistent policy signals on resource tenure, local management rights, national political support and mobilization, prices and access to credit.

Focus on incentives for local participation. Offer a range of technical and socioeconomic options and allow for flexibility and adaptation.

Local trainers and intermediaries are more efficient and cheaper than outside agents.

"Model farmers" and resource managers provide strong and positive demonstration effects.

Assure a stable long term commitment to the natural resources sector. The rural economy is changing rapidly, and short-cycle projects fail to capitalize on those changes. Abandoned projects have a negative demonstration effect.

5
Conclusions

Priorities

There is a sufficient range of technically proven and economically attractive natural resource interventions available to halt the decline of rural production systems in the Sahel. Better technological packages can and should be developed, but technology is not now the limiting factor. The greater development challenge is to bring about widespread adoption of the appropriate technologies.

Donors and the public sector will have an important role to play in training and outreach to make viable approaches available to smallholders; in providing technical assistance during initial phases; and in cost-sharing where direct benefits are insufficient to bring about participation, but where high environmental benefits warrant priority allocation of limited public budgets.

A Contract with Sahelian Populations

Arresting the decline of the rural production base in the Sahel will take concerted action over the next generation, built on a long term contract between Sahelian populations, national governments and the international donor community. Each party to the contract must share the costs of resource management. For the public sector, it is far cheaper, even in budgetary terms, to share the cost of success than to remedy the effects of failure.

Before proposing a long term strategy, it is useful to state explicitly what a successful strategy can achieve. Ultimately, we define success in human, rather than biophysical terms. Protection of the rural production base directly affects the priority concern of rural populations and therefore offers the greatest opportunity for success. Intensified management of farmland, as we have seen, also decreases pressure on the rest of the environment over time.

Opportunities for a Natural Resources Strategy

Biophysical

Goal: To establish management systems which protect natural capital and are capable of supporting the needs of the rural economy. Focus on soil fertility improvement, soil and water conservation and protection of vegetation.

Opportunities: The principal measures in the "menu" of options are shown in the table on page 113 of Volume I.

Economic

Goal: To increase opportunities for income generation through sound natural resources management practices, and to capitalize on changes in the socioeconomic context which can create new opportunities for natural resource management.

Opportunities: The four areas of opportunity recommended in Volume I include: markets and cash income, cost sharing, risk sharing, and credit.

Institutional

Goal: To bring about those institutional changes necessary to encourage and support widespread adoption of available technologies.

Opportunities: Two management principles which have been neglected and merit immediate attention are stable commitment of resources and coherent management of long term strategies.

Policy

Goal: To create a policy environment which either provides or ceases to inhibit rational incentives for smallholder participation and investment in natural resources management.

Opportunities: Three policy reform priorities are outlined in Volume I: land tenure, resource management rights, and resource pricing.

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Recommendations

Priority 1: Spread Existing Technologies

As the highest priority at all funding levels, stress the *deployment* of existing technologies which have positive and financially attractive impacts at the farm and/or village levels and which help to meet criteria necessary for a sustainable system.

Deployment of existing technologies and strategies were observed to have substantial and enduring impacts on the capacity of farms and villages to produce food, forage, wood, and other products. Farmer acceptance appears to be as dependent on risk reduction as on the potential for yield increases. Opportunities to earn cash income which reduces economic risk can be a powerful motivating factor.

Priority 2: Increase the Productive Potential

At the medium and higher funding level, support research that reduces risks and increases efficiencies of higher yielding technologies and germplasm. Plan to introduce results of this research where currently available methods to improve natural resource management have been successfully adopted.

Field evidence strongly suggests that the efficiency of higher yielding technologies and germplasms will be increased when existing methods of soil and water conservation and fertility improvement have already been applied.

Recommendations by Intervention Category

Soil Fertility Improvement: Focus resources on supporting regeneration of field trees, on manure management, on mineral fertilizer and on improving rhizobium adaptability.

Soil and Water Conservation: Extend actions which reduce soil erosion and which increase the soil's capacity to retain available water.

Maintaining Vegetative Cover: Support establishment and maintenance of a permanent cover of woody perennials.

Training and Human Development: Increase the capacity of personnel to manage soils and vegetation; encourage linkages across sectors; support advanced training of personnel capable of establishing priorities and plans for management.

Sectoral Collaboration: Use diversified A.I.D. portfolios to encourage collaboration.

Focussing Resources on Strategic Goals: Promote host country and multi-donor agreement on strategy objectives over a twenty to thirty year time frame; and creation of a more structured coordination process for monitoring of progress and allocation of scarce donor and government resources.

Resource Tenure: Work to establish clearer and more secure tenure systems.

Tax Incentives: Support policies to reflect the long term economic costs of replacing dwindling wood supplies.

Financing Natural Resources Management: Encourage the creation of "revolving funds" managed at local and village levels to provide credit to small farmers for improved management.

Contingent Incentives: Provide cash or other incentives -- contingent upon implementation of a package of natural resource management activities.

Soil Fertility Research: Support agroforestry and manure management research; mineral fertilizer research to complement agroforestry and manure management, and link it with water conserving research.

Soil and Water Conservation Research: Emphasize contour dikes, late season plowing and windbreaks.

Vegetation Management Research: Findings on the carrying capacity of natural vegetation will be extremely important in establishing principles for local resource management.

OPPORTUNITIES FOR SUSTAINED DEVELOPMENT

Successful Natural Resources Management in the Sahel

This document summarizes the Main Report (Volume I) of a four volume assessment of successful natural resources management initiatives in Mali, Niger, Senegal and The Gambia.

Volume I	Main Report
Volume II	Case Descriptions
Volume III	Financial Analysis of Interventions
Volume IV	Biodiversity

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