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OCDE/OECD

ORGANISATION DE COOPÉRATION ET DE DÉVELOPPEMENT ÉCONOMIQUES
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

CILSS

COMITÉ PERMANENT INTER-ÉTATS DE LUTTE CONTRE LA SÉCHERESSE DANS LE SAHEL
PERMANENT INTERSTATE COMMITTEE FOR DROUGHT CONTROL IN THE SAHEL

CLUB DU SAHEL

SAHEL D(89)327
August 1988
Or. Engl.

RESTRICTED

ECOLOGY AND RURAL DEVELOPMENT IN SUB-SAHARAN AFRICA: SELECTED CASE STUDIES

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Key Words: Ecology/Rural Development/Case Studies/ Soil conservation/Agroforestry/Burkina Faso/Mali/Mauritanie/Niger/Senegal/Ferlo

17915

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SELECTED CASE STUDIES

LIST OF TABLES

REMARK

The full version of this document includes several annexes, which have not been reproduced in the present version of the document, prepared for the Regional Meeting of Ségou. These annexes, to be published in a later stage, are listed below.

1. PROJET SUCCESS AND SUSTAINABILITY

   1.1 Project Success
   1.2 Sustainability

2. GUESSELBODI FOREST MANAGEMENT, Niger

3. MADJIA VALLEY WINDBREAKS, Niger

4. HORIZONTAL ROCK RIDGES IN BURKINA FASO

   4.1 OXFAM WATER HARVESTING
   4.2 GROUPEMENT NAAM/SIX "S"
   4.3 ASSOCIATION POUR LE DEVELOPPEMENT DE LA REGION DE KAYA (ADRK)

5. SOIL CONSERVATION IN THE CMDT COTTON ZONE, Mali

6. REPORT ON THE FORESTRY POLICE IN MALI

7. THE FERLO AGROFORESTRY AND PASTURE MANAGEMENT PROJECTS, Sénégal

8. HSSEY ETTINE DUNE FIXATION, Mauritania

9. BIBLIOGRAPHY

EXECUTIVE SUMMARY

The Club du Sahel commissioned a study of sustainable development in the CILSS member countries. Sustainable development was defined in terms of 1) natural resources use and 2) development activities. Eight case studies of projects and rural organizations were included in the study. Each case study included an examination of technical, economic, political and institutional criteria for sustainability.

As an introduction the study describes the causality between resource degradation in the Sahelian countries and the existing social structures and production systems. Factors responsible for resource degradation include unadaptative production systems, a disorganization of society, and unadapted aproaches to development. These factors have led to what is called a change in the cultural focus of rural society, from a subsistance culture based on agriculture, to a survival culture based on dependancy upon outside resources and overexploitation of the remaining natural resources. Sustainable development is impossible without an overall change in the social structures and production systems.

Principal findings from the study show that changes in the production system which responded to the complexity of resource use through better management of the natural resources made the greatest contribution to sustainable resource use. Non-management technologies provided a response to individual production constraints, but were unable to make significant improvement in the overall production system. Management approaches appeared to be cost effective over a wide range of ecological conditions, although the number of management based interventions currently in existance is limited.

Technological responses to production contraints were more easily (quickly) implemented than resource management approaches. Management responses to complex resource use patterns in the production system required parallel changes in the social structures to be feasible. Promoting change in social structures is both time consuming and outside the generally accepted scope of either donor or government rural development authorities.

Autonomous rural organizations provided an initial response to the necessary change in social structures. Rural organizations have been able to initiate development activities through mastery of their human and financial resources. More importantly they displayed the skills and self-confidence necessary to promote innovative approaches to sustainable resource use.

However the existing political and institutional context prevented rural people from effectively reorganizing and mastering the use of their natural resources. The exception has been where considerable initiative on the part of projects has resulted in policy changes affecting such things as land tenure, resource users' rights, and guarantees to benefits from investment in long term conservation activities. These policy changes allowed a few rural organizations to achieve greater control over all their productive resources: human, financial and natural. The greatest opportunity for sustainable development was provided by these cases.

At present and for the most part however, those in control of policies and institutions affecting resource use have little desire and limited insight into how to share or use the power and responsibility that they hold. Those who use the resources have little control over resource use. Sustainable development therefore remaine a fragmented puzzle in a puzzled world.

The case studies raise many questions concerning sustainable development. First and foremost, is sustainable development a priority ? If it is, many other questions follow. Are donors willing to modify technical and financial aid policies ? Are governments willing to put political, financial and institutional power and authority into the hands of rural people ? Are rural people willing to organize and submit themselves to considerable self-control over their use of the natural resources ? Can these measures and others be discussed and agreed upon among donors, governments and rural people in an atmosphere of respect and equality of responsibility ?

1. INTRODUCTION

This document conveys the findings of a team of consultants commissioned by the Club du Sahel to study a number of projects, activities or organizations that were felt to have made a significant contribution towards the achievement of a sustainable system of resource use in several of the member states of the CILSS. The main body of the document presents the major finding relevant to a broad audience, including a résumé of the approach used in the study. In the annexes are found: a discussion of what makes a successful project, a review of approaches in promoting development activities, and the individual contributions of the authors for each case study.

1.1 Problem Statement

This study deals with the development of sustainable rural production systems, not as an isolated or fragmented phenomenon, but as a process that involves the transformation of a whole way of life. The social structures and production systems upon which rural society depends for survival are intimately knitted together into a cultural system. Change in one of the (sub)systems results in change in the cultural system as a whole.

Sahelians have experienced change for at least three generations and on an ever growing scale. Their major experience has been that, through change, things pactically always get worse. In Sahelian countries the way of life is at stake.

Unadaptive Production Systems

The most dramatic change has been in the ability of Sahelians to feed themselves. The productivity of traditional agricultural and animal production systems is inadequate to satisfy needs. Agricultural land is "mined" of its nutrients, but not replenished. When left to fallow, it is continually grazed, preventing any renewal of its fertility. The barren soil is then eroded by wind and rainfall, or forms a crust that prevents rainfall from being absorbed. The natural vegetation of forest and grazing lands is cleared for agriculture, consumed by free-grazing animals, cut for firewood, and burned by bush fires. As matters have grown worse, a survival mentality has increasingly predominated in which every available resource is exploited simply to provide the most immediate needs.

Nevertheless, soil and vegetation are renewable resources, able to naturally replenish themselves through plant growth and the recycling of dead plant material into the soil. Sahelians are well aware of that fact, having developed traditional production systems that made use of the natural capacity of renewal to obtain their food and feed their cattle on a sustainable basis for centuries. Traditional land use rights and practices were based on natural renewal of the resources, through the practice of fallows on agricultural land, and transhumant grazing systems. Today however, in the presence of increasing population pressure on diminushing resources, traditional land use patterns present an obstacle to controlled use of resources and human intervention which could favor regeneration of the soil and vegetation. The obstacle is a question of both survival and responsibility. Regeneration requires the exclusion of resource use for a period of time, reducing the possibility of satisfying urgent needs from the already scarce resource base. Moreover, the responsibility for such action lies first and foremost with the users themselves, who hold no legal control over their lands. Therefore any such control or use restriction would only function under conditions of complete and voluntary agreement among all the users: rather utopian under the circumstances.

Therefore, in the absence of any control over resource use or regeneration, and in the face of recent growth in the needs of an expanding population, much of the Sahel has exceeded the carrying capacity of the available resources. Under these conditions, prolonged drought has been all the more disastrous for Sahelians. Survival has depended on migration to new lands, or to the cities in search of salaried employment. Today, new land is increasingly scarce, employment limited mostly to the small public sector of government, and migration more massive than ever before.

Disorganization of Society

In addition to these phenomena, the traditional society has been marked by radical transformation and disorganization through the effects of colonial structures and western education.

While some traditional leaders were undoubtedly tyrants or worse in précolonial times, most were able to effectively rule through the unanimous support of their clans or tribes. Under colonial rule, tradition leadership was used by the administration as a means of insuring the collection of taxes, transmission of decrees and enforcement of colonial law. Allegiance of leaders was no longer owed to their people, but rather to the new rulers.

Furthermore, the future leaders of the post-independence period were educated under a western system. Values and aspirations for a new and modern Africa were highly influenced by western ideas, especially as regards economic and technological theories

for development. The new educated elite class became more and more alienated from the rural people. Those who went to school had little chance to understand the significance of traditional production systems, nor gain insight into traditional institutions which had already been seriously modified.

Values of social responsibility and solidarity have to a great extent been the single most durable quality to pass from the traditional to the elite culture. However, responsibility has too often been limited to the family clan or tribe to which one's origins are owed. Traditional solidarity patterns and priorities still play a role in new government structures, making their functioning difficult to understand for westerners. These patterns created a political process for decision-making based on relations of force and allegiance among the rulers rathers than on the needs and desires of the rural populations.

Unadapted Approaches

Development aid and policy have failed to recognize the significant and deep changes that have affected the lives of the Sahelian people in a rather short period of time, or the degree to which these changes have limited the possibilities of Sahelian farmers to adapt to the new circumstances. Indeed, most development has ignored the necessity of agriculture altogether! Where cultural change has been slower and production systems less perturbed, such as Southeast Asia or South America, incremental changes induced by sectorial project intervention, through new crop varieties, fertilizers and tools, have met with greater success. In the Sahel, the project approach based on the introduction of new technology, where it has worked at all, has resulted in one-sided development of mostly cash crops at the expense of the resource base as a whole. More frequently the result has been the further disequilibrium between resources and production methods.

Moreover, development approaches are implicitly based on the assumption that the farmer is somehow sick, and that only development assistance can cure him. The effect has been to create a relationship of dependancy. In spite of the best intentions, the farmer has lost the self-confidence necessary to take initiative in adapting to change, rather expecting the answers to come from outside. The answers have not been forthcoming, and one encounters increasing scepticism on the part of farmers that farming offers any hope as a way of life anymore.

A Change of Cultural Focus

The result of all of these factors has been what might be called a general change in the cultural focus of African societies. Farming may still be a way of life for most, but it is not a way to a better life. Most rural youth today remain very attached to their natal villages. However, given the opportunity, they prefer to leave in search of temporary or permanent work in the cities or plantations of the coastal countries, or even in Europe. Others go to school in the hopes of one day having a government position. While some exceptional individuals actually opt for service in the agricultural branch, most of the low-level agents one finds there have either been given no choice, or failed to pass the entry exam for the more prestigious or lucrative jobs. Even at the national level the agricultural and resource protection ministries are generally the least funded and the least respected.

Successful rural development, based on the sustainable use of the natural resources, and in light of the trends and changes in Sahelian countries, is precluded by one very simple yet primordial question: Is sustainable rural development a priority ? If it is, it must be not only for farmers, but for national governments and the international community as well; no one of them can do it alone. The changes required must be global in scope. This implies first and foremost a change in the cultural focus of the rural societies through support both from within and from outside the rural communities. Such a change will only be possible if all those concerned are willing to look for new knowledge, to create new policies, to participate in new institutions, and to assume new responsibilities. Such a willingness, in turn, is highly dependant on who will benefit from the changes, and perhaps more significantly, who benefits more from the status quo.

1.2 Criteria for Sustained Development

A link exists between the sustainability of development activities and sustainability in terms of the preservation of an area's natural resource base:

- In spite of all other conditions being favorable for the continuation of a development activity, it is not really sustainable if it keeps reducing the natural resource base used to carry it out.

- However, the reverse does not hold true: an initiative or operation may be sustainable in terms of resource-use, but this is no guarantee that it is also sustainable as a "development" activity after outside inputs cease. Trying to explain how

ecological considerations affect project success is well and good. At the same time it must be stressed that other criteria - just as important - also must be met.

Therefore, to be sustainable in terms of both resource use and development activity, the following criteria may be applied:

Technical: New ways of doing things must first of all work. That is, they must respond to the problem as it is perceived by the people directly concerned. Development of technology is highly dependant on conception of the problem. Approaches are not neutral. Technical content is highly influenced by the approach used to define it. Sustainable development depends on new techniques which are simple enough to be replicable on a wide scale. Sustainable resource use depends on an ensemble of techniques which are comprehensive enough to embrace the complexity of resource use.

Economic: To be sustainable an activity must be "worth it" in the peoples' judgement. The basis of judging the worthiness of an action varies widely according to current satisfaction of subsistance needs, the time of year (opportunity cost of labor, prices, etc.), resources, obligations, opportunities for employment, etc. Therefore it is not surprising to find that the same technology holds varying interest to different people and in different places.

Sustainable resource use depends on long-term investment in resource conservation. Rural people can be expected to invest where short-term benefits are likely. However long term investment is influenced by both the preponderance of peoples' immediate needs and the uncertainty that they would actually benefit from long-term investments. Additionally, economic and financial feasibility are affected significantly by market and price instability, marketing policies and the availability of credit. These factors are most readily dealt with by national policies and institutions which create a suitable and stable environment within which the farmer operates.

Political: New approaches, if they are to have a significant impact on the current resource use system, must achieve approbation by the people. In some cases this may only involve the recognition of the value of doing things differently, to change social attitudes. In other cases, communal decision-making (consensus) may be a prerequisite to application of the new approach. Still others require new legislation, to modify land tenure and user rights for example, to legally authorize local management of the natural resource base by the people concerned. In all cases the people must feel that they have the right and freedom to manage local resources, and that they have a guaranteed right to the benefits, especially from long-term investments such as soil conservation, reforestation, etc.

Institutional: Closely linked to political feasibility, institutional contraints often are the direct result of policy inadequacies. Group management of resources requires viable rural organizations capable of making decisions, enforcing controls, and managing funds. Parallel institutions must be able to provide the skills, training and funding necessary to support the local organizations in their tasks. Again, perception of the problems and solutions plays a significant role in forming opinions concerning policies and institutional roles.

Approaches

The approach used to promote sustainable development is important in consideration of the criteria above. A new and sustainable resource use system, and the culture within which it must be rooted, can only be explained to people in terms of the present and known systems and culture (there are no others available). New knowledge, new institutions, new policies and new responsibilities must therefore be solidly anchored in, and derived from, knowledge and consideration of the existing situation. As new systems evolve and are assimilated, they may serve as a basis for further development and evolution. In this way, "successful" development is a step by step evolutionary process, starting with the current body of knowledge., and passing through several or many intermediary stages of adaptation towards a more sustainable ecological and cultural system. In all likelihood a final steady-state equilibrium will never be attained, as changes constantly provoke further evolution. Therefore an essential aspect of any approach must be its ability to adapt and evolve as new constraints are confronted, and as new opportunities present themselves.

Any approach should be able to respond to the following straightforward line of inquiry:

a) What makes sense to the people involved ?
b) What are people doing now, and what can or will they do ?
c) What would they do if not for constraints ?
d) What are the constraints ?
e) What can be done about them ?

The simplicity of relying on knowledge attained through communication to resolve these questions belies its utility. Nevertheless development has all too often been targeted, with objectives and indicators of success defined before any money is released: the project is assumed to be a simple execution of functions and tasks.

Under those circumstances there is no room for overall reflection and re-evaluation; communication is limited to questions of "Who" and "When", the "How" and "Why" having be written in stone before the first stone was laid.

2. METHODOLOGY

Eight projects were selected from among those known by the authors, generally from direct experience. An effort was made to include projects or programmes from a variety of sectors and ecological zones. Table 1 is a list of the projects reviewed in the study and their respective zones.

TABLE 1. REVIEWED PROJECTS LIST

PROJECT	PRINCIPAL SECTOR	ECOLOGICAL ZONE	COUNTRY
1. Oxfam	Horizontal rock ridges/agriculture	Sudano-sahel	Burkina Faso
2. Six S/ Group. Naam	"	"	"
3. ADRK	"	"	"
4. Madjia Valley	Windbreaks/ agriculture	Sahel	Niger
5. Guesselbodi	Forest/range mgmt.	"	"
6. Hssey Ettine	Dune stabilization	"	Mauritania
7. CMDT	Soil conservation/ agriculture	Sudan	Mali
8. Ferlo	a) Agroforestry	Sahel	Sénégal
	b) Livestock/pasture management		

The introduction of new technology into farming and land use systems was the major emphasis of the majority of case studies performed by the team. However, two of the case studies were concerned with farmer based institutions (ADRK and Six "S"/Groupement Naam) as well as their efforts to introduce new techniques. One case also involved a village based introduction of dune stabilization. Therefore the variety of technology as well as the approaches to its introduction were broad.

Specific levels and categories of inquiry were made to insure a (somewhat) uniform review of the various projects. This investigative approach is most easily summarized by the matrix presented in Table 2. Projects were analysed according to the technical, economic, political and institutional criteria cited earlier. In addition, each of these criteria were examined from both a local perspective and a regional/national perspective.

A synthesis of findings relative to each of the criteria is presented in the following section (chapter 3). Included is a discussion of the significant issues affecting satisfaction of the sustainability criteria. A summary of the results vis-a-vis project success is presented in Chapter 4. Individual case studies are presented in the annex.

TABLE 2. PROJECT ANALYSIS MATRIX

SCOPE of ANALYSIS	SUSTAINABILITY CRITERIA: Technical	Economic	Political	Institutional
Local	-- increasing sustainability --->			
	increasing geographic scale			
Regional/ National	v			

3. SYNTHESIS FROM CASE STUDIES

3.1 Technical Aspects

The Issues

Rural development technology has been the occupation of specialists. It has been approached with the goal of producing products rather than managing the production systems. It has implicitly ignored the interrelated nature of the production systems. It has implicitly ignored the interrelated nature of the production system, resource base, and society. For example, agronomists have focussed on short term maximization of yields. However, it has become apparent that farmers in the Sahelian countries are more concerned with risk reduction. Protection of the natural resources upon which production is dependant has not been the occupation of the agricultural services. However, the service which does retain responsibility for resource conservation and protection is not concerned with agricultural land. Grazing land has also been ignored; the services responsible for livestock development have been predominately staffed with veterinaries preoccupied with animal health. A more universal, systems approach is needed in technology development.

Resource use in the Sahelian countries is a complex issue. One of the major impediments to sustainable resource use is the multiplicity of users and uses made of the resources. The tools for dealing with complexity are organizational. Therefore improved organization (management) of resource use is considered an important aspect of technology development. Additionally, both technological improvements and better management of resource use have significant synergistic effects in improving short term production as well as in achieving long-term sustainable resource use.

In addition to these considerations, the needs and priorities of rural producers differ from those of the society as a whole. At the national level, conservation is of greater importance, while from a local viewpoint, production and risk reduction are more urgent priorities.

Table 3 provides a summary of characteristics describing the interventions applied in the eight study cases. Major findings relating to the technical criteria for sustainable development are described below, with examples from the cases provided as illustration in the sub-paragraphs.

TABLE 3. SUMMARY OF TECHNOLOGIES AS APPLIED IN EIGHT CASE STUDIES

TECHNOLOGY	RISK REDUCTION	EFFECTS ON PRODUCTION	CONSERVATION EFFECTS	POTENTIAL FOR SUSTAINABLE SYSTEM CHANGE	CONSTRAINTS(1) PARTIALLY RESOLVED)
A) HORIZONTAL ROCK RIDGES	*IMPROVED WATER SUPPLY	*IMPROVED YIELDS WHEN WATER IS LIMITING *IMPROVED FERTILIZER EFFICIENCY	*REDUCED WATER EROSION *REGENERATION OF TREES/BUSHES ON DEGRADED LAND	REDUCED RISK PERMITS INTENSIFICATION OF AGRIC. SYSTEM	*SOIL FERTILITY *(LABOR)
B) SOIL CONSERVATION	-	*REDUCED LOSS OF PRODUCTIVE CAPACITY OF SOIL	*REDUCED WATER EROSION	*REDUCED EROSION PERMITS INTENSIFICATION OF AGRIC.	*LIMITED ECONOMIC INCENTIVES *(LABOR)
C) NATURAL FOREST MANAGEMENT	*RESOURCE PROTECTION *USER RIGHTS DEFINITION	*INCREASED AVAILABLE WOOD AND GRASS ON A SUSTAINED BASIS	*REDUCED EROSION DUE TO GROUND COVER *RESTORATION OF GRASS AND TREE COVER	*WORKING MODEL OF LAND MANAGEMENT/CONTROL *PROMOTES INTENSIFICATION OF CATTLE RAISING	*ORGANIZATION *MARKETS *(POLICY)
D) WINDBREAKS	*REDUCED WATER CONSUMPTION/ EVAPORATION	*REDUCED PEAK LABOR DEMAND AT SOWING *WOOD PRODUCTION	*REDUCED WIND EROSION *LEAF LETTER CONTRIBUTES TO SOIL FERTILITY	*REDUCED EROSION PERMITS INTENSIFICATION OF AGRIC. SYSTEM	*POLICY *(LABOR) *PROTECTION OF YOUNG TREES
E) DUNE STABILIZATION	-	*REDUCED LOSS OF CULTIVATED AREAS *TREES ARE POTENTIAL SOURCE OF FORAGE AND WOOD	*REVEGETATION OF DUNES	* -	*(PROTECTION OF YOUNG TREES) *(LABOR) *(ORGANIZATION)
F) AGROFORESTRY	*CROPS PROTECTED FROM GRAZING ANIMALS	*YIELDS INCREASED DUE TO PROTECTION AND PLOWING *ACACIA SÉNÉGAL PRODUCED A CASH CROP	*LEAF LITTER CONTRIBUTES TO SOIL FERTILITY	*POTENTIALLY MORE INTENSIVE AGRIC. SYSTEM	*(FENCING COSTS)
G) PASTURE MANAGEMENT	*IMPROVED GRASS AVAILIBILITY IN YEARS *HEALTH AND FINANCIAL SECURITY SYSTEMS POSSIBLE	*IMPROVED ANIMAL REPRODUCTION AND WEIGHT GAIN	*RESTORED GRASS COVER WITHIN MANAGED AREA	*ADOPTION OF MODEL REPRESENTS A SYSTEM CHANGE FOR THIS ZONE	*(DISEASE) *ANIMAL MARKETS *(FENCING COSTS) *(POLICY)

(1) CONSTRAINT TO FURTHER EXTENSION OF THE TECHNOLOGY ARE LISTED HERE. THOSE WHICH HAVE BEEN PARTIALLY RESOLVED THROUGH PROJECT OR LOCAL INITIATIVES ARE GIVEN IN PARENTHESES.

Findings and Examples: Local Level

I. Risk abattement was achieved through a variety of means, including: improved water supply (water harvesting via rock ridges), reduced Water consumption (windbreaks), and protection from unauthorized resource use (natural forest management, pasture management, and the agroforestry model).

Reducing risk due to drought has been a major factor stimulating the adoption of horizontal rock ridges by farmers, especially in heavily populated regions of Burkina. Soil degradation in these areas is severe, causing rainfall to be lost in the form of runoff. Horizontal rock ridges allow farmers to collect and concentrate runoff on their fields, providing a supplement to sparse and irregular rainfall. Farmers benefit especially during drought years when the value of supplemental water provided by colected runoff is critical to the success of the crops. Furthermore, the initial period of each rainy season is broken by periods of drought preventig successful sowing during this period. Farmers have extended the effective length of the growing season by using rock ridges in combinaison with water pits to concentrate early rains on the seedlings. The results has been the successful establishment of crops up to one month earlier than otherwise feasible. This extension of the growing season results in greater production, and a reduction of the labor shortage that occurs during the sowing period.

Pasture management in the Ferlo region of Sénégal reduced risk to the Fulani herders in a number of ways. The primary means was through the controlled access and use of the pasture lands attributed to each family. Controlled grazing allowed better establishment of the grass cover. In drought years the improved grass cover allowed the herders to pasture their animals longer before supplemental feeding was necessary. In addition to this the project established veterinary services to treat the herds of the participating families. The services helped reduce day to day animal health problems leading to significantly improved productivity of herds. However, recent epidemics have affected all herds within the region, and the project's families have not been spared from losses. More recently, local herders organizations have started to organize saving accounts to provide a financial solution to losses due to drought, epidemics and market fluctuations. While not yet

fully operational, this initiative is a good example of how a combination of approaches may provide the best overall response to risk.

II. In most of the case studies technological improvements and/or improved resource management resulted in increased productivity while conserving the natural resource base. Those cases were : horizontal rock ridges, natural forest management, windbreaks, agroforestry, and pasture management. In two cases productivity remainded at current levels, with the major effect being to reduce or eliminate future losses in productivity due to resource degradation. Those cases were: soil conservation and dune stabilization. In no cases did the observable level of productivity decline through resource conservation measures.

An interesting example of combining productivity with conservation was observed in the agroforestry model in the Ferlo region of Sénégal. Agroforestry is typically a long-term endeavor, with both conservation and productive effects visible only after the trees have approached maturity. However, in the Ferlo model productive increases were observed immediately. This was due to two factors: deep plowing and fencing. Deep plowing was performed with a tractor to help insure rapid establishment of the tree seedlings. However, it was of equal or even greater value in improving the productivity of the annual crops that were sown between the tree seedlings. Fencing was of great value in controlling free grazing animals. Animals create considerable damage to crops in this region. Farmers attested to significant increases in crop production simply by excluding animals from the agroforestry parcels with heavy fencing obtained through the project in nearby Saint-Louis. In fact farmers claimed to obtain 100 % to 200 % increases in peanut production within the agroforestry plots, due to fencing and plowing. This has not been verified statistically. However, farmers were willing to cover much of the costs associated with both plowing and fencing. The apparent lesson is that conservation oriented activity can be combined with productive actions at the same time, and when it is, it is likely to gain much greater acceptance among farmers.

Desertification has created considerable social upheaval in Mauritania. Formerly nomadic herders have in some cases become more or less sedentary farmers. However, cropping areas are restricted to limited areas near the wells or other water sources. Because of the scarcity of farm land, protection of existing areas is very important to the lives of those who depend on them for their subsistance. Dune stabilization in Mauritania was an example of where a conservation measure,

although not responsible for increased production, was of great significance to the farmers in protecting scarce farm land from dune encroachment and subsequent loss.

Findings and examples: Regional/National Level

III. Case study interventions, excepting the agroforestry model, represent a sine qua non for a sustainable resource use system. That is to say that production may in some cases be improved by introducing additional imputs of fertilizers, labor saving devices, etc., but there will be a trade-off between short-term gains and long-term degradation unless these conservation measures (or similar ones) have not first been taken.

Efforts to improve production based on fertilizers, equipment, and plant breeding have been undertaken in the Yatenga (Burkina) since the colonial period. High population, poor soils, and poor rainfall negated production increases while plowing actually contributed to degradation through expansion onto marginal lands and exposure of topsoil to heavy erosion. Significant investment is now being carried out in the construction of rock ridges to restore degraded lands and improve water availability for crops. Additional measures such as stabling of animals for manure production and tree planting are being applied in conjunction with the ridges. Complementary effects between these measures has permited even greater increases in productivity. Desertification is so advanced however that current efforts will need to be greatly expanded before real progress is made.

In the cotton producing zone of Mali, with better climate, soils and lower population densities, technology improvement has afforded reasonable and sustained increases in production of cotton. This has fueled the development of village organizations, and local investment in village infrastructure, education, and health. Much of the gains in production have in recent years been due to expansion rather than intensification of production however. These improvements have been mortgaged from the natural resource base, which is now showing the first signs of overuse. The need to protect the environment as a prerequisite to improved production has now become apparent, and soil conservation has become a major activity for some villages.

IV. All the case studies, with the exception of dune stabilization, contributed to or provided the potential for a sustainable system change in production methods. Resource management projects satisfied the need for comprehensive control over resource use more than single technologies.

None however could be said to have achieved an overall sustainable production system at this time. Achieving a sustainable production system with these technologies is both long-term and speculative, depending in large part on: a) their adoption on a wider scale, and/or: b) the adoption of additional technologies or policies affecting the overall rational use of the natural resource base. While additional technical innovation is needed, much depends on non-technical factors.

Natural forest management in Guesselbodi (Niger) is an ecologically (and financially) sustainable system due to the global nature of the management plan and the management criteria used to direct exploitation. Management of natural forests is one component of a total resource use/management system. Agricultural and grazing lands also require new management and use policies to permit their exploitation on a more sustainable basis. Moreover, most land must be managed on a multiple use basis to satisfy the diversity of needs of the rural populations. Management objectives, criteria, and methods will vary considerably. However, the participatory approach and the ecological principles needed to manage renewable natural resources are well demonstrated at the Guesselbodi natural forest management site.

Soil conservation in Mali has been slowly gaining in popularity among farmers, especially those with limited and/or degraded land resources. Soil conservation reduces the loss of productivity of the soil. Is is unable to completely eliminate the losses however. This is especially true of soil fertility depletion caused by the crops themselves. Replenishment of soil fertility must therefore accompany soil erosion control. Furthermore, the complementary effects of combining soil conservation with soil fertility maintenance and other production oriented techniques makes economic as well as ecological sense. Soil conservation makes the use of other technologies more attractive to farmers. Therefore, a package of technologies in combination with soil conservation measures is more likely to promote sustainable resource use and development than single technologies.

The need to combine conservation with production oriented technology is far from recognized among the specialists responsible for decision-making and funding of technology development. In Burkina a large international donor agency recently understook financing of a series of regional experimental programs to test new agricultural technology. The design team visited the local agricultural extension agency (O.R.D.) in the Yatenga. They were shown sites with the new rock ridge technology, and given clear advice from O.R.D. staff concerning the necessity of starting any development with conservation methods such as those used in the Yatenga. Whatever the interceding events, the eventual programs were designed with all the traditional technologies: fertilizer, plows, etc. Rock ridge technology was absent. Ironically, rock ridges have since been introduced. This was done, not by the donor agency, but rather at the insistance of the O.R.D. responsible for implementing the programs.

Approaches to Technology Development

V. In all of the case studies the time necessary to develop or introduce a new technology or management approach was considerable. In the cases where similar examples were available for demonstration the average time to develop an interest among the rural people was about two years. Where techniques were developed through a research-development approach the time requirement ranged from four to ten years.

VI. Other factors being equal, the adoption of technologies is related to the geographic scale necessary to apply the technology. This is due to the greater consensus and organizational requirements associated with geographically large operations.

The technology demonstrating the greatest expansion to date has been horizontal rock ridges. This is felt to be due in part to the small geographic scale required to obtain the initial positive demonstration. Initial development of the technology as applied today was begun with individual farmers. Application was limited to small fields that could be managed by a family. Later, as the technique became more popular, the scale of application was increased to accommodate groups of fields and in some cases small watersheds. In all cases

however the technique has remained essentially the same, variations in spacing of ridges and layout being easily adapted to the scale of application.

VII. In gaining adoption by farmers, the approach used to introduce and refine technology is as important as the technology itself. Most of the technologies will potentially serve a useful function in many different situations, however:

a) the technology may not be fully understood by the local people for whom it is "intended".
b) local constraints and needs vary both from region to region and from farm to farm, and these may not be fully understood by the technicians.

Technology development is inherently a faulty process. The participants in technology development have quite different backgrounds. The potential for misunderstanding exists permanently. Essential ingredients in overcoming misunderstanding in the eight case studies were a long time frame., flexibility, and dialogue among participants based on a desire for mutual understanding.

Many of the case study technologies have been tried before, occasionally in the same places. While it may be argued that these previous efforts paved the way for the present "success", this certainlly is not universally accepted, least of all by the farmers. The most obvious example is the development of rock ridges in Burkina. Several large scale efforts to introduce anti-erosion works had been visited upon the Yatenga region previously. The first of these was the GERES project. To this day the farmers accuse those systems of provoking increased erosion in the waterways. Crops were alternately drowned, or deprived of extra water provided by runoff which they needed to supplement sparse rainfall. Furthermore, traditional methods of controlling excess runoff existed in the region. Some of these traditional techniques were in fact first documented by the GERES project. Later they were ignored or dismissed as not resulting from scientific methods. Such arrogance was quickly but dearly repaid. Three years and over one billion FCFA after its start the GERES project was declared an "unfortunate experience". Fifteen years later, observation and discussion between Yatenga farmers and the OXFAM project made it clear that while erosion was a dominant problem, the runoff water was also needed to supplement rainfall. From this point the traditional rock ridges were improved. At the same time, as these were local techniques, there existed in the vocabulary of the people the

language to describe and teach the improved techniques. Other traditional methods were in fact never improved upon, but simply made known to a larger audience who for too long had been told that traditional farming was "poor practice".

3.2 Economic Aspects

The Issues

Production systems and subsequent resource use in the Sahelian countries, as elsewhere, are intimately linked to the existing physical and biological resources including climate, soils, and vegetation. These natural resources provide both the potential for satisfaction of needs, and limitations or constraints to the satisfaction of additional needs. Based on these factors, production systems are classified here as either surplus, subsistance, or survival systems (see Table 4). Sustainable resource use is affected by the particular factors associated with each of these systems. These are further discussed in the following paragraphs.

Surplus Systems

The quantity and quality of resources are generally related to rainfall. In subhumid regions the biological resource are generally the first to be diminished under the pressure of increased human (and animal) needs, or decreased rainfall. This is typified in the Sudano-Guinean zone by a reduction in the number of tree and grass species. Accompanying this is a general change in the species composition in favor of more drought resistant but less productive species. Nevertheless, soil fertility and rainfall in this zone are generally sufficient for good crop production. Risk due to drought is low. The presence of a cash crop in a surplus exploitation system is at the same time a contributor to increased degradation, as well as an incentive towards conservation. Revenues generated by a cash crop lead to mechanization of the farm operation and an expansion of cropping area. This invariably leads to greater exploitation of the soil resource at the expense of fertility. However, reduced yields due to soil degradation represent significant monetary loss. Farmers therefore have a strong incentive to conserve productivity. The cash crop also provides a means of (partially) financing investment in resource conservation.

Where cash crops form a small part of the cropping area, vegetative regrowth is sufficient to allow replenishment of fertility through the use of fallow periods.

Subsistance Systems

As rainfall decreases, vegetative productivity also decreases. The effectiveness of fallow practices in restoring soil fertility is reduced by less vegetative regrowth. Where population and land pressures are not too high, a subsistance type of agriculture relying on fallow periods to restore fertility is still possible. This situation exists in parts of the Sudano-sahel and Sudan ecological zones. In regions of higher population pressures investment in soil fertility maintenance is more necessary. However, in subsistance production systems the low value of surplus cereal production is insufficient to provide much (financial) incentive to invest in improved production. Incentive to invest in the conservation of the resource base is even less. The general trend in the Sahelian countries is for subsistance systems to evolve or shift towards survival systems. This occurs as population exceeds productivity, or drought reduces productivity. Additional investment in either production improvement or conservation has depended on a shift in the production system towards either a surplus (cash crop) or survival system to provide the necessary economic incentive.

Survival Systems

Under drier conditions sparse natural vegetation, low soil fertility, and low soil moisture limit the satisfaction of peoples' needs. Natural productivity is lower than in the more humid zones; therefore human population levels (and needs) may more easily exceed the carrying capacity of the resources. When the carrying capacity is exceeded, a survival system predominates in which all available resources are exploited for satisfaction of immediates needs. Resources are thereby depleted. Investment in conservation measures is necessary if continued degration is to be reversed. Investment in a survival exploitation system is favored by production shortages which tend to increase the value or prices of necessities such as cereals, firewood, building poles, and fodder. Those unable to produce enough cereal to satisfy their needs are obliged to spend considerable money (from migrant labor, cattle sales, etc.) to purchase cereals. Conversely, anyone able to produce a surplus under such conditions can usually find a good price for the produce. Investment is nevertheless difficult. The risk of financial loss is high due to irregular rainfall. Seasonal migration intended to supplement income from external sources

reduces the available labor for labor intensive technology. Migration also results in the cultural loss of traditional labor intensive soil and water conservation practices. This situation is typical of much of the Sudano-sahelian and Sahelian zones.

TABLE 4. ECOLOGY AND ECONOMICS

RAINFALL ZONE	Wet ---------->		Dry
NATURAL RESOURCE LIMITATIONS	Vegetation	Vegetation Fertility	Vegetation Fertility Water
CLIMATIC RISK	Low ---------->		High
PRODUCTION SYSTEM	Surplus	Subsistance	Survival
INVESTMENT LEVEL AT PRESENT	Positive ---------->		Negative (1)
COST OF NOT INVESTING	Low ---------->		High

(1) Negative investment is used to describe natural resource "mining". Mining of resources will result in resource depletion if use exceeds natural regeneration. Such is the case for survival production systems.

Sustainable development must be adapted to the type of ecosystem and production (exploitation) system present. In general solutions must be found which will increase investment in resource conservation. To be acceptable however investment must be cost effective ("worth the effort") at the farm or enterprise level.

Therefore the study team was especially interested in identifying elements which influenced or favored the cost effectiveness of investment in conservation. A farm level analysis of each intervention was performed. A budget of costs and benefits over a twenty year period was used to derive internal rates of return for each intervention. The internal rate of return provided an indication of the cost effectiveness of each intervention. Table 5 provides a summary of the interventions, investments and benefits, and the calculated internal rate of return of each.

TABLE 5. SUMMARY OF ECONOMIC CHARACTERISTICS OF SEVEN INTERVENTION MODELS

CHARACTERISTICS	HORIZONTAL ROCK RIDGES (BURKINA)	GUESSELBODI FOREST MANAGEMENT (NIGER)	FERLO AGRO-FORESTRY (SÉNÉGAL)	FERLO PASTURE MANAGEMENT (SÉNÉGAL)	MADJIA VALLEY WINDBREAKS (NIGER)	HSSEY ETTINE DUNE STABILZ. (MAURITANIA)	CMDT SOIL CONSERVATION (MALI)
	INTERVENTION						
1) SYSTEM OF EXPLOITATION	SURVIVAL	SURVIVAL	SUBSIST-SURVIV	SURVIVAL	SURVIVAL	SURVIVAL	SUBSISTANCE-SURPLUS
2) DEGREE OF DEGRADATION	HIGH	LOW-HIGH (A)	LOW-MODERATE	MODERATE	MODERATE-HIGH	HIGH	LOW-MODERATE
INVESTMENTS							
3) FINANCIAL	LOW	HIGH	HIGH	HIGH	LOW	LOW	LOW
4) LABOR	HIGH	HIGH	MODERATE	MODERATE	HIGH	HIGH	HIGH
5) ORGANIZATIONAL	MODERATE	HIGH	LOW	HIGH	LOW	HIGH	MODERATE
6) EDUCATIONAL	MODERATE	HIGH	LOW	HIGH	MODERATE	MODERATE	MODERATE
7) POLICY	NONE	HIGH	MODERATE	MODERATE	LOW	NONE	LOW
BENEFITS							
8) IMPROVED PRODUCTION	HIGH	HIGH	HIGH	HIGH	MODERATE	NONE	LOW
9) CONSERVATION	HIGH	HIGH	LOW	HIGH	MODERATE	HIGH	MODERATE
10) BENEFICIARIES	FAMILY	VILLAGE(S)	FAMILY(S)	FAMILY	FAMILY-VILLAGE	VILLAGE	FAMILY-VILLAGE
INTERNAL RATE OF RETURN							
11) WITH SUBSIDIES	•	•	>2.00	>1.00	•	6.50	•
12) WITHOUT SUBSIDIES	0.82	>1/0.15/0 (A)	0.36	>1.00	0.27	>1.00	0.20.T.

(A) THREE SCENARIOS WERE ANALYSED FOR CONDITIONS REPRESENTING LOW, MEDIUM AND HIGH LEVELS OF DEGRADATION.
• FINANCIAL SUBSIDIES (OTHER THAN CREDIT) WERE ASSUMED TO BE INSIGNIFIANT IN THE ECONOMIC MODELS.
1) REFERS TO THE LEVEL OF PRODUCTIVITY OF THE PREDOMINANT TYPE OF EXPLOITATION (SEE TABLE 4).
2) REFERS TO THE DEGRADATION OF RESOURCE(S) BEING EXPLOITED.
3) FINANCIAL INVESTMENTS INCLUDING MATERIALS, EITHER LOCALLY OR EXTERNALLY FINANCED, DIRECTLY OR THROUGH CREDIT.
4) LABOR INVESTMENTS, GENERALLY LOCALLY FURNISHED, SALARIED OR VOLUNTARY.
5) INVESTMENT IN LOCAL ORGANIZATION TO ESTABLISH AND OPERATE THE INERVENTION. (NOT COSTED IN INTERNAL RATE OF RETURN).
6) INVESTMENT IN EDUCATION TO TRAIN PARTICIPANTS, BOTH LOCAL AND NATIONAL. (NOT COSTED IN INTERNAL RATE OF RETURN).
7) IMPLICIT OR EXPLICIT CHANGES IN POLICY AFFECTING INVESTMENT. (NOT COSTED IN INTERNAL RATE OF RETURN).
8) BENEFITS INCLUDE AN INCREASE IN PRODUCTION LEVELS AS COMPARED TO CURRENT LEVELS.
9) BENEFITS INCLUDE THE CONSERVATION (OR RESTORATION) OF THE RESOURCE BASE UPON WHICH CURRENT AND FUTURE PRODUCTION DEPENDS.
10) REFERS TO THE LEVEL AT WHICH BENEFITS AND COSTS ARE ACCRUED TO CALCULATE THE INTERNAL RATE OF RETURN (LINE 11 THE 12).
11) THE INTERNAL RATE OF RETURN AT THE LOCAL LEVEL (SEE LINE 10) FOR A TWENTY YEAR PERIOD. FINANCIAL SUBSIDIES TO THE BENEFICIARES ARE INCLUDED IN CALCULATIONS WHERE APPLICABLE. IN THE CASES OF THE TWO FERLO MODELS THE INVESTMENT COSTS ARE AMORTIZED OVER A TEN OR ELEVEN YEAR PERIOD.
12) AS ABOVE, BUT CALCULATED WITHOUT OUTSIDE FINANCIAL SUBSIDIES IN THE CASES WHERE SUBSIDIES ARE PROVIDED.

From a larger perspective, the social costs of resource degradation are paid by both the individual and society as a whole. Social costs include forced migration, malnutrition, social disintregration, etc. Furthermore, the costs of resource degradation will increase in the absence of significant action to reverse degradation. The ultimate cost to Sahelian societies is likely to be cultural extinction.

Given the vested interest that society has in reducing resource degradation, the study team was also interested in how the public sector may play a role in promoting investment in sustainable development. Responses to this question are found mainly in the paragraphs concerning "Approaches to Promote Investment", and in the following section on "Policy and Institutions".

Findings and Examples: Local Level

I. The cost effectiveness of each intervention was to a great extent determined by the prevailing type of exploitation system (survival, subsistance, or surplus). Management-based interventions improved the attractiveness of technology-based interventions when both were offered as a package. Recognition and accommodation of the economic and ecological factors specific to each zone improved cost effectiveness. Paragraph II, III and IV below describe findings particular to survival, subsistance, and surplus production systems.

II. Highest rates of return were observed with interventions in a survival system. In a survival system of exploitation the economic conditions of scarcity tended to improve the cost effectiveness of investment in the production of necessities such as cereals, wood and fodder. Both technology and management based interventions were generally cost effective in survival exploitation systems. Management based interventions generally improved production of fodder and/or wood products through controlled use of resources. Technological interventions generally stabilized or improved agricultural production through conservation of soil and water.

The pasture reserves in the Ferlo of Sénégal typify a subsistance system that, through overgrazing, has largely degraded to a survival pattern of resource use. Pasture management in the Ferlo resulted in improved production of

grass for fodder. When associated with an animal health program and improved water supply, the better grass production produced significant gains in animal productivity. Productivity was reportedly more stable even during drought periods when fodder was in critically short supply outside of the managed areas. The project supplied significant financial subsidies and credit to participants to cover heavy investment costs. Subsidies were necessary to initiate the activity. However, analysis revealed that the operation would still provide a rate of return of over 100% if subsidies were stopped and investment costs amortized over a ten year period. Credit would still be necessary to facilitate the amortization of investment costs. Costs of the operation were reduced by an economy of scale achieved through considerable organization of the operation. This resulted in lower costs to the participants and greatly improved rates of return on investment.

The Yatenga region of Burkina is typical of a survival system of exploitation in an agricultural zone. Technological intervention in the Yatenga provided significant returns to farmers investing in the construction of horizontal rock ridges. Training was provided by the project, and later by various other services and organizations. Training revived and improved the efficiency of traditional practices sufficiently to encourage renewed interest in an abandoned practice. Local investment was comprised chiefly of labor and organization to transport rock and construct the ridges. Labor investment varied widely depending on the availability of the rocks. It was observed that those farmers disposing of sufficient resources were quite willing to pay rental fees for trucks or animal carts to facilitate rock transport. Donkey carts became the most requested item available from agricultural credit services in the Yatenga. As the project continued to evolve, the organization of labor was facilitated by the creation of cereal banks. Operation of the cereal banks was locally controlled. The objective was to support traditional forms of labor organization adapted to the construction of rock ridges on a communal scale. Supplies of hand tools were also provided to the better organized groups as well.

III. In a subsistance system of exploitation, <u>technology</u> based interventions to conserve or improve cereal production were of lesser interest to producers. <u>Management</u> based interventions were of greater value, especially in reducing risk.

Low population densities in the south-Ferlo of Sénégal has allowed the continued existance of a mixed farming/grazing subsistance system based on a long fallow period. Farmers participating in the Agroforestry project attested to 100 to 200 percent increases in production of peanuts and cereals (unverified). Improvement was attributed to protection of the agroforestry plots, and deep plowing in the first year of the intervention. Protection was considered a form of land management for the purpose of this study, even though it was achieved with fencing. Protection reduced risk of extensive damage to crops from roaming animals. This improved productivity of the traditional cropping system. It also protected the benefits achieved through investment in deep plowing, further improwing productivity. Tree planting utilized Acacia sénégal within the agroforestry plots, formerly a traditional cash crop before the trees all but disappeared from the landscape. Farmers participated in investment costs of the fencing, plowing, and tree planting. Fencing was highly appreciated for the protection it afforded against the risk of crop loss. Plowing and, to a lesser extent, tree planting were appreciated essentially for their contribution to cash cropping (peanuts and gum arabic). The study team felt doubtful that the same level of interest in either plowing or tree planting would have existed if they were to have benefited the (subsistance) cereal production system alone.

IV. Technology based soil conservation measures had a low rate of return in a surplus production system. Degradation was not yet severe enough to create a significant crop yield response to conservation measures. Management based interventions have not yet been adequately tested in surplus production systems. However, results from other zones indicate that management based interventions may be a very effective means of improving overall productivity while insuring conservation of intensely exploited resources in surplus production systems.

The cotton producing zone of Mali is not visibly degraded. Farmers were among the first to notice the effects of soil erosion in their fields in the early eighties. Those most affected, and most concerned, were the larger cotton farmers. The consequences of soil erosion are now recognized by nearly everyone. Soil erosion control has become an important activity in some of the more affected villages. However, many labor intensive activities compete for available labor in the dry season: construction of schools, maternities,

houses, etc. Significant social investment is made through organized village groups each year. The immediate benefits of soil erosion control are modest. Soil erosion control is treated more as a social necessity than as an economic activity, for it often receives about the same amount of attention as the schools and maternities.

The Guesselbodi forest management scheme was tested under several scenarios to measure the economic rate of return under different levels of resource degradation. The scenario with the lowest level of degradation most closely resembled the resource situation in a surplus production system. Under this scenario the major intervention was based on management and exploitation of the forest. The returns on investment were greater than 100 percent.

V. Financial investment was highest in management based interventions. Management costs were higher in those cases where fencing was used to control land use. Nevertheless, the extensive nature of management operations resulted in low costs per unit area, leading to favorable rates of return. However, limited local capacity for financial investment was insufficient to cover investment costs in management operations. Project credit and subsidies covered most initial investment costs. Revenues from operations appeared sufficient to reimburse investment costs and cover recurrent costs, provided that credit was available to extend the pay back period over a longer period of time.

VI. Dry season labor was the major investment cost in technology based interventions. Dry season labor had a low opportunity cost. It was invested in conservation activities not only with significant short-term returns (horizontal rock ridges) but also those with longer term indirect benefits (windbreaks, soil conservation). Investment of low cost dry season labor seemed to be favored by prior satisfaction of subsistance needs and, perhaps more significantly, as with any investment, the assurance that benefits would accrue to those who did the work.

VII. High organizational and educational investments were related most closely to the complex nature of management based interventions. Local institutions were generally responsible for organization. Education was performed by projects, rural organizations, and government agencies.

Findings and Examples: Regional/National Level

VIII. Long-term resource sustainability was difficult to evaluate in quantitative terms. Quantitative evaluation was difficult due to both the relatively short duration of data collection, and the high variability of production levels caused by climatic variability. A qualitative evaluation of the various interventions vis-a-vis resource sustainability was made in the technical section.

IX. The economic benefits <u>to society</u> of management based interventions could be highly significant. These are in addition to the non-quantified value of conserving the productivity of the resource base.

> The Guesselbodi forest management scheme produced significant employment for woodcutters, guards, and laborers. Several civil servants were also employed. The model projection for a 50,000 ha, forest would generate over 60 million CFA per year in salaries. Under the worst scenario (high resource degradation) revenues from the operation would be sufficient to pay all salary costs after the firth year. Under the more favorable scenarios revenues from the operation would cover all financial costs, including salaries, when a twenty year amortization period was assumed.

X. Government was most able to support investment in sustainable resource use through <u>policy</u> and <u>institutional</u> changes. These are discussed further in the following sections.

Approaches to Promote Investment

XI. Successful projects and programmes were able to initiate or further promote local investment in resource conservation. Approaches to promote investment participation evolved significantly over the length of the intervention.

The majority of projects attempted to stimulate interest in activities through the use of <u>project initiated</u> training and information sessions, and utilized some form of material support, wages or food aid, to stimulate or replace local investment and participation. (A general discussion of participatory approaches used in promoting development activities is presented in annex 1.)

Other projects initiated activity in response to village initiative or requests for assistance. At the time of the study all projects had adopted this latter approach. Evolution towards this approach was in response to the development of local initiative, responsibility, and willingness to invest locally available resources. Of course initiative and investment were contingent on the prior demonstrated feasibility of a proposed technology or management system (discussed in the previous section on technology development).

As local initiative developed, relations between project and participants changed, from one of dependancy to one of collaboration. In many of the projects contractual agreements with the participating village developed. These were useful in defining the responsibilities for investment and participation. Contractual agreements often contained implicit or explicit policy changes concerning users' rights vis-a-vis the natural resources.

XII. The use of policy as a means of promoting responsibility and investment in conservation was very successful in several cases. Designation of resource use rights was always associated with designation of responsibilities for resource conservation. This was achieved by giving rights to an identifiable group. The incentive to accept this responsibility in each case was the guarantee that those who invested would indeed be the beneficiaries of the investment.

3.3 Political and Institutional Aspects

Issues

Development and sustainable resource use has been affected in profound yet subtle ways by the political conditions prevailing in each country. Past policies have been implemented with apparent disregard for either rural development or resource conservation.

The political situation since independance was characterized by a separation between rulers and ruled. The cadres who formed the bureaucracy were trained under western educational systems, indeed many were trained in western universities. This led to a greater understanding of western values and concepts, but at the expense of creating an alienation with their own rural populations.

A lack of administrators meant that most high level cadres were immediately posted to administrative positions from the day of graduation, minimizing intimate contact with the problems facing the rural farmer. Furthermore, the specialization of western education gave few tools to the graduate with which to grasp the complexity of the situation.

While the governing class was a non-producing sector of the economy, economic power was obtained by virtue of the fact that foreign aid investments passed through government channels. Donor agencies failed to recognize the inadequacies of governmental institutions as a means of pursuing developmental activities. At the same time, alternative economic or political entities were practically nonexistent at the time of independence. Political and economic inequalities between the governing class and the rural populations were reinforced by such funding policies.

Therefore, rural people have never held much, if any, real political power with which to influence decisions and policies concerning agriculture. Illiteracy has put them at the mercy of those more skilled. Manipulation of funds and corruption have resulted in a distrust of the more educated. With virtually no chance of changing the system, most have tried to learn to function without it. A disconnection between governmental initiatives and local initiatives has occurred.

Within this political and institutional environment, the issue at hand is: How can responsibility and need for the conservation of natural resources be reconcilied with the needs of farmers and society in general ? How should responsibility and costs be shared ? How can responsible use of resources be insured by those who use it ? How can policies and institutions favor equitable responses to these questions ? The answers will be long in coming, if only because the questions themselves have hardly been asked. Some indicative responses were observed in the case studies, and are presented below.

Findings and Examples: Local Level

I. Local or community consensus was necessary to promote and control responsible resource use. Furthermore, observation of group activities indicates that, at least in the short-term, group consensus was the single most important element leading to better management of natural resources.

The study team encountered three villages in Burkina and Mali which have instituted control of cattle grazing on village lands. The mandate as well as the authority for this action were derived from common agreement among the members of the villages. These villages received significant publicity and some technical support which presumably gave the actions some de facto legality in the absence of defined policy. Better policy could strengthen these efforts and encourage others by providing the means to settle disputes when various interests are at odds with each other.

II. Within this study the level of local consensus among farmers and herders was observed to depend on:

- an understanding of the value and need for change,
- the presence of economic benefits,
- the presence of guarantees for the equitable distribution of benefits among participants.

Reaching a consensus required the perception of a common interest among the participants. This was usually in the form of direct benefits from a given activity. However, it could also be in the form of rights to future benefits or future support. These are becoming an increasingly popular means of promoting the interest necessary to initiate certain techniques or approaches.

The Guesselbodi forest management scheme is based on five villages grouped together in a cooperative. After long discussion the governments agreed to grant exclusive rights of forest exploitation to the cooperative. The guarantee of economic benefits from wood cutting and grass sales has created intense interest among village members, and adhesion to the cooperative is nearly universal within the villages. Even those who don't actively participate in wood cutting attend the meetings. The financial and legal status of the cooperative has allowed members to obtain bank credit as well.

The Groupement Naam is an autonomous group of locally based farmers groups. The Groupement Naam receives external funding from a variety of sources, one of which is the Six "S". Funds are locally managed for credit and grants to member groups. Future funding is conditioned by proper management of the current funds and projects. The possibility of receiving continued funding creates a common interest in assuring proper management and execution of projects.

III. Changes in resource use patterns and users' rights may affect the various users unequally. Cases were observed where those with marginal or minority rights sustained economic or political losses when access to resources was modified.

Establishment of the Madjia Valley windbreaks required protection of the new trees from browsing animals. This was achieved by prohibiting grazing animals in the fields where trees were planted. Large cattle belonging to villagers were sent out of the region to pasture elsewhere. Sheep and goats belonging to village women were kept near the compounds where the women could care for them. The task proved to be too difficult. Fines were imposed on some women because their animals entered the restricted area. Other women found feeding and watering the animals impractical. Eventually many women were forced to abandon their small animals upon which they depended to supplement income. The situation was only remedied when the trees grew large enough to be unaffected by grazing animals.

Management of the Guesselbodi forest eliminated all grazing on forest lands. The surrounding villages moved their herds to other areas. Transhumant herders were turned away. It is thought that eventually grazing permits will be issued to reintroduce controlled grazing within the forest. Equitable distribution of the permits to transhumant herders may be a difficulty. In this case however the forest was not a very important grazing area due to the extensive degradation that existed. With proper consideration, both herders and villagers should have potential access to increased available forage.

IV. Successful rural organization was associated with identifiable groups. These were often formed along family lineage, in keeping with traditional practice. This presumably resulted from shared resources and social relations, as well as geographic proximity of farm or grazing land. These considerations resulted in small nuclear groups of homogeneous origins. Reduced diversity of needs, greater social cohesion, stronger traditional leadership, and better communication among small homogeneous groups appeared to faciltate the formulation of consensus on critical issues. Some organizations formed a federation composed of many such small nuclear groups, presumably allowing broader levels of consensus where appropiate, as well as other advantages listed below.

V. Useful functions of rural institutions observed within the study cases were:

At the village or clan level:

a) to provide a forum for the identification of development priorities and potential actions,

b) to obtain and manage funds, credit or materials for individual or collective investment,

c) to organize labor available in the village (clan),

d) to act as a legal entity representing the members in the forming of contracts either among themselves or with others.

At the federation or regional level:

e) to provide a communication link with other villages to facilitate identification of problems, solutions, and exchange of experience; to provide a communication link and representation of the groups with funding sources,

f) to reduce technical assistance and management costs through economies of scale within a region.

VI. Rural organizations obtained funds from a variety of sources including NGO's, government (credit), sale of cash crops, and local taxes. Viable management of funds appeared to be related to: a) group literacy, b) social controls within the group, and c) the conditionality of future funds on the proper management of current funds.

Findings and Examples: National Level

VII. Responsible use of natural resources will be reinforced by giving more, not less, control over resource use to those who share in its use: the rural people.

Control of resource use (and abuse) has not been feasible through government decree and sanctions alone. The costs of greater governmental control over resource use have been prohibitive. A government sanctioned review of the forest service was performed in Mali with the objective of reorienting that agency towards service rather than repression. Results of the review were manifest: a policy of

rational resource management was incompatible with the functional relationship between the forestry service and the people. Legislation was absent which could define the functional roles of people and forestry service in managing natural resources. The forest service used the receipts from fines to supplement the agency's operational budget rather than to support investment in resource conservation. Additionally, people engaged in tree planting and other activities at least partly because they felt it might reduce annually imposed fines resulting from selective interpretation of existing texts.

VIII. Turning over control of resource use to local people requires parallel legal codes which delegates authority and decision-making powers. Local structures will have to be endowed with political as well as police power. The need for local input at all stages of transition will require some form of referendum. Equally significant is the uncertainty and insufficiency of land tenure legislation. To obtain clear title to land the current text require legal and financial conditions that are essentially impossible to satisfy except for urban or residential situations. Stipulations regarding agricultural land generally exclude effective communal control, based as they are on western ideas of "private" property. Additionally, current texts require visible investment in the land as a precondition for registration. This effectively eliminates the concept of fallow or grazing lands within agricultural zones.

In the cotton zone of Mali one village unilaterally decided upon a number of measures to improve resource use in their village. All village members agreed to limit wood cutting and cattle grazing to designated areas and periods. When outside wood cutters arrived on their land the village was able to enlist the aid of the Forest Service to impose village restrictions on the wood cutters. When a large (and influential) cattle owner arrived to graze on village land he was was able to obtain a higher level of authority to protect his right to graze "when and where he pleased". An entire village was unable to commit one person to rational use of the resources upon which the prosperity and survival of the village depended.

IX. Institutions and projects tended to promote local initiatives to the extent that they responded to priorities expressed by the population. This depended in turn on the extent that local organizations provided a forum for the discussion of priorities.

Extension agents for the CMDT are employed in response to expressed and demonstrated needs in the villages of the region. For the CMDT this policy has meant greater efficiency in the use of agents, and the development of new programs of interest to farmers. For the farmers it as meant greater response to their problems, either through direct contact with extension agents, or through referal to other agencies or programs. Village have developed considerable infrastructure and organization with the assistance and training provided by the CMDT. The creation of a soil conservation program in this region is a response to farmers' preocupations. While soil conservation programs are increasingly popular in the Sahel, the CMDT program is the only one to have attacked degradation before crisis struck.

4. SUSTAINABILITY

Sustainable development, in the sense of sustained activity and sustained resource use, was not achieved in any single project or program visited by the study team.

TABLE 6. PROJECT SUCCESS IN PROMOTING SUSTAINABLE RESOURCE USE AND DEVELOPMENT ACTIVITY

		DEGREE OF SATISFACTION OF CRITERIA FOR SUSTAINABILITY		
PROJECT/ PROGRAM	INTERVENTION	TECHNOLOGY	ECONOMIC	POLITICAL/ INSTITUTIONAL
ADRK	Horizontal Rock Ridges	2	2	2
Six "S"	"	2	2	2
OXFAM	"	2	2	2
Guesselbodi	Forest Mgt.	3	3	2
Madjia Valley	Windbreaks	2	2	1
Hssey Ettine	Dune Stabilization	2	2	1
Ferlo	Agroforestry	2	2	1
Ferlo	Pasture Mgt.	3	3	2
CMDT	Soil Conservation	2	1	2
	TOTAL =	20	19	15

1 = Little Satisfaction of Criteria
2 = Significant Satisfaction of Criteria
3 = High Satisfaction of Criteria

Criteria for sustainability were presented in the introduction. Based on these criteria a summary of project success in promoting sustainable development is presented in Table 6.

Success was measured in terms of the proportion of criteria that were satisfied as a result of project initiatives. Both project goals and constraints varied among the study cases. Therefore this analysis does not provide an objective means of comparing or ranking individual projects. It does however permit a general view of the ability of projects and programs to satisfy technical, economic, political and institutional criteria specifically related to sustainability.

4.1 Project Success in Promoting Sustainability

Most projects typically developed or adopted single technologies. However, single technologies were not comprehensive enough to change overall production systems and resource use. Resource management projects were the most successful in promoting sustainable resource use. Single technologies were most easily (rapidly) introduced however.

Local participation and investment in resource conservation was prompted by resource degradation and reduced productivity. However sustained local participation was also dependant on such things as training, organization, financial requirements, and economic benefits. Horizontal rock ridges for water conservation achieved widespread autonomous replication by farmers in areas where the technique provided a solution to drought. Other interventions required support from projects or services to achieve sustainable replication. In spite of its widespread application, water conservation alone could not maintain the long-term productivity of the resource base. However, the successful technology improved both the economic and technical feasibility of complementary technical or management approaches. The cumulative effects of associated measures have better contributed to a sustainable system of resource use.

Successful rural institutions were able to sustain autonomous activities through a mastery of local productive resources. More importantly for the future, they possessed the skills and self-confidence necessary to promote innovative approaches to sustainable resource use. However, existing policies and political contexts limited the introduction of sustainable resource management interventions. Management interventions required the greatest amount of national policy changes to be feasible. Rural organizations were capable of conceiving and agreeing upon certain improvements in the use of their own resources. However, they were powerless to enact any new policies, or to enforce them. Often even

government ministries and their agencies were unable to change policy affecting resource use. Only very recently have a few governments even considered decentralizing policy decision-making to the rural communities. Some donors, through influence and patience, were able to change policy affecting resource use, to considerable advantage. In the remaining cases projects were obliged to operate within constraints of existing policy.

Therefore, sustainable activities were possible with successful rural organizations, or where the activity was simple to learn and practice. Sustainable resource use was possible where policy changes enabled a shared responsibility between local people and technicians to reorganize the complexity of resource use and users. In general however, those best able to sustain development activities have no power to reorganize resource use. Most of the rural population does not have the confidence to even believe they could do it. Those with policy authority over resource use have neither the insight into how to use their authority, nor the desire to share it with those who could use it. Donors have rarely been willing or able to intercede in policy issues. Sustainable development therefore remains a fragmented puzzle in a puzzled world.

4.2 Approaches to Promote Sustainability

A fair number of examples across the Sahel show that technologies exist which can promote sustainable development. Through such interventions, farmers and herders have been able to profit from rural development efforts that have contributed at the same time to restore the ecological balance. However, widespread adoption of these interventions is still slow and sporadic. Isolated technologies must be combined and integrated into a global change in the production system. The approach used to promote interventions and expand their scope must be modified to attain the goal of sustainable development.

I. The motivation and confidence of rural people and communities is a key factor. Within national frameworks (that, in most countries, still need to be put into effect), rural people must be given the authority and responsibility to decide for themselves how to best manage their natural resources . In the near term it is essential that rural people restore their confidence in themselves and their ability to master, or at least influence, their own

destiny. Strong, effective and equitable local institutions (established along traditional patterns within clans) are needed. Their development must be supported by both government and donors.

However, governments should not directly intervene in rural development. Government should create adequate legal frameworks, provide subsidies for credit and training, and technical transfer programs. Rural people must be given a wider range of options, and if necessary, shown new ways so they can decide for themselves how to make the most out of their resources on a sustainable basis.

Responsive dialogue and interaction between all parties is needed. Dialogue is necessary at many levels: between research/extension services and producers, between resource user groups and policy makers, funding sources, etc., within the various resource user groups, and within the various governmetal services and agencies.

Dialogue and interaction can be improved through institutional adaptations. Services agencies could be organized to respond to local coordination and program definition. Definition of technical programs could be initiated at the field level by extension personnel and village representatives rather than in the technicians' offices. Technical services could respond to and support locally initiated programs rather than draft their own. Funding of service agencies could be modified. Local resources could be used to fund service agency operations, while allowing rural organizations greater control over program content. Alternatively, local organizations could employ technical services on a contractual basis, using local funds as well as subsidies and credits to pay for services.

Conflicts and difficult choices will occur as new patterns of resource use are substituted for the habitual patterns. Government and donors can provide incentive to rural peoples and organizations to encourage the needed transformations. Provision of subsidies and credit can be based on criteria which consider the rational use and management of the natural resources. In addition to encouraging initiative in the resolution of user conflicts, subsidies and credits may provide a mechanism to help compensate "losers".

II. To achieve a sustainable production system, resource conservation measures must address the whole production system in a technically feasible and economically viable manner. Different production systems present different circumstances. Therefore different approaches are necessary which respond to the circumstances that prevail.

In survival production systems resource degradation has reduced water availability, soil fertility, and vegetative cover. Water and soil conservation can be treated with intensive measures such as horizontal rock ridges, windbreaks, etc. The positive influence of intensive approaches on agricultural production is usually sufficient to cover the costs. Restoring vegetative cover is more readily achieved with extensive measures involving management of the resource. Intensive measures may also be used to restore vegetative cover where costs can be recuperated.

In subsistance production systems resource degradation generally reduces soil fertility and vegetative cover. As in the case of survival systems, intensive methods are useful to restore soil fertility, while extensive measures are indicated to conserve and improve vegetative cover.

In surplus production systems the vegetative cover is first affected by resource degradation. In this case intensive management measures may be sufficient to maintain a sustainable production system.

In all cases, management is necessary to maintain an adequate vegetative cover. Without consideration for the vegetative cover, intensive measures to correct soil and water limitations will be more costly and ultimately unsustainable.

The introduction of a cash crop may be useful to improve the economic viability of conservation measures. A cash crop increases the value of resource productivity, and therefore makes it more worthwhile to conserve productivity. Additionally, a cash crop provides a source of revenues to help cover at least some of the financial investments that may be required.

Productive activities must be planned and executed together with resource conservation efforts. Inversely, when resource restoration or conservation activities are planned, concerns for the need to increase production must be included. Benefits from the development efforts will help to cover short-term loss of benefits associated with the conservation activities.

III. Rural production systems need to reflect such concepts as maximum allowable carrying capacity and exploiting renewable resources only to levels at which they can reconstitute themselves. Sustainability of resource use is possible provided that the

carrying capacity of the resources is not exceeded. People have an intrinsic knowledge of carrying capacity as demonstrated through the use of fallow periods and grazing movements. Introducing a more sustainable production system is less a problem of educating people in the concept, but rather a question of:

a) defining and demonstrating the value of a given approach or technique.
b) resolving problems of control mechanisms, authority, and rights to benefits.
c) moving towards a new system in such a manner that people have the possiblity to adjust to new restrictions which limit exploitation to sustainable levels.

It is clear that changing the production system to reflect the limits of carrying capacity will produce "losers", especially in the short-term. Women and transhumant herders are in the greatest danger of losing their rights to resources access. "Losers" may be reduced and the above conditions satisfied by initiating resource management and user restrictions on degraded areas and government held land. The productivity of degraded land is low, making it easier for people to adapt to restrictions on its use. The case is essentially the same for government land. Prior use rights are legally nonexistant, therefore of low value. Furthermore, distribution of legal rights would provide a strong incentive to accept a management plan which exchanges short-term restrictions for medium to long-term increases in production.

Simply stated, the raison d'être of resource management is that over the long run a managed system produces significantly more than an unmanaged or natural system. The technically simple act of controlling access to resource use favors the application of other techniques as well. The case studies show that as the value of management is more generally recognized, people become more willing to give up short-term exploitation rights in exchange for greater future production.

IV. The question of population is significant in any discussion of carrying capacity. There exists a theoretical limit to the level of human needs that can be satisfied from a given resource under a given mode of exploitation. This limit has been attained in many localities already. The most degraded areas may show significant improvement under better management. However, it is doubtful that a sustainable system of resource use can be established under current population growth rates.

5. QUESTIONS FOR THOUGHT

The experience of the eight case studies shows that sustainable development is possible, under certain conditions. Central to achieving sustainable development is the need for the various participants to become aware of their shared responsibility, and to take unified action. The question still remains. "Is sustainable development a priority ?" If it is, then the answers to many more questions must be found. The eight case studies have provided insight into how various actions have contributed to more sustainable development in different situations. More importantly, the case studies have provided insight into some of the questions that will be raised if sustainable development is to be made a priority. These questions are outlined in this final section. Questions are addressed to the donor agencies, governments and rural populations in relation to each partner's perceived responsibilities.

5.1 Donors

Above all, are donor agencies aware of the adverse consequences of current aid assistance policies vis-a-vis sustainable development ? Can donors be held accountable for these consequences, either by their constituencies or host governments ?

Are food aid policies in the best long-term interests of the donor country or the receiving country ? Can market incentives stimulate production and conservation in the Sahel when Sahelian farmers are conpeting with the subsidized European and American agroindustry ?

Can the long-term commitment necessary to support sustainable development be reconciled with the short-term planning/budgeting horizons of many donor agencies ?

More specifically, how could the funding process:

a) Act as an incentive to governments to develop new policies affecting land tenure, natural resource use, individual and collective investment, etc.

b) Be centralized to respond to local initiatives, support local decision making, and favor greater financial autonomy among local organizations.

c) Be reorganized to avoid flooding projects with money at the start, and leaving them underfunded at the end of assistance ?

How could technical assistance:

a) Function as a participant or catalyst in local initiatives rather than as project initiator or advocate ?

b) Provide assistance in programming activities at the field level to insure that local initiatives are the basis for future activities ?

c) Help develop an overall strategy based on sustainable development while reducing the complexity of the situation to understandable components ?

Could, or should, donor agencies act in concert to promote policy change among governments that fear political extinction more than ecological disaster ?

5.2 National Governments

Are national governments aware of the significance of national policies and government activities vis-a-vis sustainable development ? Can governments be held accountable by their people or the international community for the adverse consequences of national policies and activities ? Are governments willing to take responsibility for insuring that money is spent on real change in the production system ?

Would governments be willing to provide policy, adminsitrative, and legal support as incentive for responsible conservation and management of resources by those who use and know them best ? Specifically, could governments favor:

a) exchange of ideas on sustainable production systems through:

- greater authority for local organizations to determine the content and function of technical, extension and research services.

- reorganization of the technical, research and extension services to allow greater local input and control,
- support of rural organizations and non-governmental organizations in their training programs,
- support of farm level research-development programs,
- inter-regional and international exchanges between interested groups of farmers concerned with resource management ?

b) investment in resource conservation activities through:

- price stabilization for agricultural and animal products,
- reform of land tenure legislation to assure future user rights,
- guarantees to those who invest in long-term conservation that the benefits will accrue to them,
- subsidies in the form of credit for investment ?

c) management of resources through delegation of responsibility and authority for land use practices to local organizations or institutions, including:

- outside funding for local initiatives on condition that responsible use and management of resources is demonstrated,
- local management of funds and subsidies for resource management and development,
- the creation of local funds for development activities through credit, matching grants, training, etc.
- unambiguous frameworks for the resolution of conflicts of interest among resource users ?

Can governments offer incentives to rural organizations with a demonstrated interest in sustainable resource use, while withholding incentives from those who put individual and family interests above better management of the natural resources ? Can minority interests be accommodated by such a system of incentives ?

What response, if any, should be given to the question of rapidily rising population numbers, rural exodus, migration, etc.

5.3 Rural Populations

Are rural populations aware of their direct contribution to resource degradation ? Are they willing to accept primary responsibility for changing the existing production systems ? Are they willing to make sustainable development a common objective ? Are rural populations able and willing to control the use of their

resources, even when private interests may be affected ? In a word, do rural populations have the will to submit themselves to considerable communal control of their resources ?

Can rural populations organize and conduct free discussion within their villages and regions ?

Can minority and women's interests be accommodated in such discussions ?

Can villages and groups of village organize communally managed zones which might serve as experimental sites to test various techniques and approaches ?

Can villages adopt and enforce rules concerning resource use within the managed zones ?