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OPTIONS FOR PROMOTING USER-BASED  
GOVERNANCE OF SAHELIAN RENEWABLE  
NATURAL RESOURCES

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## ABBREVIATIONS AND ACRONYMS

AID	Agency for International Development
are	one one-hundredth of a hectare
BADEA	Banque Arabe pour le Développement Economique de l'Afrique
CCCE	Caisse Centrale de Coopération Economique
CIDR	Compagnie Internationale de Développement Rural
CILSS	Comité Inter-Etat pour la Lutte Contre la Sécheresse au Sahel
CLUSA	Cooperative League of the United States of America
DSPA	Direction de la Santé et des Productions Animales
FLUP	Forestry Land Use Management Project
GIEC	Groupement d'intérêt économique commun
GOM	Government of Mali
GON	Government of Niger
GOS	Government of Senegal
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association (of the World Bank)
OXFAM	Oxford Famine Relief (NGO)
m <sup>3</sup>	cubic meters
MT/ha	metric ton per hectare
NBA	Niger Basin Authority
NGO	nongovernmental organization
ODEM	Opération de développement de l'élevage dans la Région de Mopti
OMVG	Organisation pour la mise en valeur du fleuve Gambie
OMVS	Organisation pour la mise en valeur du fleuve Sénégal
PA	pastoral association
PDESO	Projet de développement de l'élevage au Sénégal oriental
PIDAC	Project Intégré de Développement Agricole en Basse Casamance
PU	pastoral unit
RNR	renewable natural resource(s)
RNRM	renewable natural resource management
SAED	Société d'aménagement et d'exploitation des terres du delta du fleuve Sénégal et des vallées du fleuve Sénégal et de la Falemé
SODEFITEX	Société pour le Développement des Fibres Textiles
SZWMP	Southern Zone Water Management Project
USAID	United States Agency for International Development

## I. EXECUTIVE SUMMARY

### A. Introduction

Management of Sahelian renewable natural resources (RNR) under current conditions is often inadequate. Pressures on the resource base generated by growing human and livestock populations have sharply reduced RNR available in the Sahel. Repeated severe droughts over the past two decades have compounded the impact of these pressures on RNR, further degrading the region's resource base.

Better renewable natural resource management (RNRM) is imperative. The paper assumes that erosion of RNR in most of the Sahel is serious and conditions will only worsen unless ways are found to encourage greater and more aggressive producer participation in RNRM.

The paper analyzes two fundamental constraints which make it difficult for Sahelian rural producers to manage their RNR effectively. These constraints are government restrictions on legal capacity at local levels to manage RNR, and exaggerated centralization of public finance power which prevents most local jurisdictions from levying taxes within their boundaries on their own initiative to finance or support RNRM actions.

The version of the analysis presented in this paper makes no systematic attempt to deal with the risk and uncertainty issues involved in estimating the costs and benefits of governing RNR under Sahelian conditions. Neither does it attempt to deal directly with the risk issues involved in participating in collective action. Issues here include the extent to which others in a collective undertaking can be relied upon to do their part to protect and maintain governed resources, and the potential costs which people may be forced to support.

The paper begins with a brief overview of the problems of RNRM in the Sahel. It then moves directly to presentation of a series of case studies of donor-financed or local RNRM initiatives. Material in the cases is organized according to the analytic framework presented in Section V.

### B. General Argument

Following is a summary of the argument of this paper presented in outline form.

## 1. Sahelian Environmental Diversity

Sahelian renewable resource management problems are technically complex. Micro-environments are highly diverse within the surface uniformity of the east-west strip ecosystems shaped by rainfall amounts which increase as distance from the Saharan edge increases. The pronounced diversity of micro-environments poses a management problem as far as RNR are concerned. Technically feasible approaches to maintaining the resource base depend on intimate knowledge of local bio-physical conditions, and ability to adapt general management strategies to the complexity of local constraints and opportunities.

## 2. One Resource, Many Scales of Problems: An Example

RNRM problems are complex institutionally, in part, because of the technical complexity of RNRM. Management of a single resource will typically involve several problems at different scales. An example will clarify the point.

### Production Unit Level

Crop production on a field in a micro-watershed or a plot within an irrigated perimeter, requires an intimate knowledge of environmental factors such as the soil conditions and water availability characteristics on those particular pieces of land. Farmers have a distinct, comparative advantage in terms of detailed, site-specific knowledge. They are best able to develop in-field water harvesting systems and control allocation of water within irrigated plots. Bunds and canals require regular attention to ensure that they are maintained and operating properly. The decision-making center, jurisdiction, or regime best suited to deal with each plot or field is the production unit which controls it.

### Micro-Watershed or Irrigation System Level

Coordinating water management within the entire micro-watershed or small irrigated perimeter is a larger scale problem. Potentially competing demands for water are involved. Potential opportunities may also exist to coordinate water use and management for a greater overall return. The potential for conflict, with its negative consequences of delay and uncertainty about investments and productive cooperation, create a need for a decision-making unit adapted in scale to the size of the coordination and conflict management problems.

A micro-watershed committee, or small irrigated perimeter management committee that represents affected producers will usually be better able to deal with these problems than either smaller or larger jurisdictions.

### Large Watershed or Large Irrigation System Level

Additional problems exist at yet a larger scale. A series of micro-watersheds within a large watershed, or small irrigated perimeters within a large irrigation system may find it useful to band together to organize a special jurisdiction to coordinate efforts at the watershed or system level--in terms of water allotments, mobilizing funds for managing joint investments such as irrigation system headworks or water retention dams, and resolving conflicts among different subunits.

### International Level

Finally, very large-scale units may be necessary to provide coordination and manage those problems and opportunities truly regional in scale, or which can only be dealt with if economies of scale can be captured in the production process. Examples here might be the provision of technical expertise on an ad hoc basis, international coordination of efforts to manage river systems through dam construction, and timed release of water flows.

This example illustrates the point that the problems associated with managing a single localized resource vary dramatically in scale. What holds for watersheds and irrigated perimeters holds, as well, for woodstock management, pasture management, soil conservation operations, and many other RNRM problems. What is indispensable for efficient management under such circumstances is multiple centers for management--not a pyramid organization controlled from the top down. The number of jurisdictions will also normally increase, the smaller the scale of problems they address.

Moreover, in many cases, RNRM problems may be best dealt with by special purpose districts, such as village irrigation system management committees at the local level; the federation of village irrigation systems in the Bakel Region at the regional level; and river basin authorities such as the Organisation pour la mise en valeur du fleuve Sénégal (OMVS), the Organisation pour la mise en valeur du fleuve Gambie (OMVG), and the Niger Basin Authority (NBA) at the international level.

Given these points, the paper argues for decentralization of control over resources where decentralization can be expected to improve management of RNR. Resource management institutions can be modified. Institutions properly designed, or redesigned, will create the incentives required to change the way rural producers currently exploit RNR, and encourage more intensive management.

Power and authority are needed to control behavior and deal with the RNRM problems at each level. Typically, authority is required to make rules about who will have access to resources,

how they will be used, what investments will be made to preserve or enrich RNR, and to change RNRM rules in light of changing conditions or the lessons of experience. Authority is required to apply the rules, resolve disputes about RNRM rules, and enforce decisions. In many cases, authority is also required to raise funds through taxation of one kind or another to finance part or all of any investments undertaken to develop the resource, as well as expenditures required to maintain the resource.

### C. Case Studies

This paper presents a number of case studies of contemporary efforts at RNRM in the Sahel. The cases are divided into three groups:

- those where a top-down effort was undertaken to manage RNR;
- those where Sahelian producers themselves undertook in a bottom-up fashion to develop RNRM systems; and
- those which are currently either in design or redesign phases involving attempts to combine top-down and bottom-up approaches.

In the first category, are the World Bank's Eastern Senegal Livestock Project (PDESO), USAID's Niamey Productivity Project, and the CARE Majjia Valley Windbreak Project. The second category also contains three cases: the wadi irrigation systems developed by peasant farmers on margins of Lake Chad, the water-harvesting systems installed by Mossi peasants on their fields in northern Burkina Faso, and the village irrigation systems developed by local farmers in Senegal's Bakel Region with some assistance from NGOs and a government irrigation agency. The third category includes the USAID Southern Zone Water Management Project (SZWM) currently under design in Senegal, the World Bank's Mali Livestock Project (ODEM) and the extension of natural forest management techniques developed under the USAID Niger Forestry Land Use Planning Project to large areas of brushwood around Niger's major urban centers.

### D. Analytic Framework

A four-part framework is used to analyze the cases. The first section focuses on the nature of RNR as economic resources. The second section examines the decision-making arrangements which determine how RNR are used and managed. The third directs attention to the patterns of behavior, or interactions, which arise when individuals, or individuals acting in groups, pursue their preferences for various kinds of RNR. The fourth section

evaluates the consequences of interactions in light of efficiency and equity criteria.

1. Attributes of Renewable Natural Resources as Economic Goods

Initially, the resources targeted for management are examined to determine their characteristics as economic goods, i.e., whether they are private goods, private goods with spillovers (externalities), common property or open access goods<sup>1</sup>, or public goods. The criteria used to categorize goods are first, feasibility of excluding potential users from access to a good, and second, mode of consumption of products or services produced by a good. Consumption may be separable and rivalrous or joint and nonrivalrous. For instance, private goods are subject to exclusion and characterized by separable consumption. Public goods are not subject to exclusion and consumption is joint. Consumption of open access and common property resources is separable. Open access goods are not subject to exclusion; common property goods are not subject to exclusion within the defined user group, but nonmembers of the group can be excluded.

These distinctions are relevant to RNRM in the Sahel because each type of good is best managed by a particular type of institution. Production and distribution of private goods is generally organized most efficiently through markets. By contrast, collective (nonvoluntary) decision-making arrangements are required at one or more levels to manage common property resources and ensure production of public goods.

Open access resources (that is, unregulated common pool resources) involve a dangerous potential for over-utilization of the RNR stock, at least in contemporary Sahelian circumstances. Over-utilization leads to a subsequent reduction in the flow of goods and services produced by the resource facility. These problems arise because of what resource economists refer to as "stock externalities", which is the tendency of individuals to consume open access goods and services without reference to the negative impacts of their consumption in reducing the supply of the RNR-produced goods and services available for consumption by other users. Crowding effects may also cause significant difficulties for RNR management, as when too many herds congregate around an open access water supply.

By contrast, common property regimes involve mechanisms to control use rates. However, problems of setting use rates and policing them always occur with common pool resources managed under common property resources. Stock externalities and

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1 Open access versus common pool resources.

crowding remain potential threats to sustainability of RNR under common property regimes.

Because consumption of public goods is nonrivalrous, once the facility (RNR) is in place, there is no need to regulate use. Regardless of these considerations, the establishment of an optimum-sized facility requires knowledge of the full range of all benefits flowing from it, and arrangements for financing and securing the facility and managing production.

## 2. Decision-making Arrangements

Decision-making arrangements, or rules, may be thought of as institutions. Institutions regulate behavior concerning resources. Some rules define authorized relationships--the rights, duties, liberties, and exposures of RNR users. Other rules define authoritative relationships (i.e., officials powers, liabilities, immunities, and disabilities) in terms of establishing, modifying, and enforcing authorized relationships. Rules create incentives and disincentives for certain types of behavior.

Decision-making arrangements are the result of policy decisions. For instance, nothing prevents government jurisdictions from dealing with public goods as private goods, or trying to manage inherently private goods as common property resources. But the fit between the nature or characteristics of a RNR good, and the institutions through which it is managed, will have an impact on the efficiency and equity of the management process. The ideal is to understand the inherent nature--whether private, common property, or public--of particular resources in their environmental and technical contexts, and then manage them as such.

## 3. Interactions

Interactions are the patterns of behavior that result when users pursue their preferences for specific RNR. These patterns of behavior are shaped by the inherent characteristics of specific RNR as goods, and by the decision-making arrangements which govern access to, use of, and investment in those same RNR. Interactions may result in preservation, enrichment, or degradation of a specific, managed resource.

## 4. Outcomes

Interactions generate outcomes which may be evaluated in terms of their efficiency in exploiting and preserving a given RNR. Interactions may also be evaluated in terms of their equity consequences, such as whether those who invest in RNRM reap a just reward or whether some users are able to ride free on the

efforts of others. Another equity criterion focuses on patterns of distribution of RNR-generated products and services.

#### 5. Public Finance Considerations

##### Resources Needed for Renewable Natural Resource Management

Management of all the RNR discussed in the case studies entails a series of costs. Management functions which must be dealt with in most of the case studies include general management of the resource (i.e., planning its use, harvesting, etc.); actual operation, maintenance, and repair of the resource (harvesting, maintenance of the RNR "facility" such as windbreaks, dams, diesel pumps, irrigation canals, rock bunds, etc.); enhancement of the RNR facility, either through extension or intensification of productive potential; and exclusion of unauthorized users when private or common property goods or services are being produced (informal or formal policing, litigation in defense of rights, etc.).

While the nature of the activities for effective management are discussed in virtually all studies, the mechanisms for mobilizing resources such as labor, services in-kind, and public revenues from local user charges or local taxation to accomplish these activities, are treated in only a few. However, given the importance of these issues, a general treatment drawing on material included in the case studies, but informed by general knowledge of local resource mobilization in the Sahelian region, is presented below in Section VI.E.

## II. INTRODUCTION

This paper deals with a problem of critical importance to the survival of contemporary Sahelian societies: the management of renewable natural resources (RNR). The consensus of Sahelian observers suggests that renewable resources are under severe and growing pressure. Two factors are commonly offered as explanations for the accelerating degradation of the Sahelian renewable resource base. First, growing urban and rural populations make increasingly destructive demands on the resource base. Second, a 20-year series of dry years have increased the vulnerability of the resource base to the destructive pressures to which humans expose them.

The argument presented here fully accepts the negative consequences for Sahelian environments of growing population pressure and persistent drought. However, a third factor is often ignored--the limited ability of most Sahelian rural societies to organize to control resource degradation, and invest in RNR preservation and upgrading where indicated. This is particularly true of RNR in Sahelian rural areas where the flow of services from these resources affects a relatively limited area. Because the rural populations of these areas lack the autonomy to regulate and operate these essential resources effectively, their supply is driven below levels essential for the survival of these communities. The paper argues that this factor often intensifies the impact of the negative consequences of population and drought.

The paper argues that inappropriate rules and institutions for RNRM explain the relative inertia of Sahelian societies in the face of the insidious threat resource degradation poses to their very survival. Sahelian local government institutions are poorly adapted to the needs of the current context. In many situations, particularly at the quarter, village, cantonal, and arrondissement/cercle levels, rural producers are prevented from taking technically simple RNRM actions because the transaction costs of organizing are prohibitive. Transaction costs, as the term is used here, refers to the money, time, and energy costs involved in obtaining legal authority to undertake activities indispensable to the preservation of Sahelian RNR.

Most Sahelian rural societies--with some instructive exceptions--lack power to make legally binding rules governing access to, and use and management of RNR on which they depend. In too many cases, land, water, trees, and pastures are specifically not under their immediate control. Rural producers in Sahelian quarters, villages, cantons, and arrondissements/cercles generally lack legal authority to develop RNR rules, enforce them, and resolve cases of disputes concerning RNR.

Most Sahelian rural societies also lack authority and power to impose taxes on themselves to cover the costs of managing resources when these costs cannot be covered by other means, such as labor and additional in-kind contributions. In many cases, the amount of public revenue needed to provide RNR guards, or realize certain investments, is very limited. Because of the nature of the resources, and the strict prohibitions on local societies taxing themselves, these small amounts often act as insurmountable barriers to better RNRM.

This paper seeks to address these issues, by presenting a series of case studies, and proceeding to a systematic analysis of these cases. The cases are, to a considerable extent, success stories, and consequently, instructive. The result of the analysis is a series of recommendations focused mainly on institutional and public finance issues of relevance to better RNRM.

Section III reviews the status quo concerning management of renewable natural resources in the West African Sahel by rural residents, other resource users, and government personnel. Section IV presents several examples of popular planning and participation in management of renewable natural resources which, when analyzed using the framework presented in Section IV and elaborated in Section V, illustrate how the sets of institutions governing particular types of renewable natural resources encourage resource users, technicians, and government officials to either manage them effectively or abuse them.

Section V fully details a framework for institutional analysis and design, which can be applied to the Sahel case studies as well as comparable renewable resources management activities elsewhere. Section VI explores implications of the case studies, when analyzed from the perspective of institutional concerns, for a policy framework that addresses: public finance issues; delegation or devolution of rule-making authority to levels necessary for efficient governance of RNR; devolution of rule enforcement authority to local jurisdictions to reduce transaction costs of rule maintenance; and devolution of dispute resolution authority to reduce resolution costs, encourage litigation in defense of RNR, and promote constant, low-level pressure for appropriate use.

Section VII presents a strategy for reinforcement and progression of existing positive trends by identifying and then removing, on a case-by-case basis, institutional constraints to user management of renewables. This will involve devising specific ways to devolve authority from Sahelian governments to rural people, with the aim of converting into operational reality the formal conclusions of the Nouakchott 1984 Comité Inter-Etat pour la Lutte Contre la Sécheresse au Sahel (CILSS) conference on desertification control, and the national and donor policies

which have subsequently been developed. Particular attention will focus on least-cost changes promoting enhanced local management of renewables as well as collaboration between technicians and resource users.

### III. SAHELIAN RENEWABLE NATURAL RESOURCES: THE SITUATION NOW

Four significant points can be made as a backdrop to data and arguments presented in the following sections of this report. None are new, so they will not be explored at length here. The four points are:

- the Sahelian resource base is highly variable over very short distances, and generally thin and widely dispersed, although exceptions do exist;
- Sahelians have heretofore used extensive RNR management systems that, under conditions of underpopulation which prevailed until quite recently, were efficient both in producing greater gain for effort invested than would intensive RNR management systems, and in conserving the resource base;
- the resource base, particularly in the central Sahelian strip (situated between the 300-700 mm isohyets) has come under increasing pressure over the last 30 years because of human and animal population growth, and conversion of most of the remaining arable frontier regions to agriculture, coupled with continued use of extensive management techniques; and
- Sahelian rural producers have a great deal of detailed knowledge about their local resource bases and, acutely aware of accelerating resource degradation, are increasingly trying to resolve the problems of intensifying RNR management, without having succeeded as yet in many places.

The pronounced variability and dispersion of the Sahelian RNR base precludes a classic Green Revolution and Training and Visit approach to improving renewable resource management and agricultural productivity. The research costs required to develop hybrid seed types and standardized technical packages adapted to the wide range of site-specific micro-environments would be prohibitive. Even assuming for the moment, development of necessary technical packages, it is highly problematic whether agricultural extension services capable of effectively disseminating such a range of technical packages could be fielded in the Sahel over the next twenty years, given limited trained human resources.

A more practical and realistic approach would focus on developing a menu of options for RNRM and for improving

agricultural productivity from which rural producers can choose in light of their own detailed knowledge of the specific resources with which they must work.

Sahelians have, over roughly the last century, been able to employ extensive production systems. Extensive pastoral production systems have probably been used since the introduction of domestic animals to the Sahel. The reliable conditions of peace and order introduced by the colonial regime and maintained subsequently by the independent Sahelian states followed three centuries of warfare after the fall of the Songhai Empire in 1594. Agricultural production systems during that period were forced by the prevailing insecurity to intensify production to some extent so that farmers could remain close to walled cities and other defensible points. But with the re-establishment of peace under the colonial regime, frontier lands hitherto unexploited because of security concerns and underpopulation were opened to clearing. Gradually, the intensive, annual cultivation techniques still practiced in some parts of the Sahel during the early Twentieth Century were replaced by extensive practices based on long fallows.

On the high Sahelian steppes, only extensive pastoralism systems are efficient because rainfall is so unpredictable. Pastoralists must frequently move their herds long distances between areas where pasture is available. During the pre-colonial and much of the colonial era, pastoralists carefully managed the grass, brush, and tree resource bases on which their herds depended by regular rotations and transhumance. Wells were controlled by the individuals or groups who constructed them, and were located at sufficient intervals from each other so that a de facto system of pasture management could be maintained. Symbiotic relationships with sedentary agriculturalists were also common. Pastoralists got access to crop residues and grain for themselves in return for manuring farmers' fields.

The creation, in the early years after independence, of public wells at which all were at liberty to water their animals, led to overgrazing since no one was able to adjust animal load to forage availability. Growing stock populations followed improvements in delivery of animal health services. This reinforced patterns of overgrazing on unmanaged areas. In addition, political authorities authorized construction of more private wells, so that the earlier de facto range management practices began to break down. This pattern can be reversed to some considerable extent by returning control over wells to pastoral groups, a strategy adopted in two of the RNRM projects discussed below.

Population pressure has been most severe in the central Sahelian band. Humanly-induced desertification now commonly occurs around major population centers across the entire Sahel.

Land is cleared, cultivation intensifies, remaining woodstock (brush and trees) is heavily exploited to meet urban domestic energy demand, and the RNR base degenerates. Most farmers continue to rely on extensive cultivation techniques at present, without making provision to protect or enrich soils now regularly subject to over-exploitation. Patches of sterile laterite appear and spread. In some areas, fossil sand dunes, when stripped of their stabilizing vegetation, become active again. Urban migration only intensifies these developments. Labor migration south of the Sahel to more humid coastal areas relieves pressure, at least temporarily. The two root causes of the problem are: growing populations, and inadequate control on the part of users of their resource bases. Without a progressive and sustained reduction in population growth rates, little can be done to avoid an environmental disaster in the mid-term. If people do reduce population growth rates, a simultaneous increase in the ability of rural producers to manage RNR may stave off the worst.

Sahelian rural producers--agriculturalists, mixed farmers and pastoralists--collectively have very detailed knowledge of the renewable natural resource bases they exploit. As always, in human communities, some individuals are far more skillful than others, but in general, producers know how to manage RNR effectively using extensive production systems. Unfortunately, because of rising demand, fewer areas remain in the Sahel where these techniques are appropriate. Producers--women as well as men--are fully aware of the degradation of their resource bases, and the disappearance of frontier regions which formerly served as areas where excess populations could find new opportunities. However, in many places, this awareness has only hit home recently, and people have just begun to grasp the fact that changes to more intensive production systems are imperative.

The battle now for survival in the Sahel, in addition to controlling population growth, depends on producers' ability to learn new techniques (those involved in intensive management systems), and to apply them on an ever-increasing scale. Indigenous examples exist. The RNRM systems developed by the Dogon on Mali's Bandiagara Plateau are a significant example. In many other areas, producers are relying more on traditional, modern, and hybrid intensive RNRM techniques. But the process is a slow one, in part, because of the learning involved and because the changes required to permit use of extensive systems are many and difficult.

Nonetheless, these changes are indispensable for the survival, and in some cases, possibly the enrichment of Sahelian RNR. Survival of the resource base and its management for sustained yield are matters of the highest priority. Sahelians simply do not have many other alternatives. The capacity of Sahelian cities to absorb additional rural migrants is limited. Few of the centers have any viable industries at this point.

Coastal countries will continue to accept Sahelian migrants, but the political status of migrants is always problematic. Better management of resources in the Sahel seems to offer the most promising opportunities. It is also a sine qua non for the survival of Sahelian societies.

#### IV. CASE STUDIES OF CONTEMPORARY SAHELIAN RENEWABLE NATURAL RESOURCE MANAGEMENT ACTIVITIES

This section presents several examples of popular planning and participation in management of renewable natural resources (RNR). When viewed in light of the analytic framework presented below in Section V, the examples can be used to illustrate how particular sets of institutions governing specific types of RNR encourage resource users, technicians, and government officials to manage resources effectively.

The case studies are grouped into three classes: partial successes through top-down delegation of authority to manage RNR in specific settings; relatively autonomous, local-level efforts to manage RNR in a decentralized manner, with or without assistance from a nongovernmental organization (NGO); and situations where a combination of top-down delegation of authority and bottom-up participation might produce highly desirable results for RNRM.

Table 1, below, provides an overview of the case studies. In the table, they are presented in the order in which they appear in the text. The first three concern top-down activities; the second three, relatively autonomous, local-level RNRM efforts; and the final three, activities currently under development or redevelopment, which will probably involve a combination of top-down and bottom-up aspects.

Readers will notice that these sorts of RNR systems involve certain aspects requiring organized action. The functions are RNR management, operation, maintenance and repair, enhancement and exclusion, and regulation. Some can be handled by private initiative or private voluntary action. Others require some degree of action under public authority, including use regulation and taxation and/or user charges. The cases contain numerous examples of these three types of actions, and the reader should examine the cases with this concern in mind.

The analytic framework used to assess the cases are presented fully in Section V of this paper. However, presentation of the case material is organized in terms of the major elements of the analytic framework. To assist the reader in understanding the case material, and the logic of the presentation, a brief preview of framework elements is offered here.

The framework consists of four parts:

- characteristics of RNR as economic goods;
- decision-making arrangements;

**Table 1. THE RNRM CASE STUDIES: AN OVERVIEW**

<b>PROJECT NAME</b>	<b>RNR TYPE</b>	<b>PROJECT/ACTIVITY CONTRIBUTION TO RNRM</b>	<b>RNR GOODS &amp; SERVICES FLOW</b>	<b>REQUIRED COLLECTIVE FUNCTIONS</b>	<b>RESOURCES TO MANAGE, MAINTAIN &amp; ENHANCE FLOW OF SERVICES FROM RNR</b>
<b>USAID Niamey Department Development Project</b>	soil	technical package inputs (fertilizer, hybrid seeds, garden irrigation) to enhance field crop, gardening outputs	higher soil productivity (problematic)	1, 2	land and water rights, local input management committees
<b>World Bank Eastern Senegal Livestock Development Project (PDES0)</b>	pasture	pasture management through well construction & tenure changes	reliable water supply; pasture grasses, leafy browse, firewood	1, 2, 3	land and water rights; taxation authority and exclusion service at wellheads, pasture management committees
<b>CARE Majjila Windbreak Project</b>	wood/soil	windbreaks for soil erosion control and wood production	soil protection and improved air quality; building poles and timbers, firewood, browse	1, 2	tree tenure rights; village windbreak management committees, (cooperative) marketing mechanism, possibly exclusion services
<b>OXFAM Burkina Faso Water Harvesting Activity</b>	surface water	surface water harvesting through dike installation to stabilize soils, augment rainy season soil moisture, buffer field crops against temporary drought	higher levels of soil moisture	2, 3	land rights; possibly micro-watershed management authority
<b>Bakel Village Irrigation Activity</b>	irrigation water	perimeter construction and diesel pump installation, water flow management, perimeter operation and maintenance	irrigation water	2	water and land tenure rights; perimeter O&M committees; federation committee
<b>Chad Wadi</b>	irrigation water	ground water management for year-round gardening	irrigation water	1, 2	land and water rights; taxation powers, well and ground water management committees
<b>USAID Senegal Southern Zone Water Management Project</b>	irrigation water	surface run-off and salt water intrusion management for double-cropping, gardening	irrigation water from surface sources, aquifers	2, 3	water and land tenure rights; taxation powers; perimeter manager committees; watershed management coordinating committees
<b>USAID Forestry Land Use Planning Project Follow-on Activity</b>	wood	brushwood management	environmental stabilization; firewood, building poles, browse, pasture grasses and hay	1, 2, 3	land and tree tenure rights; taxation authority exclusion service; local brushwood management committees; marketing organization
<b>World Bank Mopti Livestock Development Project (ODEM)</b>	pasture	pasture management through well construction and tenure changes	reliable water supply; pasture grasses, leafy browse, firewood	1, 2, 3	land and water rights; taxation authority; exclusion service at wellheads; pasture management committees

**NOTES:**

1. exclusion and regulation      2. management, operation, maintenance and repair      3. enhancement (intensification or extension of area)

- interactions; and
- outcomes.

The first part categorizes RNR into a variety of different types of goods. The criteria for categorization are: possibility of exclusion and character of consumption. Exclusion refers to the capacity to exclude would-be consumers of RNR unless they meet certain conditions set by either those who produce or own the goods, or other external authorities. Consumption may be either separable and rivalrous, or joint and nonrivalrous. Consumption is separable if one individual's consumption of a good makes it impossible for another to consume it. Leaves that livestock browse from trees fall into this category. Consumption is joint and nonrivalrous if one individual's consumption does not diminish the capacity of others to consume the good. A relevant example is improved air quality: one individual breaths better air, but others are not affected by his actions--they, too, can jointly consume better air. Weather forecasts are another example of a public good.

Distinctions are drawn among private goods, private goods with spillovers<sup>2</sup>, open access and common pool goods, and public goods.

Goods, whether private, common pool, or public, may also be categorized into three different types depending on the stage of production of goods and services. Capital goods are the basic stock, or facility. The capital stock, e.g., a windbreak, produces a flow of intermediate goods, such as poles or firewood. These intermediate goods become inputs to final goods such as shelter or cooked food. The windbreak capital stock also produces a flow of intermediate services in this soil protection, which facilitate production of intermediate goods such as field crops. The windbreaks also produce a final good in their immediate vicinity: better air quality.

#### A. Top-Down Imposition of Resource Management Projects

The cases described in this section all involve RNRM operations which were initiated by a top-down process of decision-making. They include:

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2 Spillovers, or externalities, are the positive or negative impacts which otherwise private goods create for others. A tree planted in a courtyard, which provides shade in an adjacent courtyard during the hot season, creates a positive externality for the neighbor.

- the Niamey Productivity Project, particularly that aspect of the project which stressed creation of local associations capable of managing their own affairs to some degree;
- the Eastern Senegal Livestock Project, which sought among other things to encourage producer involvement in management of pasture and water resources and eventually achieved these ends to a significant degree, though not others; and
- the Majjia Valley Windbreak Project in south-central Niger, which carried out a technically successful intervention in terms of controlling rampant wind erosion on rich bottomland soils, and is now evolving towards sustained-yield, multi-purpose management of windbreaks and associated benefits for most valley residents.

In each of these projects, technicians and planners assessed a situation, determined that better resource management was required, and proceeded to develop projects. Eventually, rural producers were asked to play a role in these projects. Special circumstances resulted in qualified project success in two of the three projects, although whether these operations are now sustainable remains to be seen.

## 1. USAID's Niamey Department Development Project

### Introduction

This case study focuses on the local organizations component of a "productivity" project in Niger as a tool for reaching the final objective of food self-sufficiency. The case does not deal directly with renewable natural resources management, e.g., the bio-physical mechanics of improving agricultural productivity, or with soil management in a technical sense. Instead, it focuses on the local institutional frameworks through which the productivity project and the Government of Niger (GON) sought to increase farmers' ability to attain food self-sufficiency. It treats those local organizations as common pool facilities which produced a flow of goods and services for local users. However, this analysis of local organizations is nonetheless highly relevant to problems of local RNRM because most require some form of local structure to make and implement governance decisions.

The series of drought years from 1968 to 1974 which struck Niger aggravated the general uncertainties of agricultural production there.

In the wake of the drought, the Niger government set self-sufficiency in staple

food grains as a national goal....To achieve this goal, a policy of promoting more intensive rainfed agriculture was introduced in an effort to break with longstanding agrarian patterns....This national policy was supported by large amounts of bilateral and multilateral development assistance (Painter 1987: 148).

For purposes of this effort, the government of Niger established project zones in six Departments. It asked each interested donor to give its support in the form of a so-called productivity project devoted to one of the Departments.

Each project had a specific character--in part, a reflection of the intervention style of its foreign financier--but all of these "productivity projects", as they came to be known, had a common focus. They all sought to introduce new or modified agricultural techniques in the form of a technical package among peasant producers, and thereby increase rainfed agricultural productivity in yields per hectare. By so doing, the scenario went, aggregate production would increase and Niger would move toward self-sufficiency in food (Painter 1987:149).

USAID was asked to support the overall effort with a project in Niamey Department. In conjunction with the government of Niger it began implementing the eight-year Niamey Department Development project (NDD) in 1977. The purpose of NDD was "To institutionalize a process of rural development through the establishment of self-managed village organizations capable of assisting farm families with the achievement of increased food production on a self-sustaining basis..." (USAID/Niger 1980:13).

NDD's strategy for increasing rainfed agricultural productivity was to extend to farmers a standard agricultural package developed with little on-farm testing by the Nigerien National Agronomic Research Institute (INRAN). Initially, farm couples learned the new techniques by training at one of the project's rural training centers. On returning to their home villages these farm couples were to act as extension agents who would teach the project technical packages to their neighbors.

In the process of maximizing the performance of improved techniques for rainfed agriculture, NDD promoted a wide variety of other rural development activities. Strengthening of local organizations was the most important prerequisite, for purposes of the present discussion, for implementation of a number of these other activities. They included programs in adult

literacy, creation of village woodlots, promotion of Diesel-powered grinding mills and development of small-scale, hand-irrigated gardens. All required a local organization capable of mobilizing rural producers to participate in these activities.

### Background

Average annual rainfall varies from about 350 mm in the north of the NDD project zone to more than 550 mm in the south. Soils range from light sandy dune soils in the north to ferruginous, crusty soils in the center, to heavy clay soils in the south.

The villagers in Niamey Department are primarily agriculturalists. However, their holdings are relatively small--particularly in the more humid southern reaches of the Department. In a survey of three arrondissements, between 83 and 90 percent of all holdings were smaller than six hectares. More than half, and in one arrondissement, up to 70 percent of the holdings were smaller than three hectares (Painter 1987:153). In the north, holdings often exceed 10 hectares (Republic of Niger 1985:54).

Agricultural land is generally owned collectively by the family farming it. Rainfed agricultural holdings are thus treated as private goods. A family obtains its rights to particular plots through the village political structure. The family retains exclusive rights to the lands assigned as long as it cultivates them. Family members can exclude others from their lands and they own the stream of products produced on their farm lands. During the rainy season, individuals may enjoy exclusive use rights to small fields on which they work after having met their responsibilities on the family's collective fields.

NDD covered four rural arrondissements (districts) in Niamey Department: Say, Ouallam, Kollo, and Filingue. The total population affected by the project was roughly 280,000. The rural population of the Department is heterogeneous. About 57 percent is of Zarma origin. Another 30 percent is of Hausa or Fulani origin. The remainder is of diverse origin (Sidikou and Charlick 1985:21).

Ethnic diversity is reflected in a diversity agricultural production systems. In particular, the role of women in the agricultural production system varies considerably from site to site. In some areas women contribute labor during the rainy season to the family fields. In others, they do not. Similarly, men have almost exclusive control of off-season vegetable gardening in some areas. In other areas, women play a major role in this sector.

The population is also relatively mobile. Significant numbers of males leave the Department annually during the dry season on labor migration to coastal countries in search of employment in low-paid urban and rural occupations.

In 1979, the Nigerien government initiated the Development Society. The Development Society proposed integrating already existing local organizations into a hierarchy of councils as instruments for popular participation in development activities reaching from the village to the highest levels of the state. The GON expected that the Development Society initiatives would decentralize power and so encourage villagers to participate in national development. The objective was to create a structure through which villagers would be able to influence formation of national policies rather than be limited simply to executing them.

Niger's national approach to rural development evolved further in 1982. Emphasis shifted from a focus on central responsibility for increasing agricultural production to a more participatory approach to rural development.

### The Problem

The organizations underpinning the Development Society were created by the central government with the object of promoting local participation in development while retaining firm control of the permissible forms through which rural producers could organize their activities. GON policy on this matter continued to insist on absolute uniformity in the character of local organizations as a matter of administrative convenience. The same three standard organizations--a village youth group, a cooperative mutual organization, and a political council, described in greater detail below--were imposed everywhere. These three types of organizations were replicated at every level in the system, and were assumed to provide producers a means of representation to the highest level of national policy making.

At the local level, the internal structure of the three organizations was always the same, whether or not the imposed set of offices made sense to local people in the local context. Administrative officials and technicians always knew what to look for by way of organizational structure when they dealt with a village. However, frequently, these structures were artificial shells unable to act unless energized by local decision makers.

Nonetheless, all development projects were assumed, under terms of the Development Society framework, to work exclusively through these three types of local organizations. The NDD project was expected to deliver goods and services at the local level through the three organizations.

The problem for the NDD Project was to devise a strategy to mobilize local organizations formed within this imposed framework. The object of NDD action was to elicit community-wide participation in local activities and programs. The central problem became the degree to which local organizational structures, designed by the central government with the objective of maximizing local participation in development and imposed on rural communities, could facilitate improvements in management of agricultural resources by introducing and managing supporting activities.

#### Technical and/or Physical Attributes of the Resource

The discussion here proceeds at two levels. The first analyzes the general attributes of the local organizations (described in the next section), which the GON imposed in NDD Project villages. The second level analyzes nature of the goods and services produced by those organizations.

Local organizations functioned as common, "opportunity-producing" facilities available in principle to all residents of a given village jurisdiction. While outsiders were typically excluded from these organizations, residents in good standing could not be denied access. However, the goods and services these organizations provided for local people were separably consumed. Resources that the local development organizations provided in their communities were the goods they brought in from and managed for external funding agencies, notably NDD.

A partial list of the goods and services made available in the communities include the following:

- a flow of credit for various purposes;
- a flow of production inputs (fertilizers, hybrid seeds, etc.);
- cemented, wide-bore wells to provide irrigation water for dry-season vegetable garden plots; and
- grain storage services through village silo facilities.

These goods and services all had the attributes of private goods. They were easily subject to exclusion and access to them could be controlled. All were separable in consumption.

#### Decision-making Arrangements

Efforts to promote improved agricultural practices within the Niamey Department Development Project could draw on certain local organizational resources. In the mid-1970s, the government

of Niger tried to create or revitalize three local organizations which later served as the foundation for the Development Society.

The first of these is the GON-sponsored, modern samarya group. It is based on traditional Zarma and Hausa youth organizations which had social and cultural objectives. Such groups predate the colonial era. The samarya, revitalized since 1975, now differs from the pre-colonial institution by extending its activities into the economic and political arenas. Since 1975-76, samarya, capable, in principle, of mobilizing local community members and resources for community projects, have been established in almost all the villages in the country. By 1981, there were 1,220 recognized samarya among the 1,546 villages of Niamey Department (Sidikou and Charlick 1985:46).

The cooperative movement had been languishing in Niger until the promulgation (beginning in 1979) of a series of laws relating to rural cooperative organizations. These laws established the Groupements Mutualistes Villageois (GMV), village mutual groups, as the basic building block of the cooperative hierarchy. The GMV grouped producers at the village, neighborhood or camp level, into small, homogeneous organizations capable of governing themselves autonomously. In turn, GMVs are grouped together in cooperatives which are the targets for government technical services and credit institutions. Each GMV or cooperative has its own management structure.

Sidikou and Charlick (1985:50) cite a report which listed 744 GMVs grouped into 133 cooperatives for the 1,546 villages of Niamey Department in 1981. By 1984, NDD had worked intensively on local development programs and training officers and members of 201 GMVs grouped into 41 cooperatives (Painter, et al. 1985:3).

The third leg upon which the Development Society stands is the Conseil Villageois de Développement (CVD), the village development council.

This new institution is supposed to constitute a permanent base for the national consultative process, whereby local opinions and felt needs can be translated at cantonal and departmental levels into planning priorities. Village councils under the action phase of the Development Society are supposed to differ from past efforts at local institutions by assuring broad-based representation of local groups, interests, and actors (Horowitz, et al. 1983: VI-18).

The village chief is ex officio president of the CVD. Theoretically, half the seats on the CVD are reserved for representatives of the samarya and the GMV.

While the samarya and the cooperative mutual were designated as the primary pillars of the Development Society, the program to create a new Nigerien society began with heavy emphasis on the village development council. Clearly, for this process to produce significantly different results from those experienced in the past, considerable discussion and study would have to precede the creation of a village council, since the conditions and needs of various groups differ from site to site. In fact, there is already considerable concern that councils may simply be created by administrative fiat and thus fail to alter mass-elite relations or the internal dynamics of village life, which keep some groups from gaining access to information and resources (Horowitz, et al. 1983:VI-19).

Traditional village sociopolitical organization overlaps at many points with, but essentially exists independently of the three organizations of the Development Society. The sociopolitical structure in villages in Niamey Department is generally autocratic, although it does not approach the rigid caste-like hierarchies of societies along the Senegal River. Villages in Niamey Department are led by a chief who owes his position to membership in a particular family. Likewise, other positions of village leadership are vested in a small group of families who virtually monopolize authority in the village. The village sociopolitical structure controls initial allocation of land rights within the village territory.

Each village group imposes rules that limit member behavior in the interests of preserving the integrity of the common facility for future group use. The jurisdictional boundaries of the groups are clearly the limits of the village lands. Those who can be members of the local organizations are people who owe allegiance to the sociopolitical structure of the village.

A family gains its position in the village sociopolitical structure simply by residence in the village. Similarly, a family is eligible for entry into the village samarya and the GMV by virtue of local residence. Membership in all these organizations lasts as long as the family maintains its residence in the village. However, a family can be excluded from the GMV for not reimbursing loans it has taken.

The Development Society integrates village-level institutions into a system of councils which reach to the highest levels of the government structure via canton arrondissement and department. The Conseil National de Développement (CND), the National Council for Development, is responsible for the direction of the Development Society. It operates in concert with the National Council of Samaryia and the Union Nationale des Coopératives, (UNC), the National Union of Cooperatives.

The community of users of the goods and services made available by NDD was largely dependent upon arrangements made by external institutions for creating and enforcing the operational rules of the organizations of the Development Society. These rules were applied uniformly to organizations of the Development Society across the country, irrespective of specific local conditions.

The general rules imposed on local organizations in the NDD Project area specified collective provision of private goods and services noted above. Despite collective provision, most were treated as private goods or services. Credit was allocated to and repaid (in principle) by individual householders. Credit was often used by householders to purchase agricultural inputs from the local GMV. These were consumed individually. Garden wells were operated as common property resources by the group of gardeners with plots close enough to the well to make hand-watering feasible. Finally, communal silos were managed as joint or common property storage facilities, although contributions were to be carefully measured to ensure equity.

Local organizations could exclude a group member from access to these goods and services, as a means of rationing the limited amounts available to any group at a given time. For instance, credit distribution patterns were to be determined by group members on the basis of their estimates of the creditworthiness of applicants. In practice, other criteria--particularly power and social status--probably applied in some cases.

Exclusion could also be used, in principle, to enforce discipline among the membership. Concerning credit, the GON imposed a "social guarantee" mechanism, i.e., collective responsibility of all group members for the acts of each member. The national cooperative system sought to impose the social guarantee (caution solidaire) through the GMVs "as a means of ensuring reimbursement of farm credit under conditions where there is often nothing else to offer as a form of collateral" (Painter, et al. 1985:A-21). The social guarantee relies on pressure exerted by the group to ensure conformity of refractory members. In principle, the group will oblige individual members to pay back their credits if the national cooperative system threatens the group with loss of GMV status and, by extension,

loss of access to the flows of credit and other inputs to support the improved agricultural production program of NDD.

The government could exclude a village organization from further access to goods or services for transgressions of individual members. In cases where this occurred, it seriously weakened (if not destroyed) the group's capacity to maintain discipline among members by excluding individuals in the group from future enjoyment of the separable goods and services.

### Patterns of Interaction

The Development Society-imposed local institutions proved highly ineffective in terms of gathering and transmitting feedback about a technical package which was seriously flawed in its initial conception, and never really worked successfully off the research station. Because the structure and functions of the local organizations were imposed, the idea of feedback on the technical package simply did not appear in the terms of reference or in the conception that local people had of their participation possibilities and responsibilities concerning agricultural development in the NDD areas. In reference to the underlying philosophy of the Development Society, this was not a compatible outcome. The philosophy required that the local organizations provide a vehicle for expression of local needs and preferences, but the monolithic technical package was such that it dictated a priori all the goods and services which would be funnelled through the local organizations, as well as the forms of technical assistance made available to local people.

Despite reliance by the GON in its dealings with the GMVs on a collective sanction mechanism to ensure credit reimbursement, "experience to date in Niger with the social guarantee ... has been mixed and the results are inconclusive" (Painter, et al. 1985:A-21).

The mixed performance of the social guarantee within NDD has been the result of two factors. In the first place, the social guarantee can only be effective in situations where group members place a high value on the returns to them as individuals or families from continued participation in group activity. However, in this case, incentives to preserve the GMV were low since the agricultural package promoted through the GMV was not highly valued. Therefore, in many cases, group members had no incentive to exert social pressure on refractory members. Members did not care if they were cut off from access to credit and other inputs. As a result, most GMVs had only limited success.

In the second place, "it must be noted that the model of social control, which is the basis of the social guarantee, is

one of an undifferentiated, highly integrated community" (Painter, et al. 1985:A-21). In many village communities in Niamey Department, the leadership is monopolized by a small group of families to the virtual exclusion of others. The communities are not homogeneous groups economically or socially. Therefore, the government-imposed social guarantee system affords outside agencies little leverage by which to influence the performance of local institutions.

Participation rates varied among the three organizations. Participation in the samaruya was far higher than in the other two local-level institutions. The samaruya was the most active of the three. Three-quarters of the respondents to the Sidikou and Charlick (1985) survey considered their samaruya very active. The activities most frequently mentioned were cultivating collective fields, construction of village facilities such as classrooms, and public health activities.

Sidikou and Charlick (1985:57-58), through their survey of local organizations in Niamey Department, have come to the following conclusions regarding participation in the local organizations of the Development Society:

- women have been underrepresented in these organizations;
- participation rates are higher for those in authority than for others; and
- participation rates are slightly higher for individuals of higher economic standing.

### Outcomes

NDD extension programs did not score well in terms of an efficiency criterion. The agricultural trainees of the project did not use the technical package that they learned at the training centers on their own fields. According to a survey carried out in 1982 of 150 trainees from sessions before 1982, only 5 percent were applying the the whole technical package. More than half the trainees were using less than 15 percent of the package. Moreover, they were using it on less than two hectares whereas the package was designed to be profitable only when used on six hectares and over (Républic du Niger 1985:56). As noted above, most farms were smaller than six hectares in size.

NDD persistence in promoting a poorly adapted technical package also suggests that the Development Society organizations were, at least during the life of the project, inefficient as feedback mechanisms intended to permit rural producers to influence national policies.

It is difficult to assess either the effort/reward or distributional equity attained by the three local organizations. However, the data presented above suggest that a systematic bias favoring the more powerful males was likely in all three organizations.

### Conclusions

The chief shortcoming of the NDD rainfed agriculture promotion program was to extend a technical package untested in village circumstances. The results show that trainees did not value the technical package enough to adopt it and implement it on their fields when they returned home. Agricultural inputs, often purchased with NDD credit, were not sufficiently attractive to justify for farmers the risk of taking out a loan unless they assumed they could avoid repayment. The silos offered no striking improvements in grain storage, and the collective arrangement increased the transactions costs (mastery of accounting principles, etc.) and insecurity of storage substantially when compared with traditional private alternatives.

Without the motivation of a practical program to increase agricultural production, villagers had little incentive to support the local organizations, particularly the GMV, which were capable of back-stopping implementation of the technical package. Producers did not need the technical package. Therefore, there was little demand for the private goods and services that the common pool local organizations managed in support of the NDD agricultural production program.

Two points stand out as a result. When group activities cost more than they are worth to individual members, the groups are unlikely to become going concerns. Had most elements of the technical package been more attractive, it would have been a fairer test of the viability of the imposed local organizations. Second, the national government imposed a framework for local organization on villages in Niamey Department in the course of implementing its Development Society scheme. Considerable reflection and consultation went into the conception of the local institutional framework. However, in the end, higher administrative authorities imposed a uniform framework throughout the country rather than allowing local people to develop organizations tailored to local circumstances. The imposed uniformity probably created obstacles to the success of many of those organizations because they did not reply effectively to local requirements.

## 2. World Bank Eastern Senegal Livestock Project

### Introduction

The Eastern Senegal Livestock Development Project (Projet de développement de l'élevage au Sénégal oriental [PDES0]) (1976-1988) provides an interesting and relatively successful case study of local institutional development for Renewable Natural Resource Management (RNRM). It clearly demonstrates the utility of administrative and financial decentralization, the importance of transferring decision-making authority and implementation responsibility to local resource users, and the need for an enabling legal framework to provide greater autonomy to local jurisdictions to deal with RNRM issues. However, the PDES0 case study also suggests that more attention should be given to understanding the attributes of the natural resources to be managed as economic goods (private, common property, or public goods) and the impact of those attributes on incentives and implementation of project goals concerning participation in RNRM.

### Project Background, Objectives, and Assumptions

The first PDES0 livestock project in Eastern Senegal began in 1976 and was financed by the International Development Association (IDA), Banque Arabe pour le Développement Economique d'Arique (BADEA), and the Kuwait Fund. The first phase ended 30 September 1983. During this period, PDES0 was the livestock component of a broader project encompassing all of Eastern Senegal and a Project Unit within the Société pour le Développement des Fibres Textiles (SODEFITEX). The project was extended in 1983 for five more years and financed by the World Bank and the Caisse Centrale de Coopération Economique (CCCE). In 1984, PDES0 II was detached from SODEFITEX and given a considerable degree of autonomy under the supervision of the Direction de la Santé et des Productions Animales (DSPA). PDES0 II was scheduled for completion in late 1988. The World Bank is currently considering extending its financial support for PDES0 because of its relatively good track record.

PDES0 I's objectives were to assist 30,000 livestock owners in the northern part of Eastern Senegal to increase their incomes by developing and operating a pasture management scheme; making livestock inputs readily available to stock owners; and improving animal health services through vaccination campaigns against the major contagious diseases. While PDES0 II (1984-88) was perceived as an extension of the first livestock project with similar objectives, planners placed a much greater emphasis on RNRM by local populations. Thus, implementation of range management plans, greater pastoralist participation in making decisions and promoting new grazing practices, and improved management of local pastoral associations became important priorities.

The project assumed that herder incomes would improve through increased animal production. Animal health measures, improved water supplies and grazing lands for the herds, and supplementary cattle feed made available on credit would increase the number and quality of livestock and lead to greater milk and meat production in the project area. Livestock owners would respond positively and organize themselves into Pastoral Units (PUs) because of the convergence of the planners' goals and their own. In addition to more animal production, these goals included village reforestation and the maintenance of fire breaks to fight bush fires. The project also assumed that with training, local people could replace government livestock extension workers and efficiently manage various activities, e.g., input credit programs, grazing plans, and veterinarian functions.

The project made no distinctions between private (e.g., cattle), common property (e.g., grazing lands), and public goods (e.g., firebreaks to contain bush fires). There was no consideration of how and why livestock owners might respond differently according to the nature of the resources to be developed or maintained. While there was greater emphasis than in the past on the importance of local institutional development as opposed to the achievement of physical objectives, the project's institutional focus was primarily on organizations and their capacity to effectively use material inputs (e.g., wells, cottonseed and mineral feed supplements, vaccination shots, administrative infrastructure for PDES0, etc.), to accomplish project goals.

#### Advantages for PDES0 of Administrative and Financial Decentralization

During the first phase of the project, PDES0 operated as a project unit attached to SODEFITEX, a Senegalese Regional Development Agency primarily concerned with promoting cotton production in Eastern Senegal and the Upper Casamance. PDES0 experienced financial difficulties in 1983 because of the failure of the central government to fund operating costs. As a result, PDES0 could no longer pay its suppliers and the latter stopped delivery of goods and services needed for PDES0 to function properly. Donors insisted that PDES0 be detached from SODEFITEX and granted financial and administrative autonomy as a condition for donor support for PDES0 II (1984-88). PDES0 obtained this in June 1984. This meant PDES0 no longer depended on the Government of Senegal (GOS) Treasury to release funds for operating costs and that the Treasury would exercise only a posteriori control over PDES0 expenditures. Administrative autonomy meant PDES0 had considerable flexibility to adapt its structure and staff to project goals, especially those related to RNRM. Thus, PDES0 could hire expatriate pastoral specialists as consultants, train Senegalese counterparts to develop range management plans and monitoring skills, and oversee functional literacy, forestry, and

anti-bush fire components of the project. It also had more flexibility in removing livestock extension agents who did not work well with local populations, and transferring its extension agents to other areas when needed.

#### Creating Pastoral Units and Local Jurisdictions from Above

PDES I organized 53 PUs within the 1.3 million hectares of grazing land in its territory during the late 1970s and early 1980s. Each PU was comprised of eight to 10 small villages and a population of 1,000-2,000 people. PDES selected the PUs after careful study of the ecological resources available for each unit, the ethnic and social composition of local populations, and current pastoral practices. Numerous consultations with the local populations explaining the project contributed greatly to securing local support. The PU represented a new form of local jurisdiction authorized to control use of water and grazing land resources within a given area. The water resources included new wells constructed by the project. The local populations organized in PUs were to assume responsibility for managing the natural resources under their jurisdiction and programs offering veterinarian services and supplementary cattle feed for their animals. Each PU elected a comité de gestion. PDES, using project funds, also established functional literacy programs in local languages of the area and other programs to train local people to serve as village auxiliaries who would aid and eventually replace government livestock extension agents. These programs were very popular and drew hundreds of students.

#### Incentives and Impediments to Herder Participation in Renewable Natural Resource Management

PDES I successfully organized the livestock owners into PUs which collaborated effectively in animal health and supplementary cattle feed programs. The PUs served as collective guarantors for credit extended to facilitate animal disease treatments and supplemental cattle feeding. Herders willingly paid for certain veterinary services and had an excellent repayment record when buying cottonseed and mineral salts to feed their animals.

These programs provided direct and immediate benefits to livestock owners by improving the quality and quantity of their animals. Because cattle were private goods, non-participation in these programs meant being denied access to inputs (e.g., vaccinations, cattle feed), and the potential benefits, (e.g., healthier and heavier animals). Free-rider problems were minimized since it was in the interest of the management committees to ensure that participants in the animal feed credit program repay their debts to avoid the denial of future credit to all participants.

An important incentive for livestock owners to organize themselves into PUs and participate in PDES0 range management plans was the promise of access to and control over the new wells constructed by the project. While PDES0 I succeeded admirably in organizing the PUs, very little was accomplished in terms of direct herder involvement in RNRM for several reasons. First, the grazing plans and other objectives had been predetermined by PDES0 planners without the involvement of the resource users themselves. The grazing plans which had been drawn up by a Belgian specialist in 1980 remained unused by livestock extension agents while the local populations were not even aware of their existence, despite the fact that they were, in theory, called upon to implement these plans. Second, the PUs had no legal status and were not granted title to the wells and grazing land in their jurisdictions. Hence, they were not able to enforce the exclusive pasture and water rights that had been promised pastoralists as an inducement to join the PUs. With no legal status, PUs remained largely creatures of PDES0. Third, little effort was made to deal with free-rider problems concerning the social forestry and anti-bush fire components of the project.

Other than exhortation, there were no mechanisms to enforce community participation in maintaining newly planted trees and firebreaks. Moreover, the local populations demonstrated little interest in these programs. The social forestry component failed because the trees chosen by PDES0 I did not suit local needs, and the fire-fighting committees established by the PUs did little to maintain firebreaks or prevent outbreaks of destructive bush fires.

While praising the progress made in organizing the PUs, a sociologist noted after his 1982 evaluation of the project, that PDES0 I was not doing enough follow-up work to involve local leadership in the project. Instead, PDES0 was moving on to organize other zones. The report also warned that lethargy would soon set in if the functions of the PUs were not more clearly defined, and stressed the need to provide the PUs with real authority to enforce water and grazing rights.

#### Changes in the Legal Status of the Pastoral Units during PDES0 II and Impact on Renewable Natural Resource Management

In 1984, the Senegalese government passed legislation that permitted diverse economic groups and associations to establish themselves as financially autonomous legal entities called Groupements d'intérêt économique communs (GIECs). The PUs took advantage of the new law and transformed themselves into GIECs. As legal entities, the GIECs were able to register the land resources in the area under their jurisdiction. This afforded them legal protection against outsiders seeking to exploit their water and grazing land resources without group authorization. It also encouraged them to take a more active role in implementing

the range management plans established earlier. These plans coordinated agricultural and livestock activities during the planting season and delayed the return of cattle to the agricultural zones at the end of the rainy season to ensure that crops would be planted and harvested without being trampled by cattle. The plans also provided for careful coordination of herd movements to avoid concentration of animals around the same watering points and grazing lands in the area.

One issue that had not been considered was the establishment of an effective system of material incentives to support the village auxiliaries who were to replace PDES0 extension agents. The literacy training programs had attracted primarily younger men. Interviews with GIEC representatives indicated that the management committees were satisfied with the auxiliaries when they did simple livestock extension work. However, the auxiliaries were young men in a gerontocratic society. They usually served only as secretaries for the management committees and generally had little influence on these committees, which were dominated by the village elders. Moreover, there were no mechanisms for remunerating the auxiliaries for their services other than a small amount of money (approximately U.S. \$70) offered by the project for those finishing the training program. As a result of the lack of incentives, many auxiliaries abandoned their posts. By 1987, PDES0 officials were questioning the utility of training auxiliaries. However, the World Bank insisted that training auxiliaries and teaching functional literacy were crucial to ensuring local management of the grazing plans and phasing out PDES0 extension agents in the project area. The project had incorrectly assumed that the management committees would want more technically competent (e.g., literate) people to help them run their affairs and would give them an important role in decision-making. In fact, the elders continued to dominate decision-making and provide few outlets for the young to use their new skills--a factor which led to the disaffection of many of the newly trained people from the project.

### Conclusions

The PDES0 project was relatively successful in implementing several of its major goals. First, financial and administrative decentralization gave the PDES0 project more authority, initiative, and flexibility in dealing with local populations. It also reduced project transaction costs by reducing the amount of time and energy usually needed in dealing with central administration supervisors of similar projects. Second, the establishment of local jurisdictions (i.e., PUs) eventually allowed members to implement range management plans designed to make fuller use of the project area's water and grazing land resources. Third, the transfer of major responsibility for managing these resources to local resource user organizations, i.e., the GIECs--giving them officially sanctioned legal status

and financial autonomy--strongly reinforced the PUs' ability to implement RNRM plans. Fourth, the shift in the role of PDES0 from a classic "encadrement" agency to a support group for local natural resource user associations, which progressively accepted more and more responsibility for managing their own resources, was carried out successfully.

The attainment of these objectives marked a considerable advance over past livestock projects which focused almost exclusively on improving animal health and producing more beef and milk for commercial markets, without considering the importance of RNRM and the need to give local resource users more authority and initiative to manage their own resources.

However, some of the project's shortcomings can be attributed to not fully conceptualizing institutional development, i.e., the establishment of local pastoral units to manage natural resources effectively. PDES0 viewed institutional development essentially as an organizational problem that could be resolved by providing inputs and resources needed by the PUs to function effectively. The project might have been even more successful had it considered the significance of differences in the nature of the various goods and services being provided and how these would affect the behavior of local resource users and their organizations. These distinctions help explain why certain project components achieved their objectives while others failed. For instance, firebreak maintenance and village reforestation activities failed to attract more than nominal support and commitment on the part of the local populations. Moreover, an analysis of the constitutional rules governing traditional pastoral social organization and how these affected the formal and informal rules governing the selection and composition of management committees, and allocation of decision-making authority within the PUs, might have avoided some of the problems concerning relationships between the PUs and the newly trained auxiliaries.

### 3. CARE Majjia Valley Windbreak Project

#### Introduction

The CARE Majjia Valley Windbreak Project, initiated in 1974, offers another interesting example of a top-down project which, once implemented, achieved a broad degree of support among farmers affected by the project. The Majjia Valley lies mainly within Bouza Arrondissement, southern Tahoua Department, in the center west part of Niger. Harmattan winds buffet this area during the dry season. They sweep down the valley as though blowing through a wind tunnel. If not controlled, the harmattan will continue to carry off tons of valley soil annually.

Because of the high water table in the Majjia Valley, fertile bottomland soils, and possibilities for flood recession agriculture, the potential loss of productivity through wind erosion was serious. During the late 1960s and early 1970s, wind erosion accelerated as many of the last naturally-occurring trees were cleared from the valley floor.

At that point, a Nigerien forester and a Peace Corps Volunteer developed a plan to install windbreaks the length of the valley in Bouza Arrondissement. Because of farmer concerns that the Government of Niger (GON) might use the planted trees to establish a claim to their lands, residents of the three villages--Garadoumés Hayi, Kware, and Lougou, where the windbreak project started in 1974--resisted the initiative until they were orally assured by the forester that they would own all windbreak trees on their fields. Subsequently, a new head forester was named to Bouza Arrondissement. In all villages included thereafter in the windbreak activity, the promise of tree ownership was simply dropped. Even in the original villages, the agreement was ignored. However, by then, valley farmers were beginning to see the positive effects of the windbreaks. They highly valued the on-site service of controlling the increased erosion caused by the windbreaks and began requesting treatment of their fields.

Once established, the windbreak plantation system operated as follows. The Nigerien Forest Service, using funds supplied by CARE<sup>3</sup>, produced tree seedlings during the dry season for transplanting as windbreak rows during the summer rains. Foresters organized villagers from those communities with land on the valley floor, as well as those from adjacent communities, to help with the plantation. Supervised by the foresters, the villagers laid out the windbreak lines, dug the holes, and planted the nursery seedlings. They received Food for Work payments for their labor. The Foresters imposed a ban on grazing in the planted areas for a period of four years, until the trees attained a size where browsing animals could not seriously damage them. Foresters, using CARE project funds, hired local guardians to patrol the bottoms. Stray animals were impounded, and owners had to pay a fine before reclaiming their animals.

The grazing ban was a technical success and the trees flourished. However, the ban impinged differentially on the population. Gardeners and farmers benefitted because during the ban, they did not need to fence dry-season gardens and fields against roving animals. Livestock-owning people "paid" the cost

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3 Cooperative American Relief Everywhere is a nongovernmental organization with sections in Europe as well as the U.S., which has actively supported renewable resource management efforts in Niger throughout the 1970s and 1980s.

of the ban, in the sense that they either had to arrange other sources of forage for their animals, or liquidate their herds. Pastoral groups resident in the valley and nearby areas, who had traditionally brought their animals to feed on crop residues in the bottoms during the dry season, generally shifted their herds elsewhere. Valley women, who lacked that sort of mobility and were unable to devise a collective solution to the problem, ended by selling most of their animals. They suffered the greatest short-term losses, and were not indemnified. However, the livestock carrying capacity of the valley without introduction of the windbreaks would certainly have continued to decline. Now that many areas have again been opened to browsing and foraging, agro-pastoralism has become attractive once more. Camels are the only animals still excluded after the ban was lifted in part of the valley. They are so tall they can destroy regeneration of pollarded trees (those that have had branches cut back to their origination point at the top of the trunk two to three meters above ground level). They tear the lowest branches off all trees. If not controlled, this type of foraging opens up wind tunnels under the trees' lowest branches, accelerating wind erosion.

Over the intervening 14 years (1974-88) from project start-up, approximately 500 kilometers of double-row windbreaks have been established on the valley floor. They are composed mainly of neem trees (*Azadirachta indica*) and mesquite (*Prosopis juliflora*), supplemented in some areas by *Acacia nilotica* spp. *scorpioides*. The breaks are planted at 100-meter intervals, perpendicular to the channel of the seasonal watercourse. The main stem runs down the valley from the northeast, first towards the southwest and then turns south below Ayaouane. More than 5,000 hectares of cropland have now been protected.

During the 1980s, the first windbreaks attained the height necessary to sharply reduce wind erosion in protected areas of the valley floor. Crop yields on protected fields either stabilized or increased, as did the production of biomass in millet and sorghum stalks. This happened despite the loss to windbreak rows of 15 percent of the arable surface in the protected areas. Proof of the project's technical success lies in valley farmers' repeated requests from the early 1980s that windbreaks be established on their lands as quickly as possible.

An interesting twist in the project developed as the trees matured. Because the combination of water and soil conditions in the valley was so perfect, they grew too well. When the project was designed, no one projected a need to harvest the trees: they were expected to produce only the on-site service of wind control. However, after 10 years, many had attained heights in excess of 10 meters and were beginning to shade out crops planted adjacent to the rows. Silvicultural tests revealed that the trees could be safely harvested by a pollarding system. Results

of various cutting trials indicate a four-year rotation will be most appropriate. One row of the four in two adjacent windbreaks will be pollarded each year. By contrast with coppicing (cutting the trees at the base of the trunk to provoke regeneration from the ground up), pollarding eliminates the need to protect trees from animal damage while lopped branches regenerate. It should ensure a regular supply of consumable wood products while maintaining the wind screen effect.

This system produces various consumable products, including firewood, building poles, and some construction timber. All are valuable. Some--particularly the building poles and construction timbers--are marketable. Firewood is critically important because it meets local demand for up to half the year. This relieves valley women of the onerous task of having to collect brushwood on the Majjia Valley slopes to use as fuel for cooking fires. At the same time, windbreak production of firewood relieves pressure on remaining natural vegetation on valley slopes. It is hoped that this will permit gradual reforestation of those areas, with a consequent reduction of hydraulic erosion. In turn, this should permit restoration of flood recession agriculture in the northern part of the valley. Increasingly rapid runoff of surface water, occasioned by progressive deforestation of the slopes, has seriously disturbed the flood recession system. Instead of trickling into the valley and flooding over the shallow banks of the main stem watercourse, runoff now cuts the main channel deeper every year in the northern half of the valley. Waters continue south--main stem banks are now too high to permit flooding except in the wettest years--and only below Ayaoune, half-way down the valley, do they begin to spill over onto fields.

Windbreak cuts are timed for the late dry season so they open the arable land immediately adjacent to the windbreak rows to sunlight during the following growing season. The result is a one-year burst in productivity in these areas, followed by a rapid dropoff as the branches regenerate over the next year and again shade out the area.

#### Technical Attributes of the Resources

Three types of goods are produced by the windbreaks: public, open access, and common property goods<sup>4</sup>. The wind protection and environmental upgrading services that result from the stock of trees that constitute the windbreaks are public goods. Consumables such as firewood, building poles,

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4 During "construction" of the windbreak, it is important to keep potential users from consuming the growing saplings. Otherwise, they will never mature to produce public services of soil erosion control.

construction timber, browse (neem, mesquite and A. nilotica scorpioides leaves, and edible seedpods from the mesquite), and a tanning material from the scorpioides seeds and pods, shift from common property to open access goods depending on the season of the year.

#### Public Goods

The wind control and micro-climate improvement services that windbreaks produce are public goods for all those who farm fields protected by the windbreaks.<sup>5</sup> They cannot be excluded from the benefits of muddled air currents. These include lowered rates of evapotranspiration, less damage to seedlings from wind-whipped soil particles, less breakage of stalks of mature plants and less damage to ripening field crops. These benefits translate into substantially greater productivity of biomass and edible crops on protected fields. At the same time, the benefits one farmer derives from windbreak-muddled air currents in no way reduce the benefits other farmers receive. Consumption of the service is nonrivalrous among those within the scope of the good. As stated above, it is inappropriate to exclude people from access to these services.

#### Open Access Goods

The nature of windbreak consumable products noted above varies on a seasonal basis as a result of land use patterns. All these consumables are alike in that they are subject to separable, or rivalrous consumption.

Exclusion is the criterion by which they may be classified as either open access or common property goods. During the dry season, valley lands are open access lands, except if fenced. Highly productive areas, such as irrigated gardens, are normally fenced; remaining areas are left open after the harvest. Users of renewable resources are at liberty to wander over valley fields as they wish. Herders and pastoralists bring their animals to browse on the lowest branches of windbreak trees and on crop residues which remain on the fields. Free-ranging animals, released by their village owners to forage for themselves on a daily basis, also enter fields. People looking for firewood, building poles, thorns for fencing, seed pods for tanning, etc., may go where they wish, whether or not they own land in the valley bottoms.

Gardeners and those who engage in flood recession agriculture frequent their own fields during parts of the dry

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5 Tenants may not benefit if owners of protected fields succeed, through the rent bargain, in capturing the entire increment to productivity produced by the windbreaks.

season. While they are on their own land, they can patrol it without any extra cost as a subsidiary activity in addition to their main purpose in being on the field. However, such activities tend to be intermittent rather than constant. Furthermore, pastoralists often spend nights on valley fields with their herds, when gardeners have returned to their village residences. Given this situation, exclusion becomes difficult to ensure. Users may find opportunity to harvest products they need without having to request authorization from anyone. This creates the problem that users, acting on their own, will degrade the windbreaks. It also leads to suboptimal production of the rivalrous goods.

#### Common Property Goods

The situation changes radically during the summer growing season through the end of the fall harvest. Then farmers spend their days in their fields and can easily patrol access to the windbreaks on their fields. Animals are kept out of growing crops (most stock owners send their stock out of the valley to summer pastures further north). People move over the fields on their way to work sites, but their actions can be observed easily and controlled.

Most of the consumable products produced by the windbreaks can be harvested at any period of the year. If fencing were possible on a larger scale, products which are now either open access or common property in nature could be converted into private goods<sup>6</sup>. However, the cost of imported fencing is prohibitive. Live fencing reinforced by branches lopped from thorny trees would take up too much room and cast too much shadow to be acceptable within current patterns of land use in the valley. Thus, exclusion is not realistically feasible for field owners.

#### Decision-making Arrangements

Until quite recently, CARE financed the guardian system that protected the windbreaks during the four years following initial plantation, but CARE has decided to withdraw funding for this activity once the windbreaks are established throughout the valley. As things now stand, when trees are well established, the Forest Service moves the local guardians to follow the advancing front of the windbreaks.

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6 Making consumption of windbreak products (wood, etc.) subject to exclusion by fencing the trees will not necessarily lead to efficient levels of utilization. Property rights, whether private or collective, will determine utilization rates. See the following sections on "Decision-making Arrangements" and "Interactions".

As a result of CARE's gradual withdrawal, the Forest Service will not be able to mount patrols once the valley has been completely protected by windbreaks. Furthermore, CARE and the Forest Service agreed that the windbreaks must be progressively harvested to maintain the associated agricultural system at peak productivity and capture valuable consumables that the windbreaks are now producing in increasing amounts.

The system now gradually being installed to manage the windbreaks is a hybrid which combines Forest Service and villager responsibilities. Foresters preside over the annual cuts to make sure the work is executed properly. Aside from that, villagers are more or less on their own. They have to organize workers to carry out the cut and divide up the harvested products according, in part, to a fixed formula. In addition, field owners must ensure that the trees on their fields are protected at all other times. Foresters retain backup authority to intervene if villagers request assistance to help protect the windbreaks, or if they fail to protect their trees.

After several years of negotiation, CARE has obtained GON agreement to the following formula for division of products harvested from the windbreaks. Field owners receive one quarter of harvested products. Each field owner gets the same amount of firewood, building poles, and construction timber as all others, whether the person has one windbreak tree or a hundred on his or her land. The remainder of the wood becomes the property of the village cooperative. The cooperative can divide the wood among members or market it at their own discretion. In principle, sale proceeds belong to the cooperative and can be allocated as members see fit. However, the cooperative must cover costs of the harvesting and distribution operations. By implication, if windbreaks must be patrolled in future to protect them from unauthorized exploitation, those costs would be supported in the first instance by proceeds of wood sales.

### Interactions

This system for managing the windbreaks as common property resources has been evolving since 1985 in the Garadoumé villages where the project was initiated as a pilot test. Commercial cuts have been undertaken with generally acceptable results. The cut undertaken during the spring of 1988 produced a six-months' supply of firewood for the three villages, and a substantial quantity of marketable building poles and construction timbers.<sup>7</sup> A total of 309 field owners received their fixed quarter share,

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7 This paragraph draws heavily on information provided by Mr. Olav Bakken Jensen, Agroforestry Programme Manager, CARE/Niger, in his letter of 10 October 1988 to Michael Furst, Africa Environmental Division, World Bank.

in accord with distribution rules. This amounted to one heavy log, six building poles, and .15 m<sup>3</sup> (cubic meters) of firewood. The remainder of the wood was processed by the cooperatives. A certain amount of the cooperative share was used to pay local workers who cut the trees under forester supervision, guards who protect the wood from the time it is cut until it is distributed or sold, and a manager for the local windbreak cooperative. The remainder was distributed locally (firewood) or sold locally, in Bouza, or outside the arrondissement. Information regarding the influence of the new harvesting system on local participation in protecting the windbreaks is not currently available. However, clearly, the purpose of allocating wood to both field owners and other villagers is to create a property stake and thus incentives for recipients to join in co-policing the windbreaks so that access control systems are maintained. If individuals regularly do nothing when they see others violating the rules of the windbreak management system by harvesting out of season, the continued existence of the windbreaks will be jeopardized. The incentive system as now constituted will have to be fundamentally revised.

Implementation problems are to be expected during the first several years. If they can be resolved in that initial period, prospects for long-term successful management of the windbreaks look increasingly favorable. The major problems that can be foreseen have to do with the degree of villager production of windbreak policing services, and the honesty and efficiency of village cooperative officials in distributing and marketing wood, and allocating sales proceeds. If transhumant herders or valley residents ever begin to harvest windbreak products on a large scale outside the framework of the forester-supervised annual cut, the possibilities that the system will collapse are significant. It will depend on whether a system of patrols can be organized again, but this time by valley residents rather than foresters.

Another significant issue concerns dispute resolution. If minor infractions of the windbreak management program can be resolved at the level of valley communities before local officials, chances are better that harvesting rules will be respected than if disputes must be taken before foresters or officials in Bouza, approximately 15 kilometers distance from the closest valley community.

The Development Society institutions, and current GON efforts to delegate increasing authority to them, could play an important role in the development of the Majjia windbreak management system. Growing local control over local affairs and the role of cooperatives in management of economic resources figure prominently in Development Society theory. Strong support of these principles in the future by GON public administrators may help local people and officials conclude that they really do

have authority as well as responsibility to manage windbreak resources. That may help shift public opinion in favor of windbreak protection and regulated exploitation. This GON policy should thus be supported whenever feasible.

### Outcomes

The interactions just described may be provisionally evaluated, in this case, in terms of efficiency and equity criteria.

#### Efficiency Criterion

In terms of efficiency, the new system for windbreak management seems promising. The criterion of efficiency, as defined here, entails management of the windbreaks aimed at an optimal mix of outputs produced at least cost. An efficient output mix involves trade-offs among:

- a level of continuous production of the local public good of wind erosion control;
- regular harvesting of consumable products; and
- pruning trees to reduce shaded areas, thereby increasing the arable surface area of protected fields.

The new system appears to include the necessary elements to approximate both the technical and optimal mix of benefits as least-cost elements of this definition. Giving field owners a reliable and substantial vested interest in preserving the windbreaks creates incentives for them to participate actively in protection. The regulated harvest provides this assurance. Given the certainty of regular harvests, field owners can be expected to police windbreak use on their own fields to preserve their share of the wood. Moreover, much as dry season gardeners now protect each other's gardens from stray animals which break in while the owner is absent, field owners now have justification to protect trees on adjacent fields, in hopes that neighbors will return the favor.

Villagers who inhabit valley communities but do not have fields with windbreaks now also have a fairly strong incentive to help preserve the windbreaks and abide by management rules. They benefit in several ways. First, some proceeds of the wood harvest are reinvested within the community to finance production of public goods such as repair of local public buildings and wells. Second, firewood that results from the cut is sold locally at a low price, apparently well within reach of average village families. Third, in some villages--as was the case

during 1987 in the Garadoumés--a portion of the firewood may be distributed free to each family.

If the present system becomes established at the local level, and villagers conclude that it is run honestly, the individual's incentive to support it will increase simply because it increases the certainty that each family or individual will gain something from the system. Building public consensus in support of the system in turn drives down the public costs of enforcement by creating a norm--and associated social pressure--favoring compliance with management rules. These considerations, while diminishing the temptation for individual users to "free-ride" by harvesting products without authorization, do not eliminate that temptation. Thus, success of the windbreaks depends crucially on continued willingness of villagers to support the management system by respecting the rules and insisting that others respect them--particularly during the dry season, when open access conditions exist.

#### Equity Criterion

Again, contingent on a minimum of honesty in harvesting, distribution, and marketing, the windbreak management system appears to meet minimum equity criteria. Field owners sacrifice some of their arable land and bear a somewhat greater responsibility for informal management of the windbreaks than do other villagers. In return, they receive soil protection services and a quarter share of the annual harvest. Other villagers, while they do not benefit directly from wind protection services, will have access to a greater supply of firewood locally on a regular basis. Villagers who are too poor to pay for windbreak firewood should nonetheless have an easier time finding wood during most of the year because of the substantial reduction of demand for naturally-occurring firewood during at least six months of the year. With the partial exception of camel owners--since camels are now permanently banned from the windbreaks--transhumant and local livestock owners will benefit from the windbreak management system if it proves sustainable. The trees will provide appreciable amounts of browse at the time of the annual cuts, during the dry season when green forage is very scarce. Neem leaves are palatable only by camels and goats, but they make up an important percentage of herd animals that frequent the valley, or can be fed with leaves cut and carried away from the windbreaks. In addition, biomass left on fields after harvests in the form of crop residues is likely to be more abundant. This will increase the cellulose component of locally available dry-season forage, and should, at least marginally, help local stock owners.

## Resources Needed for Renewable Natural Resources Management

Resources must be mobilized to manage the windbreaks, to ensure that use regulations are observed and exclusion is maintained if illicit cutting becomes a problem. Resources must also be mobilized to ensure that windbreak maintenance--in the form of periodic harvesting cuts--occurs as programmed. If the proceeds of the harvesting cuts cover these costs, then financing will pose little problem. However, if proceeds do not fully cover costs, then it will probably be necessary to rely on some combination of in-kind services (mounting guard, etc.) as contributions or mandated contributions, plus local taxes and user fees.

### B. Autonomous, Local-Level Efforts to Manage Renewable Resources

The three cases included in this section all concern situations in which Sahelian rural producers undertook significant RNR activities. The cases are: water-harvesting operations introduced by peasant farmers on the lateritic terrain of the northern Mossi plateau in Burkina Faso; the village irrigation systems developed largely by riverain farmers in the Bakel Region of the Middle Senegal Valley; and wadi irrigation systems in southwestern Chad.

The producers who developed these activities received some outside assistance, either technical or financial in nature, or both. However, the degree of local initiative in all three is marked. In all three, institutions for management of the resource were largely developed at the local level, and were based, in part, on existing decision-making arrangements. In the Burkina water-harvesting activity, relatively little institutional development was required to start the activity because it was conceived mainly as a private operation which individual farmers or families could undertake on their own. However, with time, it may become apparent that a second layer of institutional structure--a common property management regime for micro-watershed--is required to maximize benefits from water harvesting.

#### 1. Water-Harvesting in Burkina Faso

##### Introduction

This case concerns a largely bottom-up, locally-initiated RNR activity in the Yatenga Region of Burkina Faso. The activity in question is water-harvesting on farmers' fields. Water-harvesting devices trap surface run-off, promote infiltration, enhance soil moisture levels, and so increase agricultural productivity. The case is interesting for what it reveals about possibilities for dissemination of attractive and

appropriate RNRM technologies in Sahelian rural areas. The case also highlights both the advantages and disadvantages of managing arable soils as private goods.

### Background

The motivation for this type of water-harvesting activity has long been present in the Sahel. When the Dogon people were driven from the Seno Plains by Mossi cavalry several centuries ago, they took refuge on the arid, rocky Bandiagara Plateau north of the Plains. The Plateau was a highly defensible natural fort, and attractive to the Dogon for that reason. On the other hand, it was a particularly harsh environment and required constant effort to create the basis for a viable agricultural production system. The Dogon honed terracing and water-harvesting skills developed earlier in the Yatenga Region, and survived.

Further south in Yatenga, peasant farmers continued to practice water-harvesting on their fields until roughly the mid-20th Century. Various systems were used, including rock, log and earth dikes, and clumps of Andropogon gayanus, or gamba grass, closely planted in lines across the slopes of fields in the hilly Yatenga Region. All these barriers slowed the flow of surface waters off fields, and so improved agricultural productivity--particularly during drought years.

However, most of these water-harvesting devices suffered from a grave technical fault: they were constructed or planted in straight lines, at right angles to the major slope of the field rather than being contoured to maintain an angle constantly perpendicular to all variations in the slope. As a result, they always had weak places. Rain water eventually broke through at those points. Thus these dikes, or berms, increased soil erosion by gullying rather than stabilizing surface waters on the slopes. They retarded soil erosion, but did not effectively stop it.

Between 1962 and 1965, an abortive attempt was made to install a modern water-harvesting and soil conservation system on several hundred thousand hectares around Ouahigouya, the capital of the Yatenga Region. A foreign assistance project, Groupement Européen de Restauration des Sols en Haute-Volta (GERES-Volta), used heavy earth-moving equipment to construct an elaborate system of berms on farmers fields. This project was a technical success in the very short run. The dikes were all surveyed and constructed precisely on the contour, with elaborate spillover management installations. However, local people were never consulted about the character of the system, and played no role in its construction. It was only after the project was nearing completion that the issue of dike maintenance surfaced. The technicians realized farmers did not have the animal-drawn plows necessary to reinforce the berms at the beginning of each rainy season. Various attempts were made to encourage villagers to

protect the berms by planting them with gamba grass, and to repair breaches made by animals or water. However, in general, farmers saw little need for the dikes, and allowed them to deteriorate. Two decades later, the outlines of some of these barriers are still visible in the neighborhood of Ouahigouya, but most have faded back into the soil.<sup>8</sup>

Direct encouragement for reviving farmer-organized water harvesting in Yatenga came, in part, from Catholic Missionaries concerned about agricultural productivity, and from an OXFAM woman forester interested in promoting agroforestry in the arid Yatenga region. The Catholic Fathers trained surveyors and organized groups of young people to construct contoured rock terraces in villages where they were active.

The OXFAM forester launched her micro-catchment operation in eight villages close to Ouahigouya, in the spring of 1979. Working with a Burkinabe assistant, she urged farmers to develop V-shaped micro-catchments, terminating in a specially prepared soil pit. The wings of the V, made generally of soil, channelled runoff water into the pit. Trees and vines were planted in the pits. These experiments led to modest successes, but the problem of protecting tree seedlings during the dry season from wandering livestock proved very expensive.<sup>9</sup>

However, an initially unintended side effect of the agroforestry operation proved far more successful. Volunteer millet and sorghum sprouted from the manure mixed with pit soils to enrich them. Farmers who observed the enormous heads of grain on these plants were quickly convinced of the value of the technique for crop production, and began to adopt it on their own lands. Some chose degraded, abandoned laterite pans and succeeded in producing respectable crops even in dry years.

In 1981, a natural resources specialist replaced the forester and began developing a water-harvesting extension package with the Burkinabé assistant. Together, they perfected a teaching sequence to communicate to farmers the critical

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8 Jean-Yves Marchal, "L'Espace des techniciens et celui des paysans; histoire d'un périmètre antiérosif en Haute-Volta," in Maitrise de L'espace agraire et developpement en Afrique tropicalo; logique paysanne et rationalité technique. Actes du colloque de Ouagadougou. 4-8 décembre 1978 (Paris: ORSTOM, 1979), pp.245-52, gives a detailed account of this project and the reasons for its failure.

9 James T. Thomson, "Preliminary Evaluation: OXFAM Micro-Catchment Project, Ouahigouya, Upper Volta," submitted to OXFAM/Ouahigouya, May 8, 1980, pp. 7-8 for an early assessment of the problem.

importance of contoured berms as durable solutions to the water-harvesting problem. The two technicians, using small dirt models, first introduced the concept of complex (multi-angled) slopes in contrast to simple planes where straight line dikes work adequately. The weaknesses inherent in traditional straight line dikes installed on complex slopes were graphically demonstrated by dribbling water over the models. Predictably, water pierced the barrier at its low point. Contoured berms were created in the dirt model, and the experiment repeated with better results in terms of water-harvesting and system maintenance. The second step in the teaching sequence involved demonstrating to farmers use of a simple plastic-tube-and-sticks water level to identify contours on a sample slope. In the third and final step, farmers used water levels to identify contours on their own fields, prior to construction of rock or dirt dikes.

The two technicians provided follow-up support, but basically, once they had imparted the technique to several farmers in a village, their job was finished. "Spread effects" accounted for further dissemination of the technique. In the years since, contoured water-harvesting dikes have spread gradually throughout much of the Yatenga Region. Other national and international NGOs have promoted variations on the technique. Their activities have hastened its spread, but in effect, the technique of contouring water-harvesting installations sells itself in four ways:

- it improves productivity by buffering field crops against periodic drought through increases in soil moisture, a point usually clear to the most casual observer at the end of an average Yatenga growing season;
- since the contoured berms have no inherent weak points, they can be constructed at a uniformly low height along their entire length, thus reducing construction costs;
- maintenance costs are reduced, particularly during the growing season, because occurrence of expensive washouts and gullies is cut back or eliminated; and
- since the contoured dikes really stabilize soils on slight to moderate slopes, rather than simply slowing their descent, farmers who contour dike their land lay the basis for a sustained-yield agricultural production system.

The berms can be heightened gradually over a period of years as soils build behind them, so that eventually, the field is terraced. The dikes also become in-field sites for semi-protected regeneration of trees, adding an agroforestry component

to the activity. If the berms are reinforced by plantings of gamba grass, not only are they strengthened, but useful by-products (for housing, green manure, etc.), are produced.

A closer analysis of dynamics of the spread effect can provide further insight on the reasons for this essentially bottom-up RNRM success story. The practical validity of the technique is clearly important, but there are other factors at work.

### Technical Attributes of the Resource

#### Private Services

The dikes are primarily private facilities. The goods which result from the service they produce--water harvesting--are subject to exclusion. These goods are improved field crops. Crops planted in the area behind the dike produce more grain because they grow in a micro-climate characterized by higher soil moisture. Farmers frequent their fields during the growing season, and are able to physically control access to the crops, whether their lands are enclosed or not.

Consumption of the products produced by field crops--grains, stalks, and leaves for forage and construction--is separable or rivalrous. Thus, the dikes qualify in general as private facilities which produce intermediate private services (water-harvesting) and private goods (field crops).

The effects of the berms are largely confined to the relatively limited area just behind and uphill from the barrier. However, potential positive and negative externalities, or spillover effects, do exist. These externalities typically affect downslope users. Several classes of externalities are possible, depending on whether dikes are or are not constructed and, if constructed, whether they are properly maintained.

#### Private Services with Externalities

Category I externalities are generated by properly constructed and maintained contoured berms which slow runoff and stabilize soils. Such dikes, during average to heavy rains, generate positive externalities for downhill farmers. They reduce the threat on downhill fields of both sheet and gully erosion by reducing the amount, velocity, and thus the destructive power of surface runoff.

Category II externalities are generated by exactly the same type of well-constructed and maintained contoured berms under different rainfall conditions. During light rain showers, such berms will generate negative externalities or spillovers for downhill users because they trap and hold more moisture up-slope,

thus depriving downhill holders of runoff which they would otherwise have received, in addition to rainwater falling directly on their own lands.

Category III externalities are again negative. They are generated by poorly maintained dikes, whether contoured or not. Breaks generally occur in such berms at the weakest points. Water rushes through the openings with concentrated hydraulic force, and quickly creates a gully which spreads downhill, deepening as it goes and concentrates additional water. Such gullies can only be stopped cheaply by soil conservation activities--simple dike repair, if the gully is not already too advanced--at the point where the gully begins.

Category IV externalities, also negative, are produced by the absence of dikes. Since nothing slows runoff, downslope holders benefit initially from additional fine soil particles and moisture deposited on their fields. However, denuded soils not otherwise protected against runoff are soon subject to sheet and gully erosion. Once the fine, A horizon particles have been stripped from the field surface, the moisture retention capacity of the soil drops rapidly, and crop productivity falls off apace. The further downhill a field is situated (slope being held equal), the greater the runoff velocity, the more devastating the impact of this negative spillover, and the more powerless is the downhill holder to do anything effective on his own field to reduce the impact. Those who farm at the top of the slope are, by contrast, largely protected against this kind of exposure.

Category V negative externalities involve what might be called "malicious diversion," i.e., diversion by dikes of runoff from its normal downhill path and onto other lands. It is mentioned here not because it occurs frequently, but because it raises the issue of beneficial use of runoff waters, and the more knotty problem of appropriation of flows.

Depending on existence, location, and character of water-harvesting dikes, they may be purely private facilities, or they may involve positive or negative externalities.

#### Decision-making Arrangements

In Yatenga, berms have been treated mainly as private, family-controlled facilities. In part, this reflects local land tenure patterns. Most arable land in Yatenga has long since been allocated to extended families who hold it so long, as they continue to cultivate or actively claim it as fallow. Land is transmitted patrilineally among the Mossi and the Kurumba people who they conquered when the Yatenga Mossi kingdom was being established. Distinctive patterns of land transfer have developed within Mossi communities, but these do not affect the argument except in the following elements.

Mossi villages are composed of a series of lineage-controlled quarters, each subdivided into family lands. Mossi residences are spatially dispersed in these quarters. Extended families live together within the common lineage residence,<sup>10</sup> but typically at present, the extended family is subdivided into several production units working separate sets of fields. However, exceptions--extended families which still cultivate family common lands as a unit--do still exist.<sup>11</sup> Within the production unit, the senior male usually coordinates production activities on the family lands which are jointly farmed. Individual members of the unit--senior male's wives, any resident sons, and their wives--may be allocated control over small parcels for the duration of a growing season to cultivate for their own account.

### Private Dikes

The production unit head makes the decision to install dikes, whether constructed or planted, on family lands. If he decides to install contour berms, he may have to engage someone to identify the contours, or he or a family member may learn to use a water level. If rocks are not available, or gamba grass berms are not feasible, he may have to acquire special tools. Considerable work is involved in constructing earthen, rock, and planted dikes. However, the landowner requires no outside authorization or collective action to undertake dike installation. Thus, the transaction costs involved in creating berms are very low.

### Private Dikes with Externalities

A somewhat different situation applies concerning control (or production) of spillover effects associated with the non-existence or existence of dikes. At present, no generally recognized method seems to exist to resolve spillover problems.

### Interactions

At present, interactions seem to reflect the very large role for private initiative and the positive cost-benefit ratio that Yatenga farmers perceive in creating the berms as privately-

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10 Peter B. Hammond, Technology in the Culture of a West African Kingdom: Yatenga (New York: Free Press, 1966), pp. 109-20.

11 Jean-Yves Marchal, Société, espace et désertification dans le Yatenga (Haute-Volta), ou la dynamique de l'espace rural soudano-sahélien (Thèse pour le Doctorat d'Etat; Paris: ORSTOM, 1982), II, 345-57; cf. II, 433-45, for a detailed example of continued joint production.

controlled facilities. In short, contoured dikes are spreading throughout Yatenga.

The process continues to be based on individual or family efforts. This is largely a function of land tenure rules which allocate effectively private control over fields to nuclear or extended families. No collective effort seems to be involved at this time, and therefore, no time is devoted to developing a consensus about the desirability of the dikes. Transaction costs are therefore limited to those incurred within the family production unit.

One can assume that this process will continue as long as current conditions maintain, (i.e., persistent dry spells or droughts during the growing season, shortage of land, available labor). However, there is no additional information available to the writer about any problems created by spillover costs, and how Yatenga Mossi are dealing with them. Some speculation may however be useful at this point.

If no holders within a micro-watershed dike their fields, Category IV negative externalities in the form of sheet and gully erosion from uncontrolled runoff are likely. However, since no one is doing anything about it, the issue of organizing to dike the watershed may be moot. If all those who hold land on the slopes of a micro-watershed create and maintain contoured berms on a voluntary basis out of perceived self-interest, the Category I benefits of well-managed runoff will be significant and the issue of negative spillovers from too little runoff, probably a moot point.

However, as time passes and more farmers dike their fields, troublesome situations can be foreseen in Category III and IV externalities. Presumably, downhill holders will be the ones to suffer most. They will have an incentive to act. But if persuasion and voluntary action fail, the important question is what collective decision-making arrangements exist or could be created to deal with these spillover issues?

Mossi lineages have internal dispute settlement mechanisms. Assuming all holders on a micro-watershed belong to a common lineage, it is possible that downhill holders could compel uphill holders through lineage pressure to either install contour dikes or maintain existing ones. If that does not avail, earth priests (tengsobaramba), or possibly Muslim clerics, might be able to devise solutions. Mossi village headmen would probably not afford effective recourse since, as politico-administrative leaders, they traditionally leave land tenure-related issues to the earth priests. Appeals to government officials at the arrondissement or higher levels, or to members of the village-level Comités de défense de la révolution (CDR), might be successful. However, appeals outside the local area are likely

too expensive and thus, less attractive. It is not clear whether the CDR can act effectively on such issues.

### Outcomes

The tacit decision, at least within the OXFAM project, to leave decisions about collectivizing berm construction and maintenance to local people, and to recognize in decision-making arrangements the inherently private character of the water-harvesting berms, has unleashed family and individual initiative.<sup>12</sup>

Water-harvesting in Yatenga, through creation by individuals or families of contoured berms as private facilities on their fields, appears to be a highly efficient process. The increased productivity of crops planted behind the dikes is noticeable from the first year. Productivity improves over time as eroding soils accumulate behind the dike and form a shallow terrace. Probable inefficiencies are occasioned either by not constructing contoured berms or inadequate maintenance of contoured berms.

In terms of equity based on effort contributed, water-harvesting in Yatenga scores well. Those who make the investment in constructing contoured dikes clearly reap the bulk of the benefits. However, a potential for inequity exists in situations where uphill holders, by not constructing contoured berms on their lands, make it more difficult or even impossible for downhill holders to maintain effective water-harvesting devices on their lands, and expose downhill holders to severe soil erosion problems.

Uphill holders do tend, by contour diking their lands, to create positive externalities for users of downslope fields. One possible solution to this effort inequity would be for downhill holders to voluntarily assist uphill holders to construct and maintain dikes. By doing so, they would, in effect, subsidize construction and maintenance of structures from which they draw appreciable benefits. However, it is questionable whether organized collective action along these lines would be

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12 This, however, is not the case everywhere. Water-harvesting projects sponsored both by the Catholic Mission and the Voltaic (pre-1983) Government, stressed the externalities of water-harvesting and organized construction on a group basis. The upshot was sharply increased transaction costs during the construction phase--in large part, because groups of workers had to be mobilized, but in the Government project, partly because the implementing agency insisted on using its own technicians to survey contours, and employing heavy equipment to help construct the berms.

worthwhile. Only affected persons can judge that issue, in light of the specific conditions in their own local contexts.

The water-harvesting installations appear to be neutral in terms of distributional equity, since the socioeconomic status of field owners does not seem related in any discernable way to the spatial distribution of fields on slopes.

## 2. Irrigation in Bakel (Senegal)

In the Bakel area of Senegal, resource user groups dedicated to development and management of village-level irrigation began to emerge in the mid-1970s with some external technical assistance.

In early 1973, one of the thousands of migrants from the Bakel Region, a man from Koungny (a large village upriver from the town of Bakel), returned home from several years' work in Paris with a mechanical cultivator and a small pump. In Paris, he had already explored with the Compagnie Internationale de Développement Rural (CIDR) the possibilities of technical assistance for pump irrigation in his village (Adams 1977:44; Miller 1985:65). His action launched the Bakel village irrigation systems.

CIDR, funded by Oxford Famine Relief (OXFAM), sent its first technical assistant to Koungny in March 1974. His objective was to support villagers to improve productivity of their traditional crops and then to experiment with market gardening. Under the leadership of the technical assistant and the migrant who had made the original contact with CIDR, residents of Koungny organized an association of 80 members (Adams 1977:44). They soon selected and fenced off a community plot and dug a well.

By August 1974, collective associations had formed to pursue irrigated agriculture in five villages plus the town of Bakel. In January 1976, the leadership of a dozen village irrigation associations in the Bakel area founded the Fédération des paysans organisés en zone Soninké de Bakel. They were anxious about increasing activity of the Société d'aménagement et d'exploitation des terres du delta du fleuve Sénégal et des vallées du fleuve Sénégal et de la Falemé (SAED), a Senegalese parastatal regional development agency (Adams 1977:48-49).

SAED has since tried to bring these village systems under its administrative umbrella, to impose cropping patterns and individual (not collective) cultivation of plots. It has met with considerable resistance. The resolution, as it exists today, represents a compromise by all parties. In this discussion, we will focus on the initiatives of the villagers and how they have adapted to the SAED program for the area.

## Background

People of Soninke origin make up two-thirds to three-quarters of the population in the Bakel area of Senegal. Many Soninke men served in the French navy and merchant marines during the first half of the century. Around 1960, they began, in significant numbers, to fill low-paying service and day labor jobs in France. They remit their savings to their families in the Bakel area, visit home every three to four years and, eventually, return there to retire. Miller (1984:94) cites sources that estimate, "Since independence, approximately one-half of the active Soninke male population migrates at any given time. ... Among the elderly now returned to the home village, 80 per cent have migrated at least once. ... Within the Soninke villages in the Upper Basin, 83 percent of the compounds have migrants now working in France."

"Sample studies undertaken in 1978 and 1979 show that remittances may account for 50 to 75 percent of total cash household income, with traditional agricultural production accounting for less than 10 percent" (Seymour, et al. 1985:G-6).

The Senegal River at Bakel goes through an annual cycle of ebbs and floods according to the amount of rainfall draining into its headwaters. Over millennia, the river bed has developed a profile with a narrow main channel lined by levees on either side with fertile bottomland subject to annual flooding on the far side of the levees.

The farming system of the Bakel area is representative of that of the Middle Senegal Valley. People put their rainfed lands away from the river under shifting cultivation. They generally grow maize, sorghum, millet, and cowpeas under rainfall. In addition, they perennially cultivate--under a flood recession regime--the floodplain behind the levees inundated by the annual crest of the river where they grow millet, sorghum, and vegetables on their flood recession land.

Therefore, Bakel normally receives some 500 mm of rain per year. Rainfed agriculture is more reliable than elsewhere in the Middle Valley. Rainfall is high enough to cultivate the levees that line the main channel of the river and to take advantage of the alluvium deposited there on the occasions when the river overtops them. In the meantime, the floodplain of the river behind the levees is narrower than downstream. Therefore, competition for and conflict over rights to land in the floodplain is less acute than in downstream areas where rainfed production is more problematic.

## The Problem

With such a high rate of long-term male absenteeism, disproportionate reliance on labor of women and elders in the Bakel area has put a strain on the agricultural production system. In addition, a pattern of rainfall deficits compared with the 1950s and 1960s, has underlined the need for intensifying the use of available resources.

From their income in migratory labor, people had a fund of investment capital to underwrite introduction of a technology that could assure consistent levels of production and market returns to investment. The problem was to identify a reliable technology that would produce consistent levels of agricultural commodities and develop local resource management institutions to sustain it for the long-term. By 1984, there were about 30 such systems in the Bakel area.

## Technical Attributes of the Resource

Each village has only one irrigation system. The systems have generally been built on the high, narrow levees which parallel the main channel of the Senegal River. Smaller channels cut the levees at intervals, permitting flood waters to move out onto the floodplains behind them. The levees are flooded only occasionally. They have lighter soils than the floodplains and have benefitted far less from the build-up of sediments deposited by the annual river flood. Levee irrigation has to depend on diesel pumps installed atop floats to raise water from the river. Consequently, levee land has not been as valuable as the floodplain bottomland below it.

In effect, creation of village irrigation systems in the Bakel area substituted a new resource for an old one in the inventory of the villagers. The levees were usually cultivated under rainfed technologies. However, the importance of rainfed agriculture and even flood recession agriculture has diminished with the drop in average rainfall. Therefore, to a large degree, the village irrigation systems are an adaptation to evolving ecological conditions.

Farmers grow two crops a year under irrigation: rice during the rainy season, and maize and vegetables during the dry. Some villages are also experimenting with fruit crops, although so far, only bananas have proven successful.

At present, there is no major incompatibility between traditional flood recession farming and irrigated farming. Because the irrigation systems are located on higher, traditionally less valuable lands, farmers can still practice their flood recession agriculture as well as rainfed agriculture. The potential incompatibility is in the form of competition for

labor between the traditional and irrigated agriculture during harvest time in October and November (Patterson 1984:51-52).

### Private Goods

Village flood recession land is generally managed as a private good. An elaborate tenure system determines precisely which individuals have rights to each plot. All others are excluded from use during cultivation periods. Farmers working in their fields can ensure that outsiders are excluded.

Traditionally, levee lands have also been private property resources, divided among villagers. All plots on the levees have known, individual rightholders. However, other villagers can easily negotiate exclusive seasonal use of the land with owners. Before introduction of the diesel irrigation system, most levee land was under rainfed cultivation most years (O.M.V.S. 1980:B.I.15). Levee land was traditionally priority rainfed land because of the proximity of levee plots to villages, often sited atop the levees.

Finally, rainfed agricultural land situated up on the valley slopes behind the flood zone is also farmed as private property. Villagers, but also non-villagers, cultivate plots there. To get access, they petition village leaders who allocate plots from the abundant supply of undistributed land. Once land has been transferred from the village common holding to an individual, the latter enjoys considerable liberty to transmit it to others as well as to cultivate it himself.

### Common Property Resources

The challenge to the villages, then, was to adapt their usual resource management strategy to fit the sudden surge in importance of the levees in their resource inventory. In one study of village irrigation of the Bakel area, only one-third of the extended family compounds in three villages had a member with rights in the levee irrigation system (Miller 1984:152). Within the levee irrigation systems, the common property resource is irrigation water. Those who have land within a system cannot be prevented from obtaining access to the water. Use of irrigation water is essentially separable. The majority of the flow is routed onto the privately held plots controlled by households or extended families. Up to 30 percent of the irrigated surface may be set aside for collective exploitation as a common property, proceeds of which support recurrent costs of system operation and help finance new activities. The village irrigation associations have developed rules governing farmers' admission to and exclusion from both separable and collective use plots.

Village irrigation systems are relatively small. The average system covers a little over 25 hectares (TAMS 1985:73).

Each provides for common property control of the water resource. Each system is bounded by a protective dike. Irrigation outside the boundary is impossible without an extension of the technical system.

At the same time, the irrigation system is itself indivisible by design. In effect, this is determined by the capital cost of a diesel pump, without which operation of the system would be impossible. The pump must be bought by farmers in association. No single individual can afford one, and few villages can afford more than one.

### Decision-making Arrangements

Soninke society, as all the agricultural societies along the Senegal River, is a hierarchical society. However, the effects of this hierarchy are not as dramatic as elsewhere in the Middle Senegal Valley. Ample possibilities for rainfed agriculture have moderated competition for land on the floodplain. At the same time, economic pressures that have led to mass outmigration have had a levelling influence. Captive families now have access to funds that have played a role in liberating them from their patrons.

The two principles of Soninke hierarchy are a domination of noble families over captive families and seniors over juniors. Since cultivable land is not a scarce resource, the capacity to mobilize labor is a more important sociopolitical factor than control over land.

Soninke production units are relatively large. In one study (O.M.V.S. 1980:B.I.20), the average production unit in a sample village contained 5.6 households. The same village included production units of 24 and 26 households. These units are under the authority of the senior household head. The units produce on a common field and are grouped in a common compound. The wives draw food from a common granary. Members have access to individual fields which they may work after meeting their responsibilities on the collective fields.

Land on the levees belonging to the village, now the most valuable agricultural land, is owned by the production unit and managed by the head of the group. Individuals have access to land through the head of their production group. There is no individual tenure to land. Normally, rights to lands on the levee are disproportionately vested in the noble families who played a lead role in the founding and early development of the village. Production units of captive ancestry have been relatively disadvantaged. Yet, "On average, about two-thirds of the water users have slave origins, with 31 percent freemen and 4 percent craftsmen. These are approximately the same proportions found in the population at large" (Miller 1984:140).

Responsibility for management of the village irrigation system is in the hands of the board of directors of the village farmers' association. The board of directors is generally made up of five or six officers. The president and vice-president are usually honorary posts filled by the village chief and members of his family. The general secretary is the person usually in charge of the day-to-day operations of the system. He does not necessarily have any kin ties with traditional village authority structure (Miller 1984:164).

Officers are normally elected either prior to, or simultaneously with, the creation of a local irrigation association. In most cases, they are among the project administrators, are either self-appointed or nominated, and are ultimately approved by the association members. Overall, the leadership structure is quite stable (Miller 1984:126).

The authority of the village irrigation group and the traditional village authority operate in two independent spheres. There is limited overlap between them.

As a rule, control over irrigation activities does not imply control over other activities within the village. No preexisting village leadership position has been preempted by irrigation leaders, and no preexisting internal responsibilities have been transferred to irrigation leaders. However, the new position that is filled by the irrigation leader ranks him with other village leaders.

Neither does control over village activities result in control over the day-to-day operation and management of the local irrigation scheme. The village leaders are represented on the advisory council and normally concur on most major decisions. ... At times, administrative decisions are made without the concurrence of the ruling family. Clearly, however, irrigation leaders must maintain general support of the village elite to preserve normal operation of their schemes (Miller 1984:164).

The membership unit in the village irrigation association is usually the household. The head of the household represents it in association meetings. If a household member breaks the rules on its individual household plot, the household has to pay a fine. If a collective work group breaks the rules or executes an agricultural practice incorrectly on the collective plot, the group has to reconvene and carry out the task until it is done correctly.

Most of the village irrigation associations have organized into subgroups to work on land preparation for the system. Usually these subgroups persist, after the system is put into operation. The irrigation association assumes the responsibility for canal and earthwork maintenance and repair; care, maintenance, and operation of the pump; and repayment of credit to SAED. It oversees cultivation of a collective field which, by agreement with SAED, may cover as much as 30 percent of the system (Miller 1984:131). The subgroups are usually responsible for meeting collective work responsibilities.

There are two external institutions that have a direct impact on the management of the village irrigation systems of the Bakel area: the farmers' Federation and SAED.

The Federation sprang into existence in response to SAED activities in the Bakel area. Village irrigation associations wanted to retain the right to determine and manage locally the course of local irrigation development. They recognized they could benefit from SAED technical assistance as they had from CIDR. But they wanted to seek sources other than SAED for their inputs and outlets other than SAED for selling their harvests. They wanted to reserve the right to collective cultivation rather than be forced into individual plots.

Negotiations between SAED and the Federation resulted in conciliatory efforts by both parties. SAED gave up complete control over all aspects of irrigation management, while members of the Federation agreed to contractual demands that included a high degree of involvement by the state. SAED retained an overall supervisory role over the project, and the Federation retained its right to collective cultivation and crop choices (Miller 1984:63).

### Patterns of Interaction

The evolution of the systems has been from local initiative to integration in a parastatal structure back to increasing local autonomy. SAED, in the early years of irrigation in the Bakel area, saw the village associations as:

...organizationally useful entities for labor management and as administratively useful entities for credit liability, but not as real project decision-makers. ... SAED essentially assumed most of the decision-making role, establishing conditions for repossession of pump-sets if, for example, villagers did not follow the agricultural calendar (including which crop to plant when) established by SAED, did not cultivate at least 10 hectares, or did not repay debts (Seymour, et. al. 1985:C-2).

In the last five years, SAED has been giving the village associations increasing autonomy in decision-making. Areas where they now determine their own actions include:

- the size of an area to be farmed collectively for the purpose of debt repayment and accumulation of perimeter surpluses;
- the amount of labor to be assessed each family for the collective production and maintenance activities;
- collective and individual work schedules;
- varieties to be grown;
- inputs to be used;
- the fines to be assessed for the breaking of various rules; and
- the sale and utilization of perimeter surpluses (Seymour, et. al. 1985:88).

According to Miller's study:

In the irrigation schemes studied, a few isolated individuals - normally one irrigation leader per village association - maintained firm control over almost all of the activities of the irrigation associations. These leaders are not normally a part of the traditional village hierarchy, but have special skills and experience that qualify them for this position (most are ex-migrants or have an above average educational background), in addition to a good working relationship with the village leadership. In the small-scale schemes, irrigation management may be relatively decentralized down to the village level, but remains highly centralized within each local irrigation association (Miller 1984:163).

The board of directors of the village farmers' association is responsible for making the rules relating to behavior of the membership in the irrigation system. "Major decisions are normally made in closed meetings of the irrigation officers" (Miller 1984:128). Authority in Soninke villages is centralized. The result, in the irrigation sphere, is that the village irrigation leadership may sometimes impose decisions, policies, or rules on the membership without its complete knowledge or concurrence. According to Miller (1984:128-129), "Each scheme has adapted a decision-making process in accordance with its local-level constraints. ... In each case a stratified system has

evolved whereby a handful of officers maintain firm control over the operation of the irrigation scheme."

### Outcomes

Table 2 presents SAED figures on yields of rainy season rice and dry season maize in the village systems in the Bakel area from their inception until 1983-84. For example, the productivity in the village systems of the Bakel and Matam areas has been consistently higher than productivity of the centrally managed systems of Dagana or the Senegal River Delta.

Table 2. Bakel Village Irrigation Systems: Yields (MT/ha)

	75-76	76-77	77-78	78-79	79-80	80-81	81-82	82-83	83-84
Rice	2.00	2.50	4.20	5.20	4.75	4.79	6.19	4.22	5.95
Maize	2.00	2.00	2.50	2.50	2.50	2.50	2.40	2.15	N/A

Source: TAM/S 1985/83

### Conclusions

The case of village irrigation in the Bakel area shows how people have, through their own initiative, intensified their agricultural production system. They generated the capital investment for the intensification through the returns to migrant labor. Initially, the technical assistance came through their contacts with NGOs and, later, with parastatal authorities. However, the key to successful intensification has been people's ability to generate viable local resource management institutions and, subsequently, to fuse them into a federation capable of fending off assaults on their autonomy.

The irrigation systems have been developed as a common property resource of the villages concerned. The earthworks determine the boundaries of the systems. Farmers who attempt to free-ride on the system can easily be excluded technically from its benefits.

In effect, the village irrigation system is a special jurisdiction of the village. The governing body of the village irrigation system overlaps somewhat with village sociopolitical structure but acts, for the most part, autonomously. It makes and enforces its own rules through its own constitutional process.

A federation of village irrigation associations has coalesced to represent local interests in discussions with SAED,

the parastatal charged with managing irrigation development and operations in the Senegal River Valley. The initial SAED strategy was centralization of village irrigation management. This led to conflict with the federation and local common property resource management groups. In recent years, SAED has been increasingly devolving responsibility for village irrigation systems on those local groups.

The local sociopolitical system is hierarchical. Senior males of the noble lineages in the village tend to dominate decision-making. The village is composed of large extended family residence units under the leadership of the senior male. An environment with high rates of absenteeism reinforces the adaptiveness of such large production units. The labor of the absentee is easily covered by others in the group. His family is well taken care of. The income from his travels benefits everyone. Therefore, the local sociopolitical system is structured to make it costly for individuals to put distance between themselves and rules for local resource management determined through the normal local decision-making process.

The outcome of this experience has been the rapid proliferation of village irrigation systems in the Bakel area. They have attained and maintained higher production levels than the centrally managed irrigation systems in the Senegal River Valley. Moreover, the Senegalese government has acknowledged their successful management of local common property resources by conceding increasing degrees of autonomy to them.

### 3. Wadi Irrigation in Chad

Irrigation in the wadis of greater Kanem has not been the focus of significant Government of Chad (GOC) or international donor support over the years. Most of the support the wadis have received has been funneled through various nongovernmental organizations or through a special program task force of the GOC Presidency. This assistance has focused on improving the efficiencies of water-lifting technologies and the performance the agricultural technology. It has left the development of local resource management institutions entirely in the hands of the producers themselves.

Wadis are the depressions between the dunes of Kanem and Lac Prefectures. They generally have a northeast to southwest orientation. They are enclosed and separated from each other by the dunes. The wadi floors are generally flat, although they drain toward the center. Wadis rarely exceed two kilometers in length and usually measure 100 to 200 meters across. BIEP/FAO (1986:71) counts 419 wadis in Kanem Prefecture, with an aggregate area of 3,229 hectares containing 16,301 family plots.

The wadis have played a role in the food production strategies of farmers in Kanem and Lac Prefectures for some time. During the rainy season, farmers have cultivated wadis under a flood recession system, essentially. In addition, they have cultivated the dunes under rainfed agriculture systems. They have also kept large livestock herds. The succession of drought years that began in the early 1970s has wiped out much of the herds of the area and made dune cultivation uncertain.

### Background

Dune fields are inherited patrilineally. They are abundantly available even if located somewhat distant from the residential core of the village. However, they are not particularly valuable, given their level of productivity in recent years.

Wadi land has become more valuable than dune land under the rainfall patterns of recent years. All the cultivable land in most wadis, especially in the southern wadis close to Lake Chad, has already been divided up. There are a number of uncultivated wadis remaining. Moreover, some of the southern wadis have been put into cultivation only within living memory, (see Waldstein, et al. 1988, 84 for two examples).

According to the BIEP/FAO study (1986:71), the average plot size in the wadis is just under 20 ares. However, the same study estimates, that no more than 70 per cent of a plot in a wadi is under cultivation at any one time. The rest of the plot is taken up with the well, canals, protective bunds, fallow areas, etc. (BIEP/FAO 1986, 17). Many farmers have more than one plot in the wadi and/or plots in neighboring wadis.

Adelski (1987:23) estimates that, in the Chaddra area, aggregate wadi land cultivated by the average wadi farmer is 31 ares in two or more parcels. Approximately 40 per cent of the households have two plots. Most of the rest have only one. The average amount of dune land cultivated by a wadi farmer is 1.2 hectares.

### The Problem

As elsewhere in the Sahel, the abnormally dry weather pattern that has established itself in the last twenty years has challenged the ability of farmers to adapt.

Wadi farmers have responded to the stresses of the drought years by intensifying the exploitation of their main remaining resource, the wadis. Farmers have adapted to the droughts by introducing new technologies that permit them to continue cultivating the wadis despite the drop in rainfall.

Specifically, although many wadis have been cultivated for a long time, the shadoof is a recent introduction in most of them.

The shadoof is a long lever using a stand as a fulcrum. It has a recipient for water at one end and a counterweight at the other. The recipient is dipped into a shallow, hand-dug well by lifting up on the counterweight. Water is raised by pulling down on the counterweight. The shadoof is an effective water-lifting device at up to six to eight meters.

To date, farmers have met the challenge to local resource management represented by the change in agricultural technology in the wadis from harvesting rainfall and runoff from the dunes to shallow well irrigation by shadoof. However, the challenge is becoming more acute. Many farmers maintain that the water table in many wadis is lower than it was several years ago. Land on the periphery of some wadis has dropped out of production in the last few years as the water table in those higher areas has dropped to a level below the effectiveness of shadoof technology.

One response to the problem has been a search for water-lifting technologies that are effective at deeper water table levels. The first groups have formed in several wadis to buy small motor pumps for the wadis. The use of this more powerful water extraction technology presents a potential risk to the preservation of the water resource. The problem is to regulate the use of these pumps to preserve the water table and safeguard the production potential of the wadi.

#### Technical Attributes of the Resource

The characteristic features of the wadi are the presence of a different set of soils from the surrounding dunes, a relatively high water table, and the frequent presence of a small pond in the center, at least during the rainy season. Near Lake Chad, the water table near the center of the wadis will be under two meters. In the more distant wadis, the water table at the periphery will be at depths greater than 10 meters. Wadis support dense natural vegetation in contrast to the dunes that surround them.

The irrigation system in each wadi is a cluster of small hydraulically independent units drawing on the same geomorphological resources. Each independent unit irrigates from its own well and shadoof. Farmers cultivate the wadis year-round, although activity is often somewhat reduced in the rainy season when farmers are concentrating on staple cereal production on the dunes.

Shadoof technology limits the size of the average family holding. The recipient that farmers are using to lift water from their wells will contain no more than 15 liters of water. The

recipients are often recycled containers, old inner tubes, or locally woven baskets. For the most part, farmers are able to maintain up to 15 ares actually under irrigated crops with each shadoof.

Wadi irrigation in Chad is a case where a continuous evolution in the technology applied to the resource is changing the classification of the resource itself.

Before the introduction of the shadoof, wadi resources had the same status as dune land. In both cases, dune and wadi lands were initially treated as common land but then assigned to individual households. The land was subsequently managed as private goods by the original applicants and their patrilineal descendants.

Even after the introduction of shadoof technology, this arrangement has continued in the wadis. However, the potential effect of pumping groundwater on the water table raises the question of the degree to which water may become, in fact, a common property resource with separable and rivalrous consumption.

Possibly with the shadoof but certainly with the motorpump, the water lifting technology has factored subtractability into the management of the wadi resource. Patterns of water extraction on one plot have an impact on the availability of water on neighboring plots.

Exclusion may be a problem. Farmers have implicitly been excluded from rights to wadi lands through the process of assigning wadi plots. However, once assigned plots, how can a farmer be excluded from access to the water table? The answer might lie in some kind of communal policing authority under the leadership of the wadi chief. The nature of the wadi resource would permit this solution whereas concomitant communal policing of dune agriculture would be impractical.

The natural limits of the wadi, itself, provide the most useful boundaries for organizing a local resource management group. The best hydrological data available suggests that all the wadis of Kanem are sitting on an aquifer recharged through Lake Chad. Therefore, water extraction in each wadi affects water availability in all the others to a greater or lesser degree. However, the membership of resource management groups that are emerging has been organized around farmers with rights to individual wadis. This is the most practical approach for social and technical reasons.

## Decision-making Arrangements

Villages get possession of an uncultivated wadi on application to the subprefect, canton chief, or sultan. Each wadi has a chief who has the authority to assign plots to farmers when they apply to him. The assignment of the plots is usually formalized by a public rite. The wadi chief may or may not be the village chief and/or the village lands chief.

Plots in the wadi, once assigned, are inherited patrilineally. Women, other than widows, do not seem to own wadi lands. A women's rights to wadi lands come through her husband upon marriage. Single women rarely have their own wadi plots. They generally work plots lent to them by their male relatives. A widow retains her strongest claims on wadi lands if she remarries into her husband's family. Plot owners can lend their plots without informing the wadi chief. Buying and selling land in the wadis is virtually unknown.

Lands rights in the wadis are a question of overlapping authorities. Wadi farmers give token presents to the wadi chief in acknowledgement of his authority. In cases of conflict over land rights, the wadi chief, village chief, and sub-prefect play important regulatory and appellate roles.

Conte (1983) maintains that:

Clans whose headmen are vested with canton chieftaincies generally control more land per unit of population than clans not vested with such office.

All clans generally have access to dune lands on which dry millet culture is practiced but only a minority of clans, principally those vested with State-confirmed office [village chieftaincy or canton chieftaincy] have access to irrigated lands which are essential to ensure the continuity of food supply.

Within clans, control of the most fertile plots is concentrated in the hands of chiefly and/or dominant lineages, generally to the exclusion of those lineages who do not claim agnatic ties with the latter.

Outsiders with no kin ties to families with rights in the wadi have no access to a parcel.

These rules determining individual rights to wadi plots reflect a tension between the individual and the collectivity which will have to be resolved in the evolution of local resource management institutions regulating use of wadi groundwater resources under increasingly intensive agricultural production technologies.

The arena for collective choice has been narrow in most wadis to date. It has been limited, mainly, to decisions regarding rights of access to land. Rights of access to groundwater has not hitherto been an issue of collective concern. Therefore, individuals once secure on their land have been free to act according to their personal interests without regard to the interests of other wadi cultivators.

At the same time, the wadi is a bounded, sociopolitical unit. It is headed by a wadi chief. Disputes within the wadi are under the jurisdiction of time-honored institutional processes. Can these institutions extend their mandate to cover groundwater use in the wadis?

#### Patterns of Interaction

In practice, there are three levels of political authority that guarantee a farmer's rights to wadi land. At the village level, are the village chief and the wadi chief. The village chief accedes to the chieftaincy through patrilineal succession. He is, at the same time, a paid official of the civil government. Decisions concerning issues of village interest are reached through group discussion. Eventually, a consensus emerges. The village chief cannot impose a decision, but his opinions and those of the religious leaders and senior men are accorded great respect.

The office of the wadi chief is not recognized by the civil authorities. The wadi chief controls the rights to wadi cultivation. At some wadis, he is very powerful (Waldstein, et. al. 1988:90). Presumably, the power of the wadi chief in many areas has been growing in recent years, due to his control of the only remaining reliable productive resource in many villages.

The canton chief is above the village chief. He accedes to his office by his membership in the proper clan. As the village chief, he is a paid officer of the civil government.

The Sultan in Mao is at the pinnacle of this structure. As Conte (1983:34) states:

The Kanembu potentate ... continues to exercise a certain "moral" pre-eminence in the affairs of

Kanem and can still exercise considerable influence over accession to the office at the cantonal level, the distribution of land rights and certain fiscal matters.

The majority of farmers in any one wadi come from the same village. They are often related by ties of kinship or marriage. They usually share similar ties with farmers from outside the village with rights to the same wadi.

Therefore, farmers with rights in a given wadi share a number of cross-cutting and overlapping political and social ties. Mutual aid and reciprocity characterize their relationships.

Under these conditions, free-riding will not be a serious problem. On the one hand, the costs to free-riders will be too high for most to bear. On the other, the community, as a whole, will, for its own internal sociopolitical reasons, continue to support most of the remaining free-riders.

### Outcomes

Management of the wadi resource has been carried out mainly at the household level. Farmers' parcels are, with the exception of a few recently organized pumping groups, self-contained. The irrigation system has hitherto required no institution outside village social and political structure to keep it in self-sustaining operation.

To date, concerted social activity in the wadis has been limited. However, cultivators do make cash contributions toward an annual wadi rite. The money goes toward purchase of a sacrificial animal. A local cleric with cultivation rights in the wadi carries out the ceremony.

In one of the wadis studied by Waldstein, et al., the approximately 35 families with cultivation rights made contributions to acquire rights from the local sub-prefect to cut branches from thorn trees to enclose the wadi to protect their crops from animal depredations, (Waldstein, et al. 1988:87).

The germ of a more comprehensive resource management group clearly exists.

### Conclusions

Irrigation in the wadis of greater Kanem in Chad is a case in which people have developed local resource management institutions over a long period of time but where farmers have,

in recent years, been adopting new technologies which, in effect, threaten the ability of local institutions (in their present form), to sustain the productivity of the resource.

Local resource management institutions have governed access to wadi land. The challenge to these institutions now, with increasingly efficient water-lifting technologies, is to develop a capacity to govern the extraction of groundwater under the land.

### C. Combined Participatory and Top-Down Approaches

The three cases in this section concern situations where projects have been identified and planned, but not yet implemented, or where an existing project is facing considerable problems which might be resolved by redesign. The projects are:

- the Southern Zone Water Management Project in Senegal's Casamance Region, which proposes to develop a series of technical and management institutions for micro-watersheds along the Casamance River;
- extension of the Forestry Land Use Planning experimental effort in natural forest management on the 5,000-hectare Guesselbodi National Forest, near Niamey, to as much as 1,400,000 hectares of natural brushlands around the capital; and
- the Mopti Livestock Project in Mali's Niger Delta area (Fifth Region).

In each situation, the framework for institutional analysis and design, outlined in the next section, would suggest ways in which both bottom-up and top-down initiatives could be combined to enhance overall RNRM capability.

#### 1. USAID/Senegal's Southern Zone Water Management Project

U.S. Agency for International Development (USAID)/Senegal is currently designing the Southern Zone Water Management Project (SZWMP). Under SZWMP Senegalese government personnel, in conjunction with an expatriate technical assistance team, will work closely with village-level organizations to develop overall water management plans for valleys, slopes, and plateau areas on small watersheds in Ziguinchor and Kolda Regions of Senegal. SZWMP will be building on the experience of the AID-funded Casamance Regional Development Project (Projet Intégré de Développement Agricole en Basse Casamance, or PIDAC).

## Background

Since before the arrival of the Europeans, people of the Ziguinchor and Kolda Regions have been growing local rice varieties in paddies created by empoldering mangrove swamps (Linares 1981:559). The land here is generally flat and poorly drained.

Polder lands in these two regions are generally held by patrilineally related groups. Relatives' plots are usually located in the same general area. Individual plots are held and managed by household heads. There are periodic adjustments to landholding to accommodate deaths, marriages, and divisions in households as sons reach maturity (Weil 1981:41-47).

In Ziguinchor Region, farmers flood their polders easily during the wet season by, in effect, harvesting rainfall and opening polder walls to permit fresh water from natural river channels to enter. During the dry season, sea water penetrates these channels as the fresh water flows decline. Farmers permit the sea water to flood the polders after the rice harvest. Polder vertisols need to be constantly under water to be workable during the next cultivation season. Farmers then need a month or two of rains to leach the salts out of the soil before they can begin to plant again. Flooded land is cultivated perennially.

In the Kolda Region, the tidal flooding described above does not exist. Vertisols do not predominate. Paddies are not subject to salt water flooding. Farmers cultivate their flood land by harvesting rainwater and tidal irrigation. At the same time, they have rainfed plots on plateaus off the river. They cultivate irrigated plots perennially but shift cultivation of rainfed plots according to the fertility of their soils.

As one moves up the Casamance River, the farming systems gradually shift from dominance by polders subject to salt water flooding to dominance by rainfed agriculture with some tidal irrigation in the beds of seasonal tributaries of the river.

## The Problem

In the past 20 years, average annual rainfall in the Ziguinchor and Kolda Regions has fallen significantly from that of the preceding 20 years. Farmers can no longer depend on levels of rainfall adequate to flush the polders and then permit cultivation of swamp rice. In the dry season, salt water penetrates much farther up the Casamance River than before.

The problem is to identify technologies that will permit rice cultivators to adapt to these environmental changes, catalyze an institutional framework which will enable beneficiaries to manage the technologies, and develop formulas

for the long-term collaboration between these local institutions and Government of Senegal (GOS) institutions necessary to implement the target technologies.

#### Technical Attributes of the Resource

Under the SZWMP, USAID will fund construction of control structures on 40 small watersheds. According to the Project Identification Document, the planned approach is to build structures at the top of the valley and then continue down the valley. It is envisioned that a number of small water retention dikes will be constructed in a valley or in coterminous valleys. The final dike at the downstream end would then serve as an anti-salt as well as retention dike. Therefore, anti-salt dikes become just one part of the overall water management plan.

The SZWMP will fundamentally modify the nature of the resource base. It will require adapting existing resource management strategies for the watersheds to capture new opportunities. The polders have been and will remain a common property resource. However, the technology of SZWMP will dramatically increase the benefits and the reliability of irrigation. To conserve the long-term productive capacity of the improved resource, local management strategies will have to cope with increased incentives to free-riding and/or rivalrous competition for benefits.

SZWMP technology will increase the capacity to exclude potential users of the watershed insofar as the system of dike channel water flows in time and space. People relatively upshed will have to release rainwater flows on a schedule to people downshed so downshed users can benefit during the rainy season. Rainwater retained behind the dikes and flood waters retained behind the final dike as the river crests at the end of the rainy season will have to be pumped uphill when rain is not falling to benefit upshed users. Otherwise, the technology of the SZWMP system would allow upshed consumers to reduce the consumption by downshed users of water in the rainy season by restricting flows. The converse might hold in the dry season, if downshed holders refused to allow sufficient water to be pumped to upshed farmers.

The principal of sharing access among kinsmen to a common property resource has already been established in the Lower Casamance. When needed, people already circulate water between neighboring polders usually farmed by relatives.

The extent to which it will be possible to exclude a resident of a given watershed from the benefits of SZWMP technology will depend on the water management infrastructure that is put in place at that site. The system can and should be

designed to make exclusion possible in order to create group control over individual members and, in effect, deal with the free-rider problem.

However, it may be difficult to develop a system capable of excluding property holders at the top of the watershed. Landholdings are characteristically dispersed. People want to cultivate plots that cover the full range of production potential of their villages. People intentionally select plots in different locations on the watershed. This is particularly true going up the Casamance River as river flooding gradually cedes its role in agriculture to rainfed flooding and dryland agriculture. SZWMP infrastructure should ideally be usable to exclude benefits from downshed plots of a farmer who is not following local resource management institution rules on his upshed plots.

Another disincentive to free-riding may be the seasonally changing nature of the resource. During the wet season, upshed farmers will have some control over downshed access to water as rainfall drains over their lands. During the dry season, downshed farmers should have the advantage due to their proximity to the reservoir behind the final dike. Local common property resource management institutions will have to develop rules for reciprocities between upshed and downshed users based on everyone's incentives to benefit year-round. For example, could a local common property resource management institution develop rules for landholders on the banks of reservoirs to share their plots during the dry season with landholders whose plots have no access to water then? Again the objective is to develop exclusionary mechanisms that would minimize free-riding.

SZWMP has set the boundaries of the resource at the small watershed level. The nature of water resources in the project area does not allow further division of the resource. A watershed by definition is a single, natural drainage basin. Therefore, the largest water management unit should be at this level. Subdivision of this unit could be determined by its topography. For example, placement of dikes in the small watersheds would follow their natural division. However, in some cases, conflicts may arise between natural subdivisions of the resource and the sociopolitical units with claims to resource use rights.

#### Decision-making Arrangements for Use of the Resource

The SZWMP case is typical of common property arrangements in that use rights reside with individuals but, since the water resources are not practically divisible below the watershed level, management must be collective. The question then arises concerning what collective groups already exist in the small watersheds and to what degree the domain of authority of

collective groups is smaller than, larger than, coterminous with, or cuts across the boundaries of the natural watersheds. Additional field research would be required to answer this question.

The village is the largest sociopolitical unit among the Diola, the predominant ethnic group in the SZWMP area. Diola villages are composed of a series of residential structures organized along quasi-kinship lines. Larger villages are made up of several neighborhoods. In such communities, the neighborhood rather than the village is the largest functioning sociopolitical unit (Weil 1981:23-25).

Each neighborhood in a village is composed of a group of extended family compounds. The neighborhood is the home of a local group based on patrilineal kinship ties. The compounds that make up the neighborhood usually contain two or more conjugal families whose heads are close patrilineal kin, often brothers. The conjugal family is the basic building block of Diola society. It is the basic unit of production, manager of labor, and owner of the rice plots. According to local ideology, land management is in the hands of the male household head. However, in practice, he rarely makes important decisions in any realm without prior consultation with his spouse (Weil 1981: 26-35).

Cooperative work groups cut across residential social structure of the Diola village. The workforce for these groups is recruited by gender and often by age. In recent years, returning migrants have been taking the initiative to organize such associations at the village level to earn resources to sponsor cultural activities and to use their labor for village developmental activities (Weil 1981:38-41). To what degree these associations might be a medium for resource management remains an open question, but the possibility should be explored. They might even serve as a prototype for bringing nonkinship-related groups together to manage a watershed in which they all have shares.

The most difficult operational rule to develop will be the jurisdictional boundaries of local common property resource management institutions. The problem is that village lands will often not be coterminous with the resource to be managed, the small watersheds. Do villages in SZWMP target watersheds hold lands in more than one small watershed? Are lands in SZWMP target watersheds shared by more than one village? Historically, Diola villages have not cooperated extensively in the management of their common property resources. The implication may be to subdivide the small watersheds where possible to scale the common property resource to fit institutions that have proven historically effective. The objective is to fit the boundaries of a given resource management institution as much as possible

with the underlying boundary conditions determined by the technical and/or physical nature of the commons, without overloading institutions that lack historical legitimacy with management responsibilities they cannot reasonably be expected to discharge effectively.

Land in the small watersheds is already substantially partitioned. Flooded land is the most valuable resource. People get access to plots through their residence in a neighborhood and their consequent quasi-kinship relationship with its other residents. Once a relationship with others is established, a farmer may get rights to a plot through any of a number of gift, share, loan, or pledge options. People who cannot identify or establish kin ties with local community members are generally excluded from access to the resource. This rule of establishing quasi-kinship in order to qualify for access to resources helps minimize free-riding (Linares 1981:562-563).

However, rules for management of the common property resources developed under SZWMP will not be made purely at the local level. Regional offices of the Ministry of Rural Development and the Ministry of Hydraulics will play critical roles in implementation of the infrastructural development components of SZWMP and in setting the framework for local resource management. The Ministry of Rural Development, through its Department of Agriculture, will be the lead institution in implementation because of the long-term extension follow-up that will be needed to maintain the productivity of the watersheds. The Ministry of Hydraulics will be responsible for technical studies and design and construction supervision for the civil works in the watersheds.

Representatives of these ministries will participate in preliminary feasibility studies on small watersheds in response to requests from local groups. Regional technical committees, empowered to approve small watershed development plans, will also include members of these ministries.

The objective is to decentralize the operations of the two ministries, at least for SZWMP purposes. The problem here is to establish rules for autonomy for the regional offices of the two ministries while, at the same time, programming close cooperation between them within the project. This has proven a major stumbling block in the Pakistan Command Water Management Project, for example, in which USAID, the International Bank for Reconstruction and Development (IBRD), and the Government of Pakistan have been trying to develop regional coordinating institutions grouping the same line agencies as the SZWMP. Presumably, the regional technical committees will oversee the coordination.

Other external institutions will have an impact on the management of the small watersheds. In recent years, the Senegalese government has begun implementing a reform in rural organization in Ziguinchor and Kolda Regions. The regions have been divided into a number of Rural Communities each administered by a Rural Council. The Rural Communities are not necessarily coterminous with the small watersheds. To what degree can they be effective common property resource managers, especially in light of the Diola authority structure? To what degree will it be possible to develop effective subjurisdictions within the Rural Community to follow the boundaries of the small watersheds?

### Patterns of Interaction

The fundamental sociopolitical process in Diola society is consultation and development of a consensus, (Weil 1981:20-22). People do not accord prima facie legitimacy to any local authority figure. Egalitarian relations run through Diola society at all levels. The emergence of a consensus on a common property resource management issue can be a time-consuming process. In effect, the consensus-building process can give veto power in common property resource management decisions to any dissenting household head or residential group.

The advantage of this process is it enlists the support of the whole community, at whatever sociopolitical level is concerned in a particular decision. Moreover, since ties among community members are multi-stranded, involving residence, resource management, marriage and kinship, it is costly (in a sociopolitical sense) for people to withdraw their support for a decision once it is given. Therefore, the multi-stranded nature of Diola sociopolitical ties and the consensus-building process of decision-making are constraints on free-riding. In this way, the time spent building a consensus is time well-invested despite the havoc it may come to wreak with implementation schedules of other components of SZWMP.

The interactions of the external institutions involved in SZWMP and the local common property resource management institutions remain to be seen. How patron ministries reward technical personnel within their career tracks for work performed while seconded to SZWMP will be a factor in determining the quality of professional performance and relations with local groups.

To what degree an interministerial committee under the leadership of the Ministry of Planning and Cooperation will be able to mediate effectively misunderstandings between the Ministry of Rural Development and the Ministry of Hydraulics, and program their field activities within SZWMP is an issue. To what degree will external institutions be able to deliver the common property resource with the SZWMP technical and physical profile

to the beneficiaries? If the resource base is significantly different from the SZWMP description, beneficiary strategies could change dramatically.

A major contribution to effective SZWMP implementation would be the determination and institutionalization of rules of interaction among beneficiaries, between beneficiaries and external institutions, and among external institutions. The rules should be determined through analysis and negotiation among all the parties at the outset of the project. The objectives would be to develop, in an interdependent manner: rules and standards for efficient and equitable management and allocation of water for irrigation; resource user associations capable of resource conservative management of their watersheds; mechanisms to mobilize resources locally to manage micro-watersheds and irrigation facilities; and regional project management units capable of mobilizing external institutional support for the resource user associations. Institutions at both levels will have to work out rules for two-way communication between them so they can contribute to each other's programs in development and management of the watershed resource. According to these rules, neither side should have the authority to impose its program without countervailing contributions.

### Conclusions

At this stage, discussion about the outcome of SZWMP would be speculative although many of the conditions are in place for the creation of effective resource user associations within the project. As indicated in the discussion, answers to many critical questions remain to be determined.

The small watersheds are necessarily common property resources with natural boundaries. Water management systems can be designed to minimize free-riders.

There are several levels of local institutions managing common property resources in the SZWMP area. The commons have already been partitioned and the rules of access applied by the community at large. However, the size of the watersheds may surpass the scale of Diola institutions which have been limited to management of village resources.

The decision-making process of the communities in the SZWMP area focuses on consensus-building. Free-riding can be costly for community members who dissent from the consensus, once established.

Several unknown factors will have an impact on SZWMP implementation:

- the extent to which the boundaries of resource management institutions can be made coterminous with the natural boundaries of the commons;
- the extent to which external institutions can develop a common property resource with the technical attributes SZWMP now envisages;
- the extent to which the SZWMP can develop a methodology for catalyzing local institutions capable of effectively managing new common property resources; and
- the extent to which external institutions and local resource management groups can establish rules for negotiations with each other which will allow each to protect its interest in the process of designing and implementing a local renewable resource development program.

2. Natural Forest Management Extension Effort of the Forestry Land Use Management Project

Background

This case examines the Forestry Land Use Management Project (FLUP) effort to bring under sustained-yield management 1.4 million hectares of brushwood in the area surrounding Niamey. The first phase of the FLUP project was implemented by the Nigerien Forestry Service with USAID financing. The project was designed to inventory forest resources, strengthen planning capability in the forestry sector, build up an information base, and demonstrate appropriate techniques for renewable resource management in Niger.

The FLUP model sites component, which developed the techniques demonstration activity described below, worked principally in two national forests. One of these, Guesselbodi, is located 35 kilometers east of Niamey. When the project effort began in early 1981, soils, pastures, and woodstock in this 5,000-hectare forest were seriously degraded. The overall goal of the model sites component in this demonstration was restoring Guesselbodi Forest to productive status.

Project personnel incrementally tested a number of arid land management techniques and adapted them for use in the environment of western Niger. These included reforestation, water harvesting, soil conservation, pasture restoration and management, and brushwood management. This effort built on an intensive reconnaissance of forest resources: typology, soil types and degrees of degradation, arable areas, range of species and condition of woodstock, herbaceous vegetation, and wildlife.

This initial inventory also identified opportunities for environmental stabilization or resource enrichment. While this effort is ongoing, the bulk of the applied research occurred during the first six years of project activity.

Parallel to the intensive efforts to stabilize and then improve the Guesselbodi Forest environment and productive potential, another section of the FLUP project--the Natural Resources Inventory Unit--carried out sample surveys of woodstock resources within a 100-kilometer radius of five major Nigerien cities, including Niamey. The Niamey survey revealed the existence within that circle of some 1,400,000 hectares of high-potential brushwood land. Land in this category is not suitable for farming. Its highest use appears to be sustained-yield natural forest management. Under the circumstances, this will include not only rotational harvesting of brushwood for urban (and perhaps rural) domestic energy and construction purposes, but silvo-pastoralism.

### The Resource Management Problem

At the moment, the Guesselbodi management problem consists of regulating access to the various consumable resources and ensuring that sufficient investments are made in upgrading or restocking resources so sustained-yield production can be guaranteed under the highly variable, mono-modal rainfall regime which characterizes the Sahel. To deal with these issues, the FLUP project tailored cooperative institutions to fit Guesselbodi circumstances. Cooperative activity in Niger figures as an integral part of the Development Society scheme. The National Charter creates the institutional framework for the Development Society. A series of councils have been created in a top-down manner. Elected councils exist at the village/tribe, canton/pastoral group, arrondissement, department, and national levels. At the lowest level, adult members of the jurisdiction elect representatives to the council. The local councils elect representatives to the immediately superior council, and so on up the line. At each level, the administrator (village or tribal headman, canton or group chief, arrondissement sub-prefect, departmental prefect) is the ex officio head of the council. Cooperatives are created at all levels (mutuals, cooperatives, local, subregional, regional, and national cooperatives unions), and are guaranteed ex officio membership on the Development Society councils at all levels (as are certain other groups).

With technical assistance from the Cooperative League of the United States of America (CLUSA), project personnel created village (credit) mutuals in the nine agricultural and agro-pastoral communities which surround the forest area. Adult residents in each community constitute its mutual assembly. Each village elected five officials: mutual president, secretary,

treasurer (collectively the mutual's administrative council), and two comptrollers (the accounting section).

The nine mutuals were then constituted into a marketing cooperative. Officials of each of the nine mutuals (45 in all) constitute the cooperative assembly. They elected nine officials (effectively one per village): president, vice president, treasurer, secretary, three advisors (together the administrative council) and two comptrollers (the accounting unit). Cooperatives offer one framework for extending the Guesselbodi natural forest management experiment to other areas. Others have also been envisaged. Local people should have the opportunity to choose the organizational framework that suits them. Before turning to a consideration of these institutions, it will be useful to analyze the resources to be managed from the perspective of their characteristics as economic goods.

### Technical Attributes of the Resources

The major goods and services produced by the forest and pastoral resources under consideration here<sup>13</sup> can be divided in consumable and non-consumable or on-site forest and pastoral products. None of the land under consideration is judged technically suitable for farming.

### Private Goods

At present, within the area under consideration, there are no private goods. Some of the RNRs' products (firewood, building poles, pasture grasses, thatching grass, etc.) are rival goods. Because of the ambiguous nature of property rights, there are exclusion difficulties. In addition, these products are subject to the usual stock externalities associated with open access, and under some circumstances, common property resources. Many sedentary villagers probably consider bush areas adjacent to their fields, e.g., plateau lands above arable valley bottoms, as "their lands." The Forest Service, under provisions of the Forestry Code, in principle, claims control of these lands as belonging to the domain protégé, the (state-) "protected area". However, in most places, no attempt is made to exclude users who wish to exploit resources. Pastoralists, wood cutters, the occasional individual searching for medicinal berries, roots or bark, or a beekeeper--all move freely on these lands.

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13 Minor forest resources such as fruits, nuts, honey, medicinal plants, material for weaving, thatching, and rope-making, etc., are often valuable tertiary products. However, most are of relatively slight importance in the context of this overview analysis, and will therefore not be examined in detail.

Access to the areas and products in question could be controlled if it is economically feasible; that is, if the products which a section of brushwood forest might produce are sufficiently valuable to cover not only the costs of harvesting and marketing, but also the costs of controlling access through either fencing or patrols.

#### Open Access Resources

Open access resources are those from which no potential users can be excluded. The resources themselves, when harvested, are subject to separable or rivalrous consumption. Most consumable resources in the areas in question are effectively open access resources. The list here includes wood for fuel and construction, browse for forage, grasses for forage, thatching and rope-making, and wildlife.

#### Common Pool Resources

Two consumable resources, surface waters and aquifers, are common pool resources, i.e., access is restricted to a specified group, but consumption remains separable. These flow resources can be captured by persons who have access to bottomlands between forested plateau areas, such as farmers who either capture runoff waters on their fields for rainfed crop production during the growing season, or irrigate gardens during the dry season with water drawn from shallow wells which tap into local aquifers. Anyone who has access to such lands cannot be excluded from benefitting, while those who do not enjoy the necessary land tenure rights are excluded.

#### Public Good Resources

The natural bush areas within a 100-kilometer radius of Niamey provide certain environmental services that have the characteristics of public goods. These services include protection of land and soils against wind and water erosion. These consequences of maintaining woodstock and grasses on the land help improve the environment in the general region to some extent by improving air quality.

#### Decision-making Arrangements

To manage these sorts of renewable resources, institutions must be able to ensure that investments in protection and promoting regeneration necessary to ensure sustained-yield production are undertaken on a reliable basis. Different institutions will be best suited to manage different types of resources.

The institutions currently available to manage these various kinds and types of resources are relatively limited. Two types

of relevant framework legislation exist. The National Charter recognizes only Development Society Councils (at the village or tribal, local or group, and sub-regional levels) and the cooperatives associated with them as legitimate management institutions. However, the Forest Service could establish hybrid institutions modeled on the Guesselbodi experiment with a forestry cooperative to manage selected parcels of brushland. The Forestry Service, given existing Forestry Code regulations, could also permit exploitation of protected domain lands by private individuals or firms, by contracting for a combination of exploitation and land management services. This may be necessary in those areas where the dearth of local population makes it practically impossible to develop a local going concern for forestry management.

### Cooperatives

The institutional formula developed by the FLUP project for Guesselbodi is apparently being adopted for use in managing much larger tracts of brushland around Niamey. These areas may be 10,000 hectares in size, or perhaps even larger in some cases. Because the cooperative form has the blessing of the Government of Niger (GON), it is highly likely that it will be adopted for use in some of the target areas.

If the Guesselbodi Forestry Service/cooperative system is established elsewhere in the Niamey Department, it will take roughly the following form. The head forester for the arrondissement will appoint a forest manager after a highly simplified inventory of the natural resources in a given parcel has been completed. A cooperative will be organized, and membership will be open to residents of the area immediately adjacent to the parcel to be managed. A critical question concerning membership will arise in situations where transhumant herders use brushlands as pasture areas. Should they be included as members of the management cooperative? Or should the cooperative seek to work out a long-term, perhaps contractual relationship with herders who frequent the area they manage?

The forest manager, in consultation with the cooperative leadership, will work out a simple technical management plan, based probably on a rotational wood and grass harvesting scheme. He will also play a large role in setting up rules and enforcement procedures to ensure that management plan provisions are respected. Rules will determine when various products can be harvested within the area, on the basis of management plan prescriptions. They will also define who can participate in harvesting activities (for wood products this will probably be limited to cooperative members; grazing rights may be auctioned off to cooperative members or highest bidders, depending on the rule adopted), during what period, with what purposes.

The cooperators will be responsible for harvesting forest products (firewood and building poles, browse, pasturage, hay and straw) and marketing them exclusively through the cooperative. Harvesting and marketing will certainly take the form of cutting these products and selling them locally or transporting them to regional marketing centers, especially Niamey.

Technical assistance may be provided to help cooperative officials devise appropriate management schemes and financial forms to keep track of product and cash flows; identify urban or other markets; work out systems to deliver products; and deal with organizational and rule enforcement questions. Part of this assistance might focus on establishing a contract between the Forest Service and the cooperative to determine which monies, from among the revenue flows generated by the managed natural forest, would be necessarily used to pay workers who help with exploitation and implementation of the management plan, which would be used to finance protection and upgrading of the forest area, and which the cooperators might retain to dispose of as they wish.

The forest manager will have on-site authority to see that the forest management plan is respected. The cooperators will play an implementation role in carrying out management prescriptions and helping, over time, to set and refine management policy so that resources in the managed area are preserved and put to productive uses that benefit the cooperators.

### Contracting Out

The Forest Service might follow the same approach as that described above for "Forestry Cooperatives," but deal instead in underpopulated areas with private entrepreneurs or firms interested in managing brushlands for productive use. This approach would involve first delimiting the area to be placed under management and inventorying its renewable resources. Next, a simple, realistic management plan would have to be devised, preferably in collaboration with the entrepreneur(s) or firm. The plan would stipulate activities which the managing firm or individual would be required to undertake: regulate division of costs and benefits arising from brushland management, provide for periodic supervision by a forester, and establish penalties in case of non-compliance with the management plan requirements by either the Forest Service or the managing individual or organization.

Another approach would transfer formal control over brushlands from the Forest Service to local or supra-local jurisdictions, i.e., villages, cantons, or arrondissements. The Forest Service might retain oversight authority to ensure that renewable resources thus transferred for management were not

over-exploited. Officials of the local and supra-local jurisdictions in question would be left largely to their own devices in deciding how to organize and implement resource management systems on lands over which they were accorded control.

Depending on the terms of the transfer, the Forest Service might also insist in such cases on developing a simple but tightly drawn management plan. The Forest Service would oversee implementation of this plan on a regular basis. A final option would be a complete transfer of resource management authority, with no supervisory role for the Forest Service no matter what the result of local management or mismanagement. Realistically, the first or second of these three options will probably be adopted, should this general approach be applied.

Transferring management authority to local politico-administrative institutions would allow these jurisdictions to experiment with approaches to resource management other than that prescribed by the FLUP Project Forestry Cooperative scheme. Under the more flexible approach apparently adopted along these lines by the World Bank Forestry Project, possibilities may exist for local experimentation. These may include developing different management units for different resources under control of the same jurisdiction, e.g., management of brushwood parcels for firewood production by individuals, family groups, quarters, villages or inter-village groups, coupled with other, overlapping units designed to ensure that ground cover and water infiltration possibilities are preserved in the same areas.

### Interactions

Given a revival of interest under President Ali Saybou in delegating control over significant activities to the arrondissement level, it is possible that new initiatives will be permitted. At present, occurrence and success of these initiatives must be considered problematic. Key issues include the degree to which effective control over renewable resources is transferred to the local level; the extent to which local jurisdictions are allowed to work out resource management arrangements which meet with local approval; provisions for local public financing to meet the need for funds to support resource management activities; and provision of adequate dispute resolution procedures.

It is impossible to do more than speculate about interactions at this point, since the forestry cooperative endeavors outside Guesselbodi Forest are only now being initiated in Niamey Department. Contracting out, either by the Forest Service or by local communities, has not yet begun.

## Outcomes

### Efficiency Criterion

Like the preceding section, this one can only be highly speculative. Assuming a long-term commitment on the part of the GON to promote better renewable resource management at the local level, and a willingness to follow through on the rule, dispute resolution, and public finance elements involved in organizing resource management operations at the local jurisdiction or cooperative level, it is quite possible that efficiency criteria in resource management may be better satisfied under such new arrangements than under existing ones. Allowing rural people the opportunity to try to manage local resources, if buttressed by allocation of authority to develop and apply resource use rules and to tax to underwrite resource management operations if popular support at the local level warrants, can be expected over time to lead to higher degrees of popular participation in resource management activities. This, at least, is the public position of the GON.

### Equity Criterion

Assessed against the equity criterion, institutional innovations of the sort proposed above are likely to fall short of perfect equity in some respects. That does not mean that such innovations will be worse than, or as imperfect as, current resource management arrangements.

## Conclusions

The Guesselbodi operation has enjoyed dramatic success as a demonstration of feasibility of a range of resource management techniques in a Sahelian environment, with particular emphasis on the economic potential of properly managed brushwood. To some extent, it has also pioneered institutions for popular participation in woodstock management.

The next phase of natural forest management is now underway. The Nigerien Forestry Service, assisted by various donors including the World Bank and GTZ, have launched woodstock and land use management operations around Niamey. The challenge that faces these operations is the feasibility of obtaining legal authority for rural people to manage renewable resources, and necessary GON backing to carry out efforts to regulate use patterns and, where appropriate, finance investments in enriching the resource base.

### 3. World Bank Mopti Livestock Project

#### Introduction

The Mopti Livestock Project in Mali (Opération développement de l'élevage Mopti [ODEM]), like the PDES0 project in Senegal, provides an example of efforts by Sahelian governments and donors to foster more participation by local resource users in the management of renewable natural resources. Although the objectives and approach are similar in both cases, the Malian case study reflects a relatively more traditional and top-down approach on the part of Malian local administration which continued to function in the classic "encadrement" mode. However, ODEM shows a greater concern than PDES0 for understanding the natural environment to be protected and the way in which different social groups relate to their environment and to each other.

#### Project Background, Objectives, and Assumptions

ODEM began in 1975 as an important component of a larger project to promote rural development in Mali's Fifth Region. The first phase was financed by the IDA, the Caisse Centrale, the African Development Fund, and the Government of Mali (GOM). It ended 30 June 1984, after being extended for several years. The first phase of the project stressed increasing rice and livestock production and productivity. Phase II of the project began in 1984 and is scheduled to run for five years.

ODEM II reflected an important shift in orientation from the essentially "productionist" objectives of the first project. First, the protection of the unique and fragile ecology of the Delta became a central objective of the project. This was to be achieved by stockwater and pasture development outside the Delta which would support 200,000 head of cattle that would otherwise come to the Delta during the dry season. If successful, the operation would relieve pressure on the dwindling grazing resources inside the Delta and provide an opportunity to reconstitute the natural resource base within the Delta. Because of the complexity and rapidly changing nature of the resource base and the complex social organization of different communities of resource users, project planners called for a major study of the production systems in the areas affected by the project to provide the data needed to produce effective range management plans. A second major objective of the project that marked the shift away from earlier orientations was the organization of livestock producer groups into Pastoral Associations (PAs) which would assume responsibility for the protection and rational use of specific grazing lands. PAs were to pay 10 percent of the costs of constructing and most of the costs of maintaining new storage wells.

Other major objectives specifically related to the Mopti Livestock II project included:

- improved animal health through establishment of a revolving fund for the purchase and sale of vaccines; distributions and sale of mineral lick and fodder; and extension services for the maintenance of draft and dairy animals and small stock;
- upgrading of 5,000 hectares of irrigated "bourgou" pasture to improve feeding of village herds and support the integration of crop and livestock production; and
- reduction of the government's recurrent cost burden by having local resource users pay a larger share of the costs of goods and services, e.g., wells, pasture improvement, and vaccines provided by the GOM.

The project assumed that livestock producer groups would be willing and able to absorb more of the costs incurred in improving grazing and water resources which they needed. While the project reflected a greater willingness on the part of the GOM to give local resource user groups more authority to manage the natural resources in their areas, recognition of the PAs' legal status was contingent upon their accepting conditions laid down by the project. It was assumed that the ODEM livestock extension service charged with implementing the project needed to supervise closely local resource user groups like the PAs to ensure that the latter conform to project goals and objectives. It was also assumed that improved knowledge of production systems, and government negotiation of resource use rights with different resource user groups, would reveal ways to overcome difficult ecological problems and resolve potential conflicts among competing resource user groups, e.g., farmers and herders within the area, and herders coming from outside the area. Finally, it was assumed that the PAs could be organized into coherent groups capable of enforcing their decisions among their members.

#### Modifying ODEM to Foster Renewable Natural Resource Management and Promote Local Resource User Groups

While ODEM and PDES0 stressed the need to reduce government recurrent cost burdens, the methods to attain this objective reflected different approaches to administrative organization. In Mali, ODEM remained highly dependent upon the central government for funding. ODEM's parent ministry--the Natural Resources and Livestock Ministry--retained close control over project operations. PDES0 enjoyed much greater financial and administrative autonomy. Moreover, ODEM continued to function as

a classic "encadrement" extension agency. This meant the project bore full responsibility for:

- carrying out technical components;
- implementing "animation" and "sensibilisation" campaigns to prod local populations to accept its programs and conditions;
- closely supervising its clientele; and,
- enforcing contracts signed between the agency and local organizations.

ODEM sought to reduce recurrent costs by having local resource users pay more for water and livestock extension services. On the other hand, PDES0 moved to reduce recurrent costs by training local volunteers to replace state livestock extension agents.

To reflect the new concern for protecting natural resources and promoting range management by livestock owners, ODEM created two new divisions, the first concerned with range and water management, the second with providing support to the PAs. The division supporting the PAs also assumed responsibility for providing training and functional literacy programs for producer group members. ODEM thus went beyond the traditional veterinarian function of the livestock service.

#### Pastoral Associations: Instruments of Government Policy or Autonomous Institutions?

One important assumption the project made concerned existence of "traditional" coherent groups of herders in the Delta region which ODEM could organize into PAs to protect and manage water and rangeland resources in specific areas. The organizing process was initiated by ODEM. It was supposed to operate in the following manner. First, ODEM would identify likely groups and then enter into a dialogue with the livestock owners. The ODEM team consisted of a sociologist, livestock technicians, and a cartographer. Based on their knowledge of the area and their needs, PA members would identify the grazing areas to be serviced by the wells proposed by the GOM. After prolonged discussions concerning project objectives and procedures, ODEM would draw up a contract which set out the criteria agreed between ODEM and the PA for use and management of water and grazing resources. This meant acceptance by the PAs of various charges related to their use of resources (e.g., paying 10 percent of well construction costs, assuming maintenance costs of wells, etc.) Then the PA would hold elections to select a representative body which would be responsible for managing water and grazing resources in their area. Once this was done, the PA

would petition the regional governor for formal recognition of its legal existence. The ODEM team would then delimit and allocate the land in question to the PA. Finally, ODEM technicians and the pastoralists would jointly draw up a grazing management plan.

However, in practice, ODEM found that it took considerable time to organize the Pastoral Associations. Moreover, PAs were created without PA members necessarily agreeing to finance part of the costs of well construction. Thus, by mid-1987, despite the existence of several PAs, none had received official legal recognition because none had accepted the terms laid down by the project or made a financial commitment concerning well construction and other charges. As a result, no wells were built. The project response to this situation was a call for more "animation" campaigns to convince the PAs that they should pay at least some of the costs, the assumption being that livestock owners had no legitimate reasons for rejecting resource user charges.

### Incentives and Disincentives

Was this reluctance simply a question of the livestock owners not understanding the need to contribute, or did it reflect a more serious issue based on lack of incentives and clear-cut rules? For example, if the PAs paid for services and resource use, what would prevent nonmembers outside the PAs from using these resources without sharing the costs? What mechanisms would exist within the PA, which often encompassed several villages of different ethnic and kin groups, to ensure that all would pay their fair share? Would ODEM serve as the policeman and impose sanctions using state authority, or would the PAs themselves be granted enough authority to impose sanctions on nonpaying resource users? Could the elected representatives of the PAs speak on behalf of all natural resource users? These were all important institutional questions which had not been incorporated into the project design. The answers to some of these questions might explain why the herders resisted accepting government user charges. The failure of the PAs to accept these conditions also blocked their transformation into legal entities with registered property rights to water and grazing land resources in the areas falling under their jurisdiction.

### Production Systems and Property Rights Analysis: Keys to Understanding the Rules Affecting Renewable Natural Resource Management

A promising component of the project that should generate considerable data about the dynamics of ecological and social relationships in the Delta is a major production systems study. This study could provide the knowledge needed to design institutional reforms to facilitate the promotion of effective

Pastoral Associations capable of managing renewable natural resources. The study proposes to focus on the family unit in order to understand the linkages and competition between the three major production systems, i.e., agriculture, livestock, and fishing in the Mopti region, and their differential impacts on land use.

This study should provide information on the extent of imbalances between the supply of natural resources, such as water and grazing lands, and the growing demand on these resources which has led to over-grazing and conflicts among agriculturalists and herders competing for use of these resources. Moreover, the three-year study, begun in late 1987, will provide more information regarding rules relevant to land and water use among the different resource users.

In the Mopti Livestock Project, knowledge of tenure and property rights and the nature of the goods and services involved (e.g., cattle, grazing lands, and water resources), will clarify difficulties encountered thus far in organizing specific user groups like Pastoral Associations to manage specific water and grazing resources on behalf of all users of these resources in areas allocated to them. Resources like Sahelian grazing lands and government-created wells are most often treated as open access properties. When demand exceeds the supply of these resources, as is now increasingly the case, open access resources must be converted into common property resources controlled through appropriate management systems, if the resources are to survive.

In Mali, as in most parts of Sahelian Africa, tenure rights are no longer clearly defined. Traditional tenure rights and land use systems have been breaking down as a result of environmental deterioration and growing demographic pressures on increasingly scarce resources. Moreover, the state systems, which in some instances have attempted to replace the traditional tenure systems, are not working effectively. One of the major questions in the ODEM project is the extent to which the GOM will actually transfer to local resource users organized in PAs, full tenure rights over highly prized water and grazing resources which are likely to become even more valuable in the future. Even if this were done, it is questionable whether diverse resource users outside the PAs would recognize the PAs' tenure rights and be willing to pay user charges without extensive negotiations among the GOM, PAs, and themselves. Agreement must also exist concerning mechanisms to resolve conflicts among the concerned parties. These kinds of issues are usually not incorporated into strategies designed to promote local resource user organizations and encourage them to assume more responsibility for RNRM. It is not enough to create organizations with assigned functions. One also has to create a viable institutional framework that will clearly spell out the

rules which will be acceptable to local resource users and provide them with the autonomy, power, incentives, and enforcement mechanisms to make effective RNRM feasible.

### Conclusions

ODEM II reflects changes in the thinking of donors and Sahelian governments that have induced them to adopt development strategies more concerned with protecting and managing natural resources and promoting greater local participation in these processes. However, the ODEM and PDES0 cases suggest that the emphasis on promoting local organizations and natural resources management, while an advance over past centralist strategies emphasizing physical production objectives, is not sufficient to ensure local autonomy, greater participation, and effective management of renewable natural resources. These latter goals cannot be achieved without changing the rules and devising new institutional arrangements that would make the implementation of these goals more feasible.

V. FRAMEWORK FOR INSTITUTIONAL ANALYSIS AND DESIGN OF SAHELIAN  
RENEWABLE NATURAL RESOURCE PROBLEMS

It is important to understand the particular attributes of specific RNR goods and services, and to provide for their production through appropriate private markets or public institutions, or through an appropriate mix of the two. Failure to do this can and frequently does lead to suboptimal levels of production and consumption, and/or to waste and inefficiencies in the allocation and use of scarce resources. Most Sahelian rural producers are too poor to undertake activities willingly when their common sense understanding of the attributes of the goods or services in question and the rules governing provision and use of those goods or services in their areas, suggests such RNRM activities will not lead to efficient or equitable outcomes.

Sahelian peasants recognize the phenomenon of the free-rider<sup>14</sup>, and they know that inability to deal with free-riders can threaten long-term sustainability of an RNRM endeavor. They also understand the importance of rules in channeling behavior and introducing predictability into relationships. When rules governing an activity are not sufficiently specified (if at all), or when inadequate provision is made for dispute resolution, rural producers tend to conclude that the powerful will dominate, and those who lack patrons will probably not derive much benefit from the activity, or may even be harmed by it. Likewise, failure to understand the scale at which specific common property or public good resources are best produced can undermine efforts to interest rural producers in RNRM by raising the costs of management to levels that are prohibitive for rural producers.

This section outlines an analytic framework which is useful in diagnosing the causes of RNRM problems and developing possible solutions to them. Diagnostic and design phases of the analysis incorporate the views of representative individuals involved in the use and possibly in the management of the target RNR. Constraints that these individuals confront, as well as opportunities they can exploit, will be critical in shaping patterns of conduct.

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14 The following Hausa proverb, for instance, neatly sums up the social dilemma posed by the free-rider problem: Wani da tusa, wani da samun riga. "While some are passing wind with effort [in an endeavor], others get nice clothes [i.e., reap the benefits of others' investments]"

The four parts of the analytic framework are:

- attributes of RNR as goods;<sup>15</sup>
- institutions viewed as sets of rules;
- interactions concerning specific RNR among individuals and groups in light of the attributes of those RNR and rules governing their use; and,
- outcomes of these patterns of interaction, evaluated in terms of criteria of efficiency and equity in RNRM.

A. Attributes of Renewable Natural Resources as Goods

The attributes of RNR, viewed as goods and the services<sup>16</sup> they produce fundamentally influence the conditions of their production and consumption. Private goods, because of their inherent characteristics, are best produced through private market production and distribution systems. Production of common property and public goods and services in appropriate amounts typically requires the intervention of government(s) at some level(s). For example, attempts to have farmers produce trees which are inherently private goods in village common property woodlots, or to have Sahelian pastoralists manage inherently common property or open access pastures on the basis of private efforts, are not likely to give satisfaction.

Four basic categories of RNR goods, which have been used repeatedly in presenting the case studies, are described in this section. They are: private goods, private goods with externalities, common pool goods, and public goods.

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15 Resources are treated here as goods, in the sense of capital stocks which typically produce flows of intermediate or final goods and services.

16 RNR can be viewed as producing both goods, (e.g., windbreaks, firewood, and forage, etc.), and services, (e.g., protection against wind and water erosion). The analytic framework employed here can be used as well to analyze conditions of production and consumption of other classes of goods and services--consumable products such as bread, furniture, and housing, and services such as road maintenance, provision of law and order, dispute resolution, health, and education.

These four types of goods are distinguished from one another in terms of two criteria:

- exclusion, i.e., the extent to which it is technically feasible to exclude potential users from access to a given type of good; and
- mode of consumption, i.e., whether the good is consumed in a joint and nonrivalrous manner, or whether consumption is separable and rivalrous.

### 1. Private Goods

Private goods are those subject to exclusion and separate or rivalrous consumption. Arable soils, for instance, are considered private goods in many Sahelian rainfed agricultural systems. So, too, are trees produced in enclosed gardens.

### 2. Private Goods with Externalities

Private goods with positive or negative externalities are only partially subject to exclusion. They may generate spillovers (good or bad) which produce benefits or damages for others within the domain affected by those externalities. Water harvesting installations on uphill fields may generate positive spillovers for downhill holders by reducing the threat of sheet or gully erosion on the latter's fields when rains are abundant. But they may also produce negative spillovers if they prevent surface water from moving onto downhill fields during drought periods.

### 3. Common Pool Resources

Common pool resources are not subject to easy exclusion. However, consumption of the resource is separable. Shallow aquifers in valley bottoms are a pertinent example. Those who hold land rights in the valley can get access to the water and use it until the supply is gone. While supplies are adequate to meet demand, one individual's usage, e.g., to irrigate a dry season garden, does not interfere with use by others. But if demand outstrips supply, the resource can be exhausted.

Common pool resources may be treated legally, depending on institutional arrangements (see Section V.B. below), as common property goods, open access goods, or private goods. Common property goods are not subject to easy exclusion among a defined group of users, but all other potential users can legally be excluded. Consumption of the resource remains separable.

Open access resources are similar to common pool resources except that they are not subject to exclusion. When demand exceeds supply, they cannot be managed to regulate demand because

all are at liberty to exploit such resources. Anyone and everyone enjoys liberty of access. Consumption of open access goods is separable or competitive. When resource supply exceeds demand, this is efficient. However, the same system may threaten survival of a resource when demand exceeds supply. Boreholes that produce unlimited supplies of open access water illustrate the problem. Since nothing prevents additional herders from using adjacent pastures until they are exhausted, herders gravitate to unmanaged boreholes immediately after the rains and graze their animals in the vicinity until forage supplies give out.

#### 4. Public Goods

Public goods are not easily subject to exclusion. Consumption of the services such goods produce is joint or nonrivalrous. Sahelian woodstocks, where they are abundant, generate a public good of improved air quality by slowing wind velocity and reducing wind erosion. Better air quality is freely available to all those in the area. Consumption by one person does not potentially or actually interfere with consumption by others.

#### B. Institutions as Sets of Rules

Institutions, whether families, voluntary groups, local, regional, national or international governments or agencies, can be conceptualized as a set of rules which order human behavior in going concerns.<sup>17</sup> Institutions, as the term is used here, are the broadest category of rule sets; organizations are a subset of institutions in this conceptualization. For instance, Sahelian Ministries of Rural Development are organizations, defined, in part, by their personnel and operational rules. All organizations are institutions, but many institutions are not organizations. For instance, the sets of rules that define conditions under which organizations come into existence, how institutions such as property and markets function, how organizations can legally operate and relate to each other, and how they go out of existence, are institutions but not organizations.

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17 This section draws heavily on the work of John R. Commons in institutional economics. See his Legal Foundations of Capitalism (Madison, Wisconsin: University of Wisconsin, 1959; first published in 1924: Macmillan, New York), pp. 65-213. See also Vincent Ostrom and Elinor Ostrom, "Legal and Political Conditions of Water Resource Development," Land Economics, XLVIII, No. 1 (February 1972), 1-14.

Institutions also define how individuals can legally relate to RNR. National Forestry, Water and Land Tenure Codes, and "traditional" family, quarter, village, and cantonal regulations all define who controls what aspects of the use and management of specific resources. All are institutions as the term is used here. Their relative power and authority in ordering human behavior in any particular situation must be understood by observers who wish to analyze RNR management problems, or identify opportunities to increase productivity of RNR.

This conceptualization of institutions focuses on the pragmatic results of rule sets, or working rules, in ordering individuals' behavior in activities, organizations, and enterprises. The impact that any set of rules has in effectively controlling behavior, rather than its formal legality or illegality, is of prime interest here.<sup>18</sup> Rules that, in practice, channel human behavior may be referred to as the "working rules of going concerns."<sup>19</sup> By analogy, rules in this sense constitute "The basic architecture of human institutions, social organizations, or enterprises..."<sup>20</sup> What is important is that the design of the rule system be sufficient to support the structure (of RNRM for instance), rather than that it be approved by one or another political body. However, lack of legal recognition may discourage nonlegal or illegal organizations from arising and managing RNR.

Institutions, or sets of rules, channel human behavior into relatively predictable patterns by creating positive and negative incentives which induce individuals to adopt desirable practices and avoid ones which the rule makers determine are inappropriate. Multiple institutions influence and structure how humans conduct themselves in using Sahelian RNR. Even a nonexhaustive list of institutions and organizations involved with Sahelian RNR would have to include the following:

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18 Distinctions between "formal" and "informal" rules, e.g., state-authorized legislation or administrative regulations versus the traditional rules ("customs") of pasture management developed by autonomous groups of pastoralists, or the local rules of village irrigation system operation, are not terribly relevant in this approach. What counts is practice.

19 Commons defines "going concern" as follows: "The going concern [a group of individuals] is animated by a common purpose, governed by common rules of its own making, and the collective behavior in attaining that purpose we distinguish as a 'going business'." Commons, Legal Foundations..., pp. 144-45.

20 Ostrom and Ostrom, Land Economics, 2.

- nuclear and extended families;
- quarter governments;
- village regimes, insofar as they affect land use practices;
- canton, arrondissement, and cercle regimes, insofar as they influence resource exploitation and management activities, or land use practices;
- RNR codes;
- national Forestry and Environmental Services;
- Agricultural, Livestock, Hydraulics and Rural Development Ministries working at various levels throughout the country;
- framework rules bearing on permissible forms of political organization and public financing established by other government agencies such as the Ministries of Interior and Finance;
- nongovernmental organizations; and
- projects financed by external funding agencies and implemented by government personnel and external advisors.

The rules that define these institutions inhibit or promote management of renewable natural resources. Occasionally, a single institution will exercise overriding influence on management (or abuse) of a particular resource in a specific area. However, far more frequent are those situations in which two or more institutions play roles in structuring the opportunities for and impediments to RNRM. Analyses of RNRM problems should first identify the institutions which influence resource use patterns. They should then explore the interrelationships among different sets of rules.

Rules can be analyzed in terms of three sets of relations: authorized relationships, authoritative relationships, and the determining powers of officials.

#### 1. Authorized Relations

Rules governing any relationship allocate rights, liberties, duties, and exposures (see definitions of these terms below) among the parties to transactions in the relationship. Rules in this sense can be thought of as rules of the game which assign

capabilities and limitations for action among the players.<sup>21</sup> The particular allocation in any relationship creates strategic opportunities for some and constrains others to behave in specified ways, or exposes them to certain risks. In turn, these capabilities and limitations operate as incentives or impediments to particular actions.

Authority to act involves assigning a right to an individual. Rights create the most powerful capability because they enable rightholders to control others' actions. Every right in an authorized relationship is paired with a correlative and equivalent duty. A person under duty must either perform, avoid, or forebear in undertaking acts covered by the right.<sup>22</sup> Thus, duty is the most constraining form of limitation on one's capability to act. A landowner, for instance, enjoys a right, or capability, to determine whether others will be allowed to exploit his field, and if so, on what terms. A tenant may be required, within the terms of the contract between owner and tenant permitting the latter to cultivate the land, to do certain things (plant specific crops, pay a set share of the harvest to the landlord) and forebear from engaging in other acts (the tenant may be allowed to collect deadwood but must forebear from lopping green branches or felling trees, planting trees, cultivating with the slope rather than on the contour, etc). All others are under a duty to avoid using the field.

Both rights and their correlative and equivalent duties are limited in extent. Where a rightholder's capability to control another's conduct ends, his exposure to the consequences of that other's conduct begins. Likewise, where the correlative duty ends, the other person is at liberty to act, and can do so whether or not his actions damage the first person. For instance, in the illustration just given, the tenant may be at liberty to allow gullies or sheet erosion to reduce the productivity of the field while he farms it, and the landowner is exposed, to a correlative and exactly equivalent extent, to the damage and loss caused by his tenant's behavior. Figure 1. illustrates authorized relationships.

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21 Ostrom and Ostrom, Land Economics, 3.

22 Commons, Legal Foundations..., p. 78, Fig. 1 and accompanying text.

## CORRELATIVES and EQUIVALENTS

LIMITS and RECIPROCALLS	RIGHT	DUTY
	EXPOSURE	LIBERTY

Figure 1. Authorized Relationships<sup>23</sup>

The landowner may be able to increase his power to control the tenant's behavior by expanding his own rights and the tenant's duties in their share-cropping arrangement. If so, he reduces to that extent his own exposure and the tenant's liberty to use the land as he wishes. The landowner might make installation of water harvesting devices, such as bunds, a condition of renewing the tenancy contract. If the tenant accepts, the landlord probably increases the absolute amount he receives from the harvest as well as the long-term value of his land. Conversely, the tenant accepts an enlarged duty which requires him to avoid mining the field by taking certain steps to preserve soils on the land.

### 2. Authoritative Relations

Authoritative, or power relationships are required to determine, maintain, or change the allocations of authority--rights, duties, liberties, and exposures--in authorized relations. Officials (family heads, forestry guards, managers of village irrigation systems, sub-prefects, earth priests, presidents, village headmen, canton chiefs, and Muslim clerics) exercise authoritative decision-making capabilities. These take the form of powers, liabilities, immunities, and disabilities. Figure 2. illustrates Authoritative Relationships.

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23 Adapted from Commons, Legal Foundations..., p. 97.

CORRELATIVES and EQUIVALENTS

	<i>Official 1</i>	<i>Citizen A</i>	<i>Citizen B</i>	<i>Official 2</i>
LIMITS and RECIPIENTS	POWER	RIGHT	DUTY	LIABILITY
	DISABILITY	EXPOSURE	LIBERTY	IMMUNITY

Figure 2. Authoritative Relationships <sup>24</sup>

Individual officials exercise these powers to create or change regulations governing collective enterprises; for instance, in organizing a pasture management association, modifying rules governing land tenure in an area, determining access to water in a project-developed irrigation system, or conditions under which local communities can finance activities through taxes; or resolving disputes by determining the particular limits of contested rights, duties, liberties, and exposures in an authorized relationship.

3. Determining Powers

Officials are usually subject to supervision in their exercise of authoritative powers. Their decisions are subject to review by superiors, voters, or judges. However, all officials make some decisions where they exercise discretion not subject to review. When officials can decide issues without their decisions being reviewed, they exercise determining powers--that is, their decisions define the "working rules" of those laws which actually govern conduct in a given situation.

Institutional analysis that focuses on authorized and authoritative relations, and determines powers of officials, is likely to get at the sets of incentives and disincentives which encourage rural producers, technicians, officials, and others to support or impede RNRM. Such analysis should attempt a crude estimate of the transaction costs and potential benefits to

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24 Adapted from Commons, Legal Foundations..., p. 118.

particular individuals and officials of specific activities related to RNRM.

For example, the probable transaction costs to a farmer in the Majjia Valley of enforcing windbreak management rules when he apprehends someone lopping branches from a windbreak tree on his land will influence his willingness to coproduce windbreak policing services. Which official is competent to decide how such infractions should be treated? How much would it cost the potential landowner plaintiff, in time, energy, and money, to get a resolution of the case? Would he derive any direct benefit from his efforts, or would he, in effect, be producing "windbreak law and order," a public good for other valley farmers and residents at personal costs which he cannot expect to recover? What are the implications of this assessment for the enforceability of windbreak management rules, and therefore, the sustainability of the windbreaks?

This same type of analysis can be applied to problems that may arise in Mali Delta Pastoral Associations when it is necessary to raise funds to finance, in part, construction and maintenance of group wells, or when uphill holders in the Southern Zone Water Management Project Area want access to irrigation waters during the dry season. Other examples abound.

### C. Interactions

Interactions concerning resource use result when rational but fallible individuals adopt strategies to maximize their preferences for RNR goods and services of various types within the constraints and opportunities established by sets of working rules governing: access to and use of RNR, and human capacity to organize and fund RNRM activities. Decision-making arrangements concerning RNR can take into account their nature as economic goods, or they can ignore it. Production and consumption of inherently private goods should be organized through the private sector for greatest efficiency. But private goods--trees under certain situations, for instance--may be treated as common property goods as a matter of policy. In such cases, it is likely that incentives to produce and manage these goods will be distorted by the imposition of unnecessary institutions. The incentives to which RNR producers and users respond may then be inappropriate. Similarly, inherently common property goods may be treated as open access goods. Again, distortions and inefficiencies may be expected in production, management, and consumption of these goods. Some examples may illustrate the point.

In some situations, RNR are inherently private goods because of patterns of use, technology available for exclusion, and because they are characterized by separable or rivalrous

consumption. Where these same RNR are treated as private goods by working rules, it is reasonable to expect that such resources will be managed and produced in amounts where the marginal cost of additional services or final commodities produced by the resource will be just equal to the value of these services or commodities, either as inputs to final commodity production processes or as final commodities themselves. If there is demand for building poles at prices consistent with farmers realizing profits by producing poles, they will appear on the market in quantities consistent with demand and cost considerations. However, if poles are produced in village common property woodlots, an efficient, i.e., least-cost, supply of such poles will be produced only if collective organization is adequate to provide effective management of the woodlot and a system of distribution of the benefits of production is established which provides producers with adequate incentives. Failure to meet these conditions will result in higher long-run costs and ultimately, an end to production of poles through such arrangements.

If irrigators in a Soninke village water system in the Senegal Middle Valley find they can shirk their duties to participate in cultivation of the collective plot, it is probable maintenance of the plot will suffer. However, irrigators may be able to hold each other accountable, either by having recourse to the system manager as the official charged with enforcing authorized relationships concerning irrigation system operation, or by relying on him to verify that irrigators meet their obligations to bear their share of the burdens of system management and expansion. If so, then that system may become a reliable enrichment of the production potential of the families involved. The same holds for Mossi farmers who have downslope fields in northern Burkina Faso. If they can compel uphill field holders to make and maintain water harvesting devices, they may succeed in managing the positive externalities to be gained through water control in a micro-watershed.

The issues will vary from resource to resource, from site to site. Generally, private RNR goods and services will be produced if there is adequate, effective demand to cover all costs of production, including costs of creating and maintaining land tenure rights.

Strategies adopted by individuals concerning private goods are heavily influenced by the extent to which authorized relationships can be enforced. If the owner of an RNR can insist that others respect their duties not to use the resource without his authorization, or to use it only with his authorization and as he specifies, then the market opportunities largely define his willingness to produce. However, if these conditions cannot be assured, a conflict arises between his incentives and the market incentives. The uncertainty of his control over resources as

inputs drives up his production costs. Uncertainty about his ability to keep others from appropriating the output leads him to discount the value of probable market opportunities.

Common property resources, public goods, and services associated with RNR will probably not be produced in adequate amounts if it is possible for some users to "ride free"<sup>25</sup> on the efforts of others to maintain or enrich an RNR such as a pasture or watershed. Conversely, if resource management units enjoy the power or authoritative relationships necessary to structure appropriate, authorized relationships concerning a given RNR and its management, use, and maintenance, then chances are much better for eventual success of efforts to preserve or enrich such RNR.

Strategies adopted by individuals vis-à-vis common property RNR and public goods and services produced through management of RNR will depend on individual users' expectations of what other users will do concerning the RNR.<sup>26</sup> If a user assumes probabilities are good that other users will abide by a set of use regulations designed to ensure survival of the resource, chances are s/he will also abide by use rules. Such expectations are shaped by knowledge of shared expectations about how an RNR should be used and the consequences of misuse, and the existence of an enforceable set of working rules concerning use. If those elements are in place, the temptation to ride free is markedly reduced. However, if users expect other users to free-ride whenever possible (in anthropological terms, there is little or no "social pressure" to abide by reasonable use rules) then they have a strong incentive to ride free as well. Such situations typically result in a breakdown of resource management efforts.

#### D. Outcomes

Outcomes of interactions, in terms of the character of RNRM efforts, may be evaluated in light of various criteria. Two criteria often used are efficiency and equity. Very briefly, efficiency in RNRM activities can be evaluated by the resource management effect achieved for a given investment, or the cost at which a given level of resource management can be achieved. As

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25 Cf. Ronald J. Oakeron, "A Model for the Analysis of Common Property Problems," in Proceedings of the Conference on Common Property Resource Management (Washington, DC: National Academy Press, 1986), pp. 13-29, esp. 21.

26 C. Ford Runge, "Common Property and Collective Action in Economic Development," in Proceedings of the Conference on Common Property Resource Management (Washington, DC: National Academy Press, 1986), 31-52, esp. 42-48 on "the assurance problem."

far as common property RNR are concerned, efficiency may be defined as achieving an optimal use rate that ensures resource survival, but does not exclude any demands for uses that could be met without impairing the quality of the resource.

Analysts refer to equity in two different ways--first, as distributional equity, and second, as a fair return based on effort and contribution. Equity as the term is used in most public-sector policy discussions typically refers to appropriate distribution of benefits among income classes. Equity is served in RNR insofar as people who make investments in RNR receive a reasonable return on their investments.<sup>27</sup> Fairness in the allocation of returns on investments, honest management of commons and public goods and services, and a fair pattern of access to an RNR also constitute indicators of equity.

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27 This and the preceding paragraph draw, in part, on Oakerson, Proceedings..., pp. 21-22.

## VI. POLICY IMPLICATIONS

Efforts to promote better management and governance of RNR through decentralization should seek to:

- devolve resource management authority to the local-level regimes whenever appropriate;
- strengthen the capacity of producers to manage the flow of RNR as private goods where appropriate; and,
- strengthen the capacity of producers to implement resource management operations through local governments and special districts for management of specific resources, provide the institutional framework for private management activities, and develop collective management systems where these are indispensable to preservation of the resource base.

These three broad objectives of efforts to decentralize<sup>28</sup> control over Sahelian RNR are proposed in light of the salient characteristics of the Sahelian renewable natural resource situation. Sahelian environments are marginal. RNR are not concentrated in great abundance, but spread thinly over the land. Resource endowments also change sharply over short distances. Diversity is the one constant in these otherwise highly variable micro-environments.

The characteristics of RNR, viewed as economic goods, are also quite varied. Soils, pastures, surface waters and aquifers, and the woodstock may have the characteristics of purely private goods, private goods with spillovers, those of open access or common property resources, or of public goods. Each of these

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28 "Decentralization" can be defined in three ways: deconcentration, delegation, and devolution. Deconcentration describes the act of shifting certain administrative operations from central levels to subcentral levels. Delegation involves transfer of power and authority from higher- to lower-level decision centers, but typically within the existing politico-administrative framework. Devolution is normally used to characterize a permanent hand-over of authority and real decision-making power from higher- and lower-level jurisdictions. See Dennis A. Rondinelli, "Government Decentralization in Comparative Perspective: Theory and Practice in Developing Countries," *International Review of Administrative Sciences*, XLVII (1981), pp. 137-139. Devolution and delegation are the types of decentralization of most interest in improving management of Sahelian RNR.

types of goods is best managed by a specific complex of rules or institutions. Ill-adapted institutions can easily impede or totally frustrate resource management initiatives rather than facilitate them.

#### A. Institutional requirements

Management of RNR depends on the capacity of governance institutions to meet certain requirements. They must be:

- adapted to the nature of the goods under management;
- capable of efficiently making, applying, and flexibly adjusting working rules for the governance and management of specific resources in given micro-environments, in light of the changing condition (degradation or restoration) of, and new demands on, the resource in question;
- capable of efficiently, fairly, and cheaply resolving disputes concerning access to and use of managed resources, so that transaction costs involved in dispute resolution do not dissuade producers from defending their resources; and
- capable of providing financing to ensure the continuity of management activities as perennial, low-intensity operations.

Implicit in these conditions is the assumption that willing, sustained, popular participation in control of resource use is indispensable for effective management. Producers must be willing to help apply resource use rules; suggest improvements in management systems and work for their introduction; and bear their fair share of the costs of management operations.

#### B. Fitting Institutions to Renewable Natural Resource Types

Most Sahelian micro-environments contain a range of RNR. Resources that are private goods, private goods with externalities, open access and common property resources, and public goods may all co-exist in one place. A single institution cannot adequately manage all these different types of resources efficiently. Resource management institutions must take account of the nature of the goods under management. Extra institutional capabilities are necessary to manage collectively RNR which are either common properties or public goods. It is thus important, in efficiency terms, that inherently private goods be managed as

private resources except if there are compelling reasons to do otherwise (e.g., equity concerns).

Another reason it is appropriate to manage RNR as private (or family) rather than collective (common or public) goods whenever possible has to do with the certainty of return on investment in resource management. The individual or family who invests in managing a private resource can expect to reap a direct gain on the investment, provided authorized relations concerning the resource, i.e., property rights, are respected. This holds whether it takes the form of tree planting, bund-construction, protection of trees and pastures from over-exploitation, or irrigation canal maintenance. When investments are realized in collective RNR, the investment-benefit relationship is more indirect. Public goods will be available for joint consumption by all within the domain of the good. Common property resources will be available for separable consumption by those who enjoy legal access to the good. But in both cases, the amount of the good which can be produced and consumed depends upon collective choices and how they are enforced. If some ride free on others' investments, those others will not reap their equitable share of benefit from the investment, or they will pay more for it than they should.

### 1. Private Goods

Private goods cannot exist without a minimal structure provided by basic institutions. They require police and dispute resolution agencies to ensure respect for property rights and decide conflicts, and an institutional structure capable of financing those activities. However, special management institutions are not required because personal needs or market demand generally provide individual owners with motivation to ensure adequate management of the resource.

The same set of institutions are required to manage private goods with externalities as are required for pure private goods. Additional authority may be required to regulate negative externalities.

### 2. Common Property Resources

Institutions required to govern common pool resources which are treated as common property resources include those which supply police services, resolve disputes, and finance the activities. However, power, or authoritative relationships, are also required to organize collective activities in order to coordinate behavior concerning the resource and apportion supply to demand. Power is required to make, modify, and apply the working rules governing access to, and use and harvesting of the resource in light of its evolving condition. Authoritative relationships are required to alter existing working rules or to

develop new ones to guide management and to provide for dispute resolution procedures. Power may be necessary to levy taxes (in cash, kind, or labor) to finance investments in protecting or enriching the resource.

### 3. Open Access Resources

The only institutions necessary to maintain the open access status of resources are those required for private goods. Authoritative interventions may be required to prevent individuals from seeking to privatize or otherwise subject an open access resource to management; that is, to infringe on the liberty of all potential users to exploit the open access RNR as they see fit. Maintaining an open access resource as such is clearly not equivalent to managing it. In fact, maintaining open access as the working rule governing exploitation of an RNR may result in its impoverishment or terminal degradation.

### 4. Public Good Resources

Institutions required to provide public goods are the same as those required to manage common properties. Public goods will not be produced in desired amounts without collective action capability because potential producers cannot otherwise be assured of compensation for their efforts--the exclusion difficulties and joint or nonrivalrous consumption characteristics of public goods make this impossible. The exception to this rule occurs when the benefits to one individual of providing a public good (to which others within the domain of the good will automatically have access) outweigh his costs in doing so.<sup>29</sup> The same result can occur when the positive spillovers associated with producing a private good are in the aggregate sufficient to produce a public good. In this instance, the public good will be generated without the necessity for collective action. An example of this situation would be farmers producing numbers of trees on their own lands to obtain separable benefits (firewood, soil protection, fencing materials, browse, building poles, etc.) sufficient to generate the public good of improved air quality as a costless side benefit without the necessity for collective action.

These considerations could account for the presence of certain public goods. However, in the absence of appropriate, collective decision-making arrangements, the level produced would inevitably be below the optimum level of the good.

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29 Mancur Olson. 1965. The Logic of collective Action: Public Goods and the Theory of Groups. Cambridge, MA: Harvard University Press, p. 22.

### C. Structuring Authoritative Relationships for Efficient Renewable Natural Resource Management

These institutional requirements can be met in most Sahelian countries by creation of framework legislation transferring (delegating, or preferably devolving) rule-making and application authority, dispute resolution powers, and public finance authority to quarter, village, cantonal, or arrondissement units. Framework legislation authorizing creation of special resource management districts involving, for instance, all irrigators in a village irrigation system, or all villages along a seasonal water course which offers dry season gardening possibilities, or all land holders within the boundaries of a micro-watershed, should also be considered.

Ideally, given the multiplicity of RNR in any Sahelian local environment, development of a range of resource management institutions should be encouraged. Multiple institutions existed in the past in many Sahelian societies. In many places, considerations of administrative convenience have reduced this local multiplicity and variability to a single standard format, for instance the Development Society Councils in Niger, or the ton in Mali. Under these conditions, costs of public entrepreneurship in seeking new approaches to resolve RNRM problems are potentially very high for extra-legal/informal organizations which lack authority to make and enforce use rules for such resources.

More efficient RNRM in Sahelian contexts depends on giving RNR users much more attractive incentives to take the initiative in managing their resource bases. It also depends on removing obstacles and impediments which currently dissuade rural producers from such attempts. Broadly speaking, these dual goals can be achieved by: increasing popular control over resources, and facilitating collective action concerning RNR.

#### 1. Vesting Renewable Natural Resource Rights in Sahelian Rural Producers

Vesting Sahelian rural people with clear rights to the resources upon which they depend for survival in agricultural, agro-silvo, agro-silvo-pastoral and silvo-pastoral production systems creates a positive incentive for more management. If farmers and agro-pastoralists own their own land, the trees and bushes that grow on that land, and can control water sources which flow over and under the land, they have at least marginally greater capacity to control variables in their production systems. If pastoralists have control over wells in the high steppe zones of the Sahel, they have marginally greater capacity to regulate exploitation of pastures.

Authorized relationships can be changed in many situations, e.g., through modification of forestry or land tenure codes, to vest Sahelian rural producers with clear rights to particular RNR which they exploit in a direct fashion. This should enhance their ability to control access--to compel other potential users to avoid exploiting their resources without owner authorization. In consequence, probabilities increase that individuals or families who invest in RNR preservation, management, and enrichment will themselves reap the benefits of their investments, rather than seeing them consumed by free-riders. If better management of RNR can lead to increased productivity and a better standard of living through auto-consumption or sale of products, or to a more secure standard of living through protection or enrichment of the resource base, enhanced security of property RNR rights will--other things being equal--increase producer-owners' incentives to undertake or intensify RNRM initiatives.

Other things may not be equal. When the resources in question have the characteristics of private goods as defined in IV.A.1., efficiency will be enhanced if well-defined property rights to those resources are held by private individuals or firms. If states, in decentralizing control over RNR, insist that they all be treated as public goods or even common properties, such policies will vitiate otherwise powerful incentives for private management, by adding to normal production costs those associated with organizing (unnecessary) collective management regimes. Conversely, treating common pool resources as private goods may lead to serious difficulties in ensuring efficient governance.

Other problems, addressed below, have to do with relations between authorized and authoritative relationships. Unless property rights, whether held collectively, on a family basis, or individually, can be enforced, the working rule (as experienced by resource users) will continue to be one of exposure to the unregulated claims of many or all other users. In effect, this will freeze incentives for RNRM at their current low levels.

## 2. Facilitating Collective Action Concerning Sahelian Renewable Natural Resources

Privatizing control over RNR is appropriate as a policy only where the goods in question are inherently private goods. Many RNR are either inherently public goods, or common property resources, or private goods with marked externalities, as those terms are used above in IV.A.2-4. Management of such RNR will typically require collective action by a management regime or regimes at some level(s) in the polity.

The Bakel village irrigation systems illustrate this point. Four levels of regimes are involved in managing these systems.

First, the group of irrigators within each village is organized at the system level. Second, construction, maintenance, and collective parcel cultivation are all undertaken by subunits within the village irrigators' organization. Typically, these units are organized within the regime framework--the authorized and authoritative relationships--associated with the extended family. Third, in order to preserve the autonomy of individual village system members to organize production processes as they see fit, counter to the wishes of SAED technical and supervisory personnel, the villages found it necessary to organize a Federation with powers to represent the individual village system regimes in negotiations with SAED. Finally, NGOs and SAED constitute the fourth order of regime, ones with access to expertise and funding sufficient to allow them to provide technical assistance to village systems on engineering and other issues.

Each of these regimes, with the exception of SAED in its original form, was organized to handle a specific set of problems which required collective action. Note that each is organized at a different scale, according to particular problems which it is called upon to address.

- The village irrigation system is, in effect, a special irrigation water district or regime, created to ensure that water is provided on a reliable basis, and to provide quality control over construction and production processes.
- The family-based regimes--the subunits of the village irrigation system--simply extend into that context the traditional control over agricultural production strategy and supervision of day-to-day production operations which family regime officials provide on family lands.
- The Federation was originally an ad hoc regime created to parry the perceived negative consequences of allowing SAED to follow through on its take-over strategy. The Federation regime persists as a going concern presumably because it continues to provide coordination services in negotiations with SAED which village system officials find essential.
- The NGOs and SAED as separate regimes provide technical and some financial assistance to village system operators.

### Problem Scale

Two factors explain why this multiplicity of regimes is efficient: problem scale and transaction costs. First of all,

each regime is appropriate, in terms of size, to deal with a specific scale of problem. In-plot production decisions can be handled quite adequately by family regimes, assuming they have access to relevant information about family needs, market prices for crops, and access when they decide they want it to technical assistance, e.g., to obtain information about new agronomic techniques. Such decisions do not require authoritative interventions of either village regime officials, Federation officials, or SAED officials. Bakel family farmers, to judge by the production statistics cited in Table 1, have consistently demonstrated an ability to out-produce SAED-managed operations. Their success is in no way mysterious. They have a marked comparative advantage in time-and-place-specific knowledge of the micro-production conditions that prevail in any given day on their plots. They also have strong personal incentives, reinforced by the collective control of the family regime, to show initiative in managing the RNRs--water and soil--which they control to obtain the outputs that provide them with the greatest satisfaction consistent with preservation of the basic resources.

Ensuring system-wide coordination of effort, during construction, maintenance, and collective production operations, is a somewhat larger scale problem and requires the irrigation system-level regime. However, the village irrigation system regimes are not of adequate scale to handle negotiations with SAED on production strategies because, as single units, they lack bargaining power. The Federation plays a critical role with this still larger level problem because it offers the possibility of concerting the weight of all the village systems in one unified bargaining position vis-à-vis SAED. Finally, SAED is organized at a scale that allows it to realize economies of scale in hiring expensive personnel, purchasing and maintaining expensive equipment, and operating irrigation works necessary to the overall functioning of the large irrigated perimeters. Village irrigation systems can tap into this sophisticated engineering potential on an ad hoc basis as such services are needed.

### Transaction Costs

Transaction costs are the second factor explaining the probable comparative advantage of systems permitting management of specific RNRs by multiple as opposed to single regimes. Transaction costs are the outlays in time, money, and energy necessary to arrive at a decision. Family regime officials have power, within a set of authoritative relationships governing behavior of members of the family going concern, to make decisions about crops, locations, sequencing, and cultivation techniques and measures. This means they can respond rapidly to changing conditions at very low transaction costs. Currently, they are not compelled to contact SAED officials to deal with these issues. Thus, they economize significant outlays of time, energy, and money. Similarly, village system officials do not

require authorization from Federation officials, much less SAED officials, insofar as system construction, maintenance, water allocation, and collective plot management issues are concerned. However, if village system officials want technical assistance, they know SAED is organized to provide it. This cuts down on the transaction costs associated with obtaining help.

A further element of efficiency may exist if NGOs are still active in the area, and able to provide alternative sources of technical assistance. If that is the case, village system officials have some leverage against SAED technicians and officials. If the transaction costs of SAED technical assistance are higher (or the quality lower) than those involved in obtaining similar services from NGOs, then village system managers have an incentive and opportunity to exercise their own initiative to reduce overall costs of organizing the system by dealing with NGOs to obtain necessary services.

### Renewable Natural Resource Management Rules

Within each of these regimes, rules for managing RNR must be developed and subsequently modified if experience reveals ways to improve the efficiency, effectiveness, or equity of management activities. In discussing RNRM rules, distinctions among several types of rules based on the concepts of authorized and authoritative relationships are helpful.

#### Authorized Relationships: Property Rights and Other Rules

Many management rules take the form of authorized relations. These are defined by property rights and other rules, such as Senegalese national enabling legislation authorizing creation of Groupements d'intérêt économique communs, which allow individuals to act on their own initiative, or to collaborate with other individuals on a voluntary basis to achieve certain RNRM goals. Included here are authorized relations stipulating whether the managed RNRs are legally private properties, common property resources, possibly a mix of the two, or public goods. These authorized relations specify in the most general terms who is permitted access to the RNR; and who can authorize RNR harvesting, fix times at which various products can be harvested, and specify allocation of products harvested.

#### Authoritative Relationships: Rules Governing Collective Choices

Another set of rules result from collective, as opposed to individual, choices about RNR and their use and management. Such rules concern common property and public good resources, and control of spillover effects generated by private resources. These rules created by collective choice processes define a first level of authoritative relationships. In choosing these rules,

regime officials (at whatever level of regime) make decisions which are binding on individual users and can be enforced by the application of sanctions if necessary. The rules that embody authoritative relationships will also specify what powers local, intermediate, and national regime officials can exercise. These might include, for instance, specifying which officials have power to determine amounts of common property or public good RNR to be produced or harvested in any given year, while maintaining a sustained-yield or increased flow of these products over time. Collective choices also determine the roles that citizens, acting as officials, can play in managing RNR. Examples here would be the power that a simple member of a going concern established to manage RNR might exercise to enforce specific use rules such as harvesting regulations when s/he observes someone committing an infraction of those rules, or the power members exercise when they help select concern officials.

The capacity of a local RNRM regime to make, alter, and enforce its own rules concerning the resource will tend to reduce transaction costs of rule changes and encourage experimentation in the face of management problems. However, if rule changes can only be approved by officials at higher levels exercising authoritative or determining powers, the costs of experimentation will be higher. In the latter situations, local regime members and officials may judge them to be sufficiently high that experimentation is not worthwhile; expected costs of changing rules will outweigh potential benefits. Where local RNR users and managers arrive at this conclusion, RNRM problems and inefficiencies will be allowed to persist. If they persist long enough, management efforts may falter or simply cease altogether. Once that happens, resource degradation can be expected to accelerate.

#### Authoritative Relationships: Constitutional Rules for Renewable Natural Resource Management Regimes

Constitutional rules define a second level of authoritative relationships. They specify rules for making rules. Constitutional rules determine how--in accord with what decision rules--officials are selected and how they can make and change collective choices (operational rules) about RNRM.<sup>30</sup> Constitutional rules also often provide means by which the constitution can be modified.

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30 Larry L. Kiser and Elinor Ostrom. 1982. "The Three Worlds of Action: A Metatheoretical Synthesis of Institutional Approaches.: In Elinor Ostrom, ed., Strategies of Political Inquiry. Beverly Hills, CA: Sage Publications, pp. 179-222. esp. 207-209.

If local regimes are empowered to introduce such changes, subject to respect for constitutional procedures, once again the costs of institutional innovation can be lowered. If they are, and if conditions warrant, decision rules for making and changing resource management may be relaxed. That is, it may become easier for officials or management regime members to propose and win approval for new management rules which would facilitate collective action concerning RNRM.

At the same time, a clear danger exists. If necessary safeguards in the form of restrictions on the capacity of majorities of regime members to authorize constitutional changes do not exist or are abrogated, it may become too easy for majorities at the local level to introduce RNRM operations at the expense of minorities. If that happens, the viability of RNRM operations may be seriously undermined as disgruntled minorities take direct action to protect their interests.

#### Conclusions: Facilitating Collective Action Concerning Sahelian Renewable Natural Resources

The points made in this subsection suggest that efforts to ensure sustained-yield management of Sahelian RNRs are likely to be complex. They will involve a series of problems, typically not all at the same scale. For this reason, and because of the weight of transaction costs in influencing the decisions of individual actors involved in RNRM activities, multiple regimes will often be necessary to ensure efficient management of even a single resource. Institutions are expensive to create. It is thus important to explore the RNRM potential inherent, first through privatization of control over RNR and then through existing local regimes before creating new ones. At the same time, if existing general purpose regimes cannot adequately handle the additional burden of activity required to manage an RNR effectively, it may very well be appropriate to create a special district(s) or jurisdiction(s) to manage the resource.

Such regimes must enjoy authoritative powers to create the framework of authorized and authoritative relationships necessary to facilitate both individual and collective action concerning resources under management. If local regimes enjoy authority to make, modify, and enforce RNRM rules, probabilities are good that local officials and others, acting as "public entrepreneurs," will gradually develop efficient RNRM concerns that are supported by resource users. If those same regimes have local processes by which they can change their constitutions in controlled ways after due deliberation and subject to safeguards for the fundamental rights of all regime members and resource users, experimentation in improvement of RNRM institutions is likely to occur.

D. Enhancing Dispute Resolution Capabilities to Promote Efficient Renewable Natural Resource Management

The issue of dispute resolution is both critical and often ignored in designing and analyzing projects, or RNRM activities. When legal problems (e.g., property rights disputes concerning RNR), are not resolved, they can seriously impede or totally block efforts to exploit and manage contested RNR. Attention to the existence and exercise of authoritative relations concerning dispute resolution in going concerns involved in RNRM can provide critical insights into both problems and opportunities in RNRM.

The same factors of problem size and transactions costs figure in this analysis as in the analysis of appropriate scales for RNRM regimes. The issues can be illustrated by the proposed extension of the natural forest management practices developed at Guesselbodi National Forest to very large regions of natural brushwood around Niamey. In some sites, proposed approaches envisage collaboration by the Forestry Service and rural producers to manage brushwood for fuelwood production, exploitation of in-forest pastures and browse, and production of a variety of other secondary forest products. In other sites, it is assumed that local people will be able to organize woodstock management at the forest level, within the framework of an overriding system of supervision of fuelwood cutting, regeneration management, and marketing to be put in place by the Forestry Service.

These activities, whether undertaken with or without direct guidance from the Forest Service, will require considerable reorganization of existing patterns of behavior. All approaches agree that users should be vested with certain property rights over the resources they will be expected to manage. Various approaches to the problems of brushwood forest exploitation, regeneration, and use are proposed. Included as options are forestry cooperatives along lines tested at Guesselbodi; exploitation of brushwood tracts organized by local communities as appropriate; and leases to private entrepreneurs let by either the local community which has ownership rights to a brushwood tract, or by the Forest Service where there is no community in the immediate neighborhood of the forest.

Rules will be developed over time to implement management operations, and ensure investment in regenerating brushwood resources, and authorize controlled exploitation practices. These rules place legal constraints on the liberty of individual users to exploit the resource in order to maintain or enhance the RNR and thus the value of the liberty of exploitation.

A critical issue here turns on authority to enforce the RNRM rules that develop over time. Both members and officials of

management concerns can be expected to make rough calculations about the value of pursuing any potential enforcement action. If individuals who identify infractions of use rules or abuses of power by concern officials conclude that it is worthwhile to try to sanction infractions or correct abuses--or have them sanctioned or corrected by an appropriate official--then the working rules concerning management of the RNR are likely to be relatively predictable and congruent with the formal rules of management.

However, if members and officials consider recourse too expensive for them in terms of what they will personally gain from the transaction, then the working rules may be predictable, but they will not likely conform to formal management rules. Instead, RNR mismanagement or undermanagement will result from the working rules, as individual or official users find they can ignore authorized rights and duties, and exercise a large unofficial liberty to exploit the RNR in question.

Who then is authorized to enforce RNR use and management regulations? This question is critical because it raises the issue of the transaction costs of enforcement proceedings, and the likelihood that recourse will be invoked by members or officials of RNRM going concerns. If local regimes (e.g., officials of Bakel Region villages which have created local irrigation systems, headmen, or Muslim clerics in Majjia Valley villages where windbreaks have been established, Pastoral Association officials in Mali's Inner Delta Region, or Pastoral Unit officials in Eastern Senegal, etc.), can enforce RNR rules, transaction costs will be low. If infractions can only be respectively sanctioned by SAED officers, Bouza Arrondissement foresters, Malien civil administrators or ODEM project employees, or by Senegal administrators or PDESO personnel, costs of recourse will be relatively higher. Probabilities of enforcement will weaken correspondingly.

A second set of issues concerning recourse relates to the degree to which rule enforcement and dispute resolution procedures are perceived by members of the going concern, officials, and outsiders to be fair and predictable or potentially biased and subject to abuse of power. Where the former situation exists, temptation to violate use rules is reduced because it is perceived that the dispute resolution system treats disputants equitably and sanctions are more predictable. Where enforcement or dispute resolution procedures can be rigged and manipulated, achieving an enforceable decision becomes more difficult and expensive. Transaction costs rise under such circumstances, and discourage people from trying to maintain RNRM rules as enforceable rules of conduct.

Two further points bear mentioning here. First, national administration officials and civil servant technicians concerned

with RNRM will probably have to play a critical backup enforcement role. For instance, if a local RNRM regime has difficulty enforcing its duly adopted use rules, it should be possible for regime officials to obtain support from administrators and technicians. Such support should be offered when requested, if a brief review of the situation indicates there is prima facie grounds for believing RNRM regime officials are acting in an appropriate manner.

Second, attempts to devolve RNRM power to local regimes will involve certain risks. Among these are abuse of power by regime officials, and the possibility of bloodshed as competing groups of RNR users struggle to defend their interests in a particular resource. Such incidents are clearly regrettable, but they should not be grounds for withdrawing RNRM authority from the local level. Rather, the authority of local regimes and processes for dispute resolution should be strengthened, subject to continued respect for due process as understood by local resource users.

E. Enhancing Public Financing Capability of Local Renewable Natural Resources Management Regimes

1. General Considerations

Previous sections of this paper have explored the characteristics of RNR regarding the effects of both nonrivalry and nonexclusion in necessitating collective action to create, expand, and maintain RNR, and operate them in an efficient manner. Efforts to enhance and strengthen local RNR management regimes and to examine possibilities for local public financing capability is based on the recognition that, for the most part, rural RNR systems confer their benefits over a relatively small geographic area. Consequently, the framework for the following analysis of local public finance of RNR assumes no substantial geographic spillovers of benefits or costs beyond the boundaries of the local RNR regimes here considered.

Public financing capability will often be a critical factor determining the capacity of local regimes--quarters, villages, cantons, special districts--to provide the support necessary to ensure that RNR attain appropriate levels of resource base and service flow. The case studies and analysis of institutional considerations regarding RNR presented above indicate several areas or purposes for which locally raised revenues or resources in-kind would be integral to the creation or expansion of the resource base of RNR and to the provision of a sustained flow of services from it. These purposes include:

- costs of creation or expansion of RNR resource base;
- costs of establishment of a management and planning agency;
- costs of maintenance, repair, and operation;
- costs of exclusion, collection of fees, and enforcement of regulations regarding use;
- external costs of use of services of RNR;
- costs of harvesting production of a publicly operated resource; and
- operating costs of publicly operated agencies for distribution and marketing of final goods produced by RNR.

Two rather different perspectives underlie the following analysis for potential public finance or control of rural RNR by local organizations. One perspective assesses the need for local support in line with the objectives for existing RNR as established in proposed or ongoing projects. Here, available nonlocal financial and other support as well as the local activities and organizational goals embodied in the project are taken as given. The question for local finance is: how can resources be acquired to perform the activities assigned to local participants under the existing or proposed RNR regime? The second perspective approaches the question of local public finance of an RNR by deriving the appropriate local contribution, methods of raising revenue, and setting of regulations regarding use from the theory of optimum investment and operation of RNR. The guiding principle, as with all use of economic resources, is economic efficiency, i.e., the use of resources to the point where marginal benefits equal marginal costs.

While there is substantial literature on the economics of RNR which discusses optimum conditions and policies to reach them, the necessary assumptions regarding institutional arrangements, technical knowledge, and information on preferences makes application extremely difficult--especially to the kinds of local RNR discussed in this paper. Furthermore, the goals of managing these RNR include consideration of distributional equity, not taken into account in efficiency criteria for RNR. Nevertheless, concepts of efficiency as applied to RNR do have a place in proposing and evaluating alternative sources of local finance and regulatory provisions to be enforced through local bodies. Therefore, in the following discussion of how localities might deal with each of the items specified above, consideration will be given to potentially feasible methods of financing activities assigned and to what economic efficiency

considerations suggest regarding how local finance should be utilized to maximize benefits from RNR.

## 2. Local Finance of RNR

The previous section has identified seven areas or purposes for which local resources would be appropriate in support of RNR regimes. What principles or guidelines can be provided as to how each of these purposes can or should be accomplished?

### Creation or Expansion of RNR Base

Efficiency considerations require that a decision to create or expand the resource base of RNR be justified by consideration of the expected present value of net benefits. Determination of this expected present value is no mean feat, and is particularly difficult for RNR projects where future benefits hinge on the establishment and maintenance of local regimes for system maintenance. Since the rural RNR under consideration here are presumed to yield benefits over a limited area, there is a basis for assigning the financing of the capital costs of the creation or extension of the resource base to the local residents who are expected to benefit from the project. Practically, this means that the government authorities encompassing the population of the benefit area would raise the revenues through taxation or other assessment. Assessment of contributions to capital costs by families and producing units should be in proportion to their expected net benefit from the services of the RNR. This benefit will depend on the quantity of services they anticipate receiving from the RNR and the value of these services to them--either as final consumption or as intermediate inputs into the production of marketed output.

Where land tenure rights support the use of a property tax and local government jurisdictions have the legal authority and technical capacity to administer revenue and expenditure programs, it is customary to finance a capital improvement which yields benefits to a clearly demarcated user group by a special assessment. Funds are borrowed by the governmental authority and annual taxes increased to cover interest and amortization. The share of the capital costs borne by each taxpayer is proportional to property ownership or to some other measure of benefit, (e.g., street frontage). Where the investment is for a commercial resource which does not affect private property values directly, as in improvements to a fishing bank, alternative arrangements such as increased charges for licenses and permits are used.

In the Sahel, a number of considerations rule out finance via local property taxation. The most fundamental is that, due to land tenure arrangements and weak local administrative capacity, there are virtually no rural land taxes in the Sahel. This prohibits local borrowing and subsequent repayment through

property tax revenue. In the absence of regular property taxation, an alternative would be a single, one-time capital cost levy on families with traditional land use rights, or perhaps a levy imposed on a village basis with the amount of the levy varying with some measure of benefit such as land area and proximity to RNR service flows. Even this presents probably insuperable difficulties in rural areas lacking cadastral surveys. A further obstacle to a one-time assessment on families is that in the Sahel, land tenure rules do not allow those who have rights to rural land to sell it. Thus, there is no way for those who have the right to use the land to capitalize the benefits of the RNR and utilize the increased value of their holdings to finance such a levy.

As described in some of the case studies, in practice, something similar to a single assessment for capital construction sometimes does occur. If regulations regarding use are reasonably well-enforced, it is possible to make contributing to the construction or improvement of an RNR a condition of continued entitlement to use of the land as well as to any RNR services subject to exclusion. Such contribution, of course, results in no abrogation of obligations to pay user fees or taxes to support operating costs. Contributions of this sort generally take the form of in-kind services--usually labor. A more formalized alternative here is possible in countries that continue to use some form of rural head tax. While this tax generally is objected to on the grounds that it does not take ability to pay into account, this is not a disadvantage in terms of financing the capital costs of RNR where presumptive future benefits should determine tax liability. A village- or region-specific supplement to the regular annual head tax and to the livestock tax (for projects providing services useful for husbandry) in those areas expected to benefit from the RNR would impose burdens roughly proportional to expected benefits. An option might be to accept labor services in lieu of payment where such inputs were useful. The problem which remains here is that even if the present value of the future benefits exceeds costs of the work on the RNR, rural farmers and peasants have no way of financing relatively large current costs, and neither does the local rural authority.

Despite the locally circumscribed benefit area of these rural-based RNR projects, the difficulty of estimating the expected present value of net benefits of a RNR, the absence of a source of local revenue that can apportion contributions in line with expected benefits, the scarcity or nonexistence of loan funds for rural projects, and concerns for regional and sectoral redistribution all militate for "outside" sources of funds for capital investments in RNR. Particularly for the major expansion or creation of a new RNR, or a major expansion or renovation of an existing RNR, the central government, directly through its budgetary resources or indirectly through negotiations with

external donors, virtually always provides the major share of finance for any capital expenditures or major renovations.

#### Cost of Establishment or Improvement of Managerial and Planning Capacity

This area has many similarities to that of capital construction. It is a cost whose benefits redound to the entire RNR benefit group. Benefits to local residents should at least be equal to the costs of establishing this capacity. The problem here, again, is lack of a suitable tax base where there is no property tax. Contributions of local labor can be helpful for construction of office facilities and housing for officials, where these are required. Organizing local groups and establishing regulations regarding use requires some trained personnel, in concert with vehicles and other support services. The importance of knowledge of local conditions and customs suggests that along with professionally skilled staff participation, it is essential to include local residents who have received on-the-job training. Funds for the professional staff, along with services contributed by local staff, are needed. While there is some significant potential for local resource mobilization here, outside funds also seem essential, and all of the projects surveyed have funds budgeted for this purpose.

#### Maintenance, Repair, and Operation

Once a capital facility such as RNR is created, costs must be incurred in order to deliver a flow of services. Day-to-day operation usually requires manpower as well as inputs of raw materials. If maintenance and repairs are not carried out over time, the capital stock deteriorates so that increasingly fewer outputs result from the applications of labor and other inputs, and eventually, deterioration may become so severe that no amount of inputs can provide certain outputs formerly available. What considerations apply to local financing of these costs?

The economic principles here are clear. They sharply distinguish two cases. One such as irrigation water, is where additional consumption of the services provided by the RNR is associated with marginal costs of maintenance, repair, and operation (referred to below simply as operational costs). This applies to the rival goods and services produced by the common property features of RNR. The second case arises when consumption is nonrival such as the windbreaks provided by the trees which augment grazing resources so that additional consumers do not impose extra maintenance, repair, or operating costs since they all can share in consuming whatever amount is produced. Here, since there is no marginal cost associated with additional consumption, no one who is a potential beneficiary should be excluded from consuming. Under these circumstances,

charges for use are inefficient and other means of finance need to be employed.

### Rival Services and User Charges

As for the rival common property services (e.g., water), fiscal principles imply that their users should be charged in accordance with the costs they impose in supplying the services. This results in an efficient use of the resource because the user charge acts like a price and prevents excessive consumption where the benefit to the user is below the marginal cost of producing the service. A frequent problem which arises in implementing this approach is that most RNR produce some sort of joint product (e.g., water supply and flood control), and it requires a great deal of technical knowledge to assign its marginal contribution to costs to each of the products. Another salient feature of RNR which creates difficulties for financing their operating costs is that much of their output takes the form of services which present problems of exclusion (e.g., improved grazing where range land is not fenced). Thus, even if the contribution of each unit of consumption to marginal cost were known, it is often impossible to collect from users.

Local fiscal policy regarding covering the costs of rival services from RNR then depends heavily on whether exclusion is feasible. For some goods, exclusion is literally impossible. For others, it is possible but costly. The next section discusses financing exclusion costs as part of the local fiscal responsibility for RNR. Here, it is important to point out that public policy responses to exclusion difficulties can take several forms. One policy is to incur the costs necessary to establish the capacity to exclude and then collect a fee or charge from users of a publicly operated RNR which includes exclusion costs. For example, this would ensue if there were a guardian at a public well who collects fees for its use. Even here, it is possible to limit access to a selected group (e.g., those who financed the construction of the well) prohibiting outsiders from purchasing the water. An alternative form of exclusion involves preventing nonpayers from consuming, but not allowing general use, as when a pasture or field is fenced-in and only a select group is permitted to use it or when guardians protect trees from being cut.

### Rival Services and Local Taxation

If exclusion, establishment, and collection of user fees are too costly or not feasible for other reasons, recourse has to be made to alternative means of financing local contributions to operating expenses. If the local authority has the power, the alternative is to tax owners or users of the land an amount determined by the utilization of the services of the RNR. Thus, while lack of exclusion precludes a fee or user charge per unit

of service, a levy can be imposed based on presumptive use of the service. If the use of the land can be exclusively reserved to the landholder/taxpayer, this form of taxation is more readily acceptable since the exclusion ensures that the service is solely consumed by the taxpayer. The problem here, as with the financing of capital investment in rural RNR, is that in the absence of a system of rural property, there is no suitable tax base to serve as a proxy for ownership for the use of the RNR services. In Sahelian countries, the traditional village head tax appears to be the only possibility. Allowed to vary across villages in accordance with the availability of RNR services and within villages according to the utilization of services depending on family circumstances and characteristics, a supplement to the annual head tax in villages served by a RNR regime could be established. Knowledge of local circumstances by local organizations would enhance the feasibility and equitability of this source.

Still another approach to local funding of operational costs is the method described above where common fields are cultivated and the proceeds applied to operating costs. The rules and regulations which establish and enforce the size of the common area and distribution of responsibilities for tending the fields are crucial to the maintenance of the arrangement. If there is a close link between responsibilities assigned to families and their utilization of the services of the RNR, then the scheme would seem equitable. If not, problems are likely to arise due to dissatisfactions and feelings of exploitation. In addition, the proceeds from the common fields need to be roughly equal to the costs of maintenance, repair, and operation of the RNR. It would be useful to examine operational schemes of this sort to observe what linkages, if any, there are between the financial yield of these fields and actual RNR operating expenditure, and to observe how funds are handled and administered.

However, it should be noted that the local tax approaches and common field method all have the same deficiency in that they provide no disincentive to consumption of as much of the common property resource services as users can obtain consistent with their providing positive net benefits--regardless of the marginal costs of producing the service. However, this feature of these taxes makes them suitable for covering the operating costs of any public good aspects of the RNR. Here, the objective is to distribute the marginal costs of the given amount of the public good produced (e.g., better air, windshelter) without providing any disincentive to consume it. In practice, the public good aspects of RNR are likely to be modest and this favorable feature of taxes unrelated to actual consumption is far outweighed by the negative consequences for the rival common property outputs of RNR.

### Other Approaches

For some services, it is possible to circumvent the absence of exclusion and still tax consumers for marginal costs imposed. The approach is to tax an input used as a complement to the nonexcludable services of the capital facility. The classic illustration of this is taxation of vehicles, tires, and gasoline to cover the marginal costs of road usage. There are inputs complementary to services of certain RNR, such as seeds and fertilizer, which complement irrigation water. Unlike tires and gasoline (needed by all who drive the highways), fertilizer and seed are used by many who do not have access to local RNR. Consequently, a general tax on them would impinge on many who are not using the services of the RNR. Where local markets for such complementary inputs are isolated or where a supply of inputs is provided as a component of the RNR project, consideration might be given to a special tax which would function to recover operating costs. To apply this approach, careful studies would be necessary to establish the relation between specific inputs and use of RNR services and to determine the marginal costs of different services.

Another possible approach to local revenues to cover operating costs applies to marketed goods whose production is enhanced by RNR projects. A local sales tax on goods for which services of the RNR are significant inputs, set at a level determined by the marginal costs of the inputs, would recoup these costs. Apart from establishing the proper level of tax, there are many obvious limitations here. Costs associated with goods used for own consumption or of bartered goods would not be recovered. Such a tax should not raise prices or reduce profitability of production because the tax serves as a charge for otherwise free inputs which raise productivity in the area where they are available. However, implementation of such a policy would require coordination of sales tax policies among adjacent regions. Inadequate coordination would result in dislocation and inequitable burdens on residents of areas with and without RNRs. A further difficulty here is that local jurisdictions in the Sahelian countries have virtually no experience in collection of sales taxes.

### Exclusion, Collection of Fees, and Enforcement of Regulations Regarding Use

As mentioned in the previous section, the capacity to exclude is a critical element in the potential for local finance. Where services of RNR can be measured in discrete units and quantities consumed by individual users identified, charges can be levied by local agencies. In such cases, the fees collected can be used to cover the costs of exclusion and collection as well as operating costs. It should be recognized that for some services, the costs of collection may exceed the marginal costs

and benefits of the inputs for which the fees or charges are being levied. This is the usual conclusion of those who have examined the potential of fees for well water.

Exclusion by construction of fences or by posting of guardians prevents free-riding and therefore, makes taxation of land holders more palatable. This type of exclusion generates primarily private benefits, and there is little rationale for it being publicly financed. The obstacle to such private activity is the usual reluctance of land users to engage in agricultural investments under tenure regimes that do not provide title to rural land. Under certain circumstances, exclusion provides social benefits rather than private benefits--as in the case of the windbreak trees that must be protected from foraging livestock until they reach a certain height. Here, the costs of guardians should be included in the local taxes levied to finance the construction of the windbreaks. However, normally, this would be part of the outside funding provided for improvement of the resource base of the RNR.

Exclusion costs also arise regarding the harvesting of private marketable goods on publicly maintained areas of RNR. Those managing the RNR may sell (or auction) the rights to harvest these goods to private entrepreneurs who would bear the burden of guarding the crop. If the RNR management were to harvest and sell the output, the costs of those who guard against unauthorized appropriation should be paid out of the sales proceeds of the harvested products.

Costs of administering the enforcement of regulations regarding the use of the rival services of the RNR are extremely important. With the exception of the limited potential for user charges, all other methods of covering operating costs of RNR provide no serious incentive for economizing in the use of these scarce services. The key to ensuring acceptable (if not optimal rates) of use of RNR lies in establishment and enforcement of these regulations. To the extent that resources rather than custom and tradition are involved in achieving adherence to the regulations, local public funds will be needed. The costs of this enforcement are properly borne by those who will benefit, i.e., those entitled to receive the services. Once again, a property-based tax would be most suitable, but in the absence of such taxes in rural areas, the village head tax appears to be the only available possibility.

#### External Costs of Use of Services (Stock Externalities)

One of the standard problems of the efficient rate of utilization of common property resources is that, in deciding how much of the RNR services to use, an individual takes account only of his or her costs of using the resource and equates this to the

marginal benefit. This generally leads to excessive utilization of RNR because the lower the stock (e.g., supply of water), the more costly it is to produce another unit of service or output. An illustration is that upstream diversion of water raises the costs of obtaining a unit of water downstream. Economists call this a stock externality and normally, would try to eliminate it by taxing the use of the water to raise its price to a level that would reflect not only the marginal costs of producing it, but also the extra cost imposed by reducing the stock. The purpose of such a tax is not to raise revenue, but to control use to avoid degradation of the resource base.

Generally, it does not seem feasible to use local finance to adjust for this problem regarding RNR. For irrigation water, where user charges are more easily utilized, the charges can be set to include these external costs (if they are known). For marketed products which use RNR services subject to stock externalities, the appropriate policy would be a tax surcharge, but as was said above, it is generally not feasible to collect sales taxes to cover local RNR costs. The inescapable conclusion here is that, with rare exceptions, if excessive exploitation of the resource base of rural RNR is to be avoided, it has to be through the establishment and enforcement of regulations regarding use and not through incentives conveyed through prices and taxes.

#### Harvesting Publicly Produced Final Products

Local public resources are needed here to pay for workers, vehicles, and other inputs needed to harvest products grown on public lands. The obvious approach is to use the proceeds from the sale of the products to defray harvesting costs. Even if there are some rights to this produce by local residents, enough can be held out for private sales to cover these costs. It may be advantageous to assign some of those willing to trade labor services for monetary tax obligations to the task of harvesting, and use the funds garnered from sales to pay for materials and supplies needed in the operation of the RNR and not available from in-kind contributions.

As alluded to above, another approach here is to sell or auction rights to harvesting to private traders. This has obvious advantages in RNR reducing burdens or hard-pressed managerial capacity.

#### Marketing and Distribution of Final Goods

If the management of the RNR decide that local products can better be distributed and marketed by an agency of the RNR regime than by independent traders and merchants, operating costs will be incurred. As in the finance of harvesting above, the costs of this operation should be funded out of sales. Local managers

will have to decide on prices to charge for marketed goods. In the absence of counter-indications, there are strong arguments for setting prices at market level (i.e., at the prices charged in local markets).

### 3. Summary and Conclusions

As pointed out in several of the case studies, a major obstacle to more effective management of rural RNR is the lack of clear property rights to land in rural areas. This difficulty plagues efforts to enhance local fiscal capability in meeting the financial requirements of the development and sustaining of RNR. Expansion of user charges wherever possible is a long-standing and appropriate prescription, but only a small portion of RNR services are suitable for the required metering of quantity called for by this method of finance. Dedication of proceeds from common fields can help cover operational costs when the RNR contributes to marketable products, but depending on how assignments to work the field are determined, it may not distribute the burden in proportion to the benefits received from the RNR. The village head tax, so long in disrepute, holds some interesting promise since it can be varied within a given village based on family situation related to use of RNR services and across villages to reflect accessibility to RNR services. Marketed goods that emerge as a publicly owned by-product to RNR (e.g., firewood on windbreaks) should probably be sold or auctioned to private merchants unless traditional views of property rights would undermine the policy.

## VII. STRATEGIES TO ENHANCE POPULAR CONTROL OVER AND PARTICIPATION IN MANAGEMENT OF SAHELIAN RENEWABLE NATURAL RESOURCES

### A. Introduction

Feasibility of proposals to decentralize control over RNR is based on the perceptions of Sahelian governors that the balance of incentives and disincentives favors the change. Weighing against decentralization are the vested interests of many bureaucrats and technicians in maintaining control over RNR; for instance, of the protracted resistance of the Malien Forestry Service to shift control over RNR to rural producers. Two other concerns that leaders should consider to some degree include: first, delegation or devolution of control involves risks that semi-autonomous local decision makers will further damage rather than renew the RNR base; and second, authorizing groups to organize at local levels involves some risk that collective power will be used for political purposes other than those intended.

Two factors favor a move toward decentralization. First, environmental degradation and falling agricultural productivity is coupled with growing perceptions among decision makers (based on real examples) that rural producers can manage resources effectively. Second, donor conditionality ties provision of funds to policy changes. Both considerations may be problematic as far as Sahelian officials are concerned, but they can change officials' priorities. Through NGO- and donor-financed projects and structural adjustment lending, Sahelian countries are permitting delegation of power to subnational, and sometimes, even local levels. A number of projects have been successful over the last decade in creating practical examples of the advantages of decentralized control of RNR. Examples include PDES in Senegal; diverse, project-financed efforts in Burkina Faso promoting village land management; and in Niger, the Central and Eastern Livestock Project, and the Guesselbodi, Majjia Valley, and Cantonal Land Management forestry and agroforestry operations in the western half of the country.

Most of these projects have operated in an incremental, sometimes temporarily extra-legal manner, in terms of promoting user control over resources. This strategy has advantages-- chiefly, that it tends to avoid politicizing delicate issues. However, many of these operations are now reaching the point where existing rule systems impede further progress. Significant changes in the legal, organizational, and financial frameworks for decentralized management of RNR must now occur. Translation of experimental changes into more widespread practices promoting involvement of users in making and implementing RNRM decisions

can and should continue to be incremental, to permit accrued experience to inform future efforts at control transfer.

At present, most decentralization in the renewable resources area takes the form of delegation rather than devolution. This reflects the constitutions of sahelian states. All are formally single-center polities. In principle, authority that the center decentralizes can be reclaimed. However, successful management of resources may institutionalize the transfer of control authority to lower levels within these polities.

Donor coordination should insist on:

- transfer of property rights over RNR to local users wherever and as soon as possible;
- devolution of appropriate rule-making power to local officials so they can devise RNRM rules appropriate for their situations;
- devolution of enforcement powers to local officials responsible for RNRM through general or special purpose districts, with attention to structuring dispute resolution procedures so they are transparent and reliable; and
- devolution of public-financing authority to local regimes.

These generic recommendations will now be discussed in more detail.

B. Transfer of Renewable Natural Resource Property Rights to Producers

This is currently a sensitive but important issue. The objective is to create incentives for producers to invest in and manage RNR for sustained-yield by ensuring that they will reap the benefits of such actions, rather than seeing them taken by free-riders or government officials exercising authoritative or determining powers.

Critical points to bear in mind are: (a) there are many methods of achieving this objective; (b) the character of the handover will involve privatization of RNR property rights in some cases, but control by groups or public jurisdictions in others; and (c) the handover process can be incremental in nature as well as total and completed in one step. If producers are already managing some RNR effectively in terms of local working rules, it is possible and highly desirable to transfer full control over resources to them, confirming the de facto control

they already enjoy. Bakel Region village irrigation systems illustrate this situation. Complete transfer of control is also possible where producers are not already fully managing resources, if rights and duties concerning the RNR in question are clearly explained to all parties beforehand, and adequate provision is made for authoritative support of authorized relationships where necessary. The PDES0 and ODEM livestock projects illustrate different stages of this scenario, as well as some of the difficulties in ensuring adequate management.

In other situations, a gradual process of transfer may be most effective. The slowly growing involvement of producers, through membership in the Guesselbodi Forestry Cooperative, in forestry management decisions as well as in the benefits of sustained-yield forest exploitation, illustrates one sort of limited transfer. It is not clear that producers will become co-managers of Guesselbodi Forest RNR, but there seems to be no question that many already find their limited involvement highly attractive. Attempts to extend control over RNR in brushwood forests around Niamey will probably progress toward complete transfer. However, the National Forest Service will probably retain supervisory control for a long period while producers master production and organizational techniques indispensable to maintain efficient exploitation of these RNR.

### C. Devolution of Authoritative Powers to Local Jurisdictions

#### 1. Jurisdiction Scale Problems

Case materials presented in this report indicate that most RNRM systems are complex and require multiple levels of regimes or jurisdictions to ensure efficient and equitable management. Local irrigation and water management systems, such as those described in Senegal's Bakel and Casamance Regions, encounter problems at the level of the production unit, and irrigation perimeter or micro-watershed level. Frequently, producers or their officials see a need for inter-system coordination, and find that this service is best provided through a supra-local jurisdiction such as the Bakel irrigators' Federation. Jurisdictions at the irrigation perimeter or micro-watershed and supra-local levels are special districts organized to deal with a series of specific problems. Finally, certain technical, input supply, and marketing services may be best handled through even larger regimes.

The same is true for pasture management problems. Particular areas of pasture are best managed by individual users or small groups of herders. For instance, organization of relationships among local production units for boundary maintenance and possible controlled temporary exchange of grazing

rights in years where some units have abundant forage resources and others not, will probably require a larger jurisdiction. Even larger jurisdictions may be necessary to work out relationships between transhumant pastoral groups and users of other resources in the territories they frequent during certain periods of the annual production cycle, e.g., the Inland Delta of the Niger, or the agro-pastoral and agricultural zones of most Sahelian states.

Upon close analysis, woodstock management also turns out to be a multilevel problem. Trees on individual fields may be best managed by those who use those fields. However, a small-scale jurisdiction may be necessary to provide woodstock policing services, particularly during those periods of the year when producers do not frequent their fields. The same applies to natural forest areas. They may be best managed by private individuals or enterprises, or by small groups, but small jurisdictions may provide the best supervision in the first instances of those activities. These jurisdictions might patrol areas under management to ensure that use regulations, particularly cutting rates and woodstock regeneration procedures, are respected. Arrondissement- or cercle-level Forest Service units could provide technical support with silvicultural problems. They might also serve as a backup support mechanism in terms of enforcing locally developed use rules.

Most RNR, if the case studies presented in this paper are indicative, require more than one regime for effective management. Governments and donors should explicitly recognize this multilevel aspect of RNRM, and work to create conditions in which users have a range of regimes through which to organize management efforts, and from which to draw support of various types on an ad hoc basis.

Special districts are quite different from general purpose jurisdictions (village, canton, arrondissement, governmental units) which deal with a wide range of problems. Members of special districts often share common concerns about a limited set of problems, so it may be somewhat easier to achieve consensus. Special districts are also quite efficient in focusing the attention of a small number of officials on providing the target services. Since special district officials deal with a limited set of problems, it is much easier for members of such jurisdictions to make competent judgments about the performance of officials. If water does not flow, or political lobbying does not produce desired results, producers are likely to be able to pinpoint causes. Such a high level of accountability is rarely found in general purpose jurisdictions, both because of the range of problems and the diverse and potentially conflicting interests of jurisdiction members.

In light of numerous and different scales of problems involved in RNRM, donors and governments should authorize general purpose jurisdictions at several levels to address these issues. Governments should also permit creation of special purpose jurisdictions to deal specifically with RNRM questions. If producers think their interests would be served by creating such jurisdictions, they should authorize that initiative.

## 2. Renewable Natural Resource Authoritative and Authorized Relationships

Sahelian governments and donors should devolve or delegate authority to local regimes at several levels to design and operate RNRM systems. This will involve authorizing local jurisdictions to make, apply, and modify local RNRM working rules. The purpose of such devolution is to reduce the transaction costs of organizing to producers, when their experiences convince them organization would be worthwhile. Producers should be empowered by acting through existing general purpose jurisdictions, or through special purpose jurisdictions created specifically to deal with RNRM problems, to set, experiment with, and modify management systems. If they know such systems can be designed to meet local needs and deal with local problems using procedures producers are familiar with and believe they can control, producers may become less resistant to introduction of controls of RNR exploitation. If transaction costs are low enough, public entrepreneurs such as village headmen, local notables, cooperative leaders, and canton chiefs will find it attractive to experiment with RNRM institutions.

An important issue to be decided is whether transfer of authoritative powers concerning RNRM should be conditioned on a formal expression of willingness by local jurisdictions to take responsibility for managing RNR. It can be argued that such a condition should be a sine qua non on the grounds that RNR will otherwise be devastated by users intent on profiteering or satisfying imperative short-term needs. However, RNR users may consider that collective management for some or all of the resources within a jurisdiction is unnecessary. They may conclude this either because of an abundance of specific RNR, or because they believe private individuals will manage target resources adequately. On balance, it is probably appropriate to simply delegate RNRM authority, even at the risk of resource degradation, and let local communities pursue their opportunities as they see fit. Such a system will certainly facilitate local initiative in RNRM.

Devolving or delegating RNRM authority to local communities will require state framework legislation (laws, ordinances, or decrees). Framework may be incorporated in specific RNR codes, or through rural codes that broadly address issues of land use management. Formal rules of these types should always be drawn

as frameworks only, with responsibility for changing the content left to the officials of local jurisdictions actually involved in RNRM.

### 3. Dispute Resolution Powers

In all cases where RNRM authority is devolved or delegated to local jurisdictions, such units should be allowed to make and change management rules, apply them as necessary, and resolve cases of dispute concerning the working rules for managing RNR. Such authoritative powers can be abused. Therefore, it is necessary to provide for channels of appeal from the decisions of local moots and courts. In general, appeals judges should avoid overturning local decisions except in situations where these are patently unfair or abusive. Otherwise, most local decisions will be appealed by the losing litigant, and the transaction costs of RNRM dispute resolution may escalate to the point where RNRM is not feasible.

## VIII. REFERENCES

- Adams, Adrian. 1977. "The Senegal River Valley: What Kind of Change?" Review of African Political Economy, No. 10, (September-December): 33-59.
- Adelski, Elizabeth. 1978. Socioeconomic Report on the Wadis in Cheddra, Kanem. Ndjama, Chad: CARECHAD.
- BIEP/FAO. 1986. Developpement de Ouadis du Kanem, Document de Projet. Ndjama, Chad: Bureau Interministeriel d'Etudes et de Programmation/ Food and Agriculture Organization.
- Commons, John R. 1959. Legal Foundations of Capitalism. Madison, Wisconsin: University of Wisconsin.
- Conte, Edouard. 1983. Marriage Patterns, Political Change and the Perpetuation of Social Inequality (in South Kanem, Chad). Paris, France: ORSTOM.
- Hammond, Peter B. 1966. Technology in the Culture of a West African Kingdom: Yatenga. New York, New York: Free Press.
- Horowitz, Michael M. with the assistance of Eric J. Arnould, Robert B. Charlick, John H. Eriksen, Ralph H. Falkingham, Curt D. Grimm, Peter D. Little, Michael D. Painter, Thomas M. Painter, Candelario Saenz, Muneera Salem-Murdock and Margaret O. Saunders. 1983. Niger: A Social and Institutional Profile. Binghamton, New York: Institute for Development Anthropology.
- Kiser, Larry L. and Elinor Ostrom. 1982. "The Three Worlds of Action: A Metatheoretical Synthesis of Institutional Approaches." In Strategies of Political Inquiry, Elinor Ostrom, ed., 179-222. Beverly Hills, California: Sage Publications.
- Linares, Olga F. 1981. "From Tidal Swamp to Inland Valley: On the Social Organization of Wet Rice Cultivation among the Diola of Senegal." Africa, 51 (2): 557-595.
- Marchal, Jean-Yves. 1979. "L'Espace des techniciens et celui des paysans; histoire d'un périmètre antiérosif en Haute-Volta." In Maîtrise de L'espace agraire et développement en Afrique tropicale; logique paysanne et rationalité technique. Actes du colloque de Ouagadougou, 4-8 décembre 1978. Paris, France: ORSTOM.

- Marchal, Jean-Yves. 1982. "Société, espace et désertification dans le Yatenga (Haute-Volta), ou la dynamique de l'espace rural soudano-sahélien." Ph.D. Dissertation. Paris, France: ORSTOM.
- Miller, Richard Paul. 1985. Peasant Autonomy and Irrigation: Innovation in the Senegal River Basin. Cornell Studies in Irrigation, No. 4. Ithaca, New York: Cornell University.
- Oakerson, Ronald J. 1986. "Common Property and Collective Action in Economic Development." In Proceedings of the Conference on Common Property Resource Management, 13-29. Washington, DC: National Academy Press.
- Olson, Mancur. 1965. The Logic of Collective Action: Public Goods and the Theory of Groups. Cambridge, Massachusetts: Harvard University Press.
- O.M.V.S. 1980. Etude Socio-Economique du Bassin du Fleuve Senegal (Edition Provisoire). Dakar, Senegal: Organisation Pour la Mise en Valeur du Fleuve Senegal.
- Ostrom, Vincent and Elinor Ostrom. 1972. "Legal and Political Conditions of Water Resource Development." Land Economics, Vo. XLVIII, No. 1 (February): 1-14.
- Painter, Thomas M. 1987. "Bringing the Land Back; Changing Strategies to Improve Agricultural Production in the West African Sahel." In Lands at Risk in the Third World; Local-Level Perspectives, Peter D. Little and Michael M. Horowitz, eds., 144-163. Boulder, Colorado: Westview Press.
- Painter, Thomas M., Roger J. Poulin, David Harmon and Douglas Barnett. 1985. Development Management in Africa: The Case of the Niamey Department Development Project in Niger. Evaluation Special Study No. 36. Washington, D.C: U.S. Agency for International Development.
- Patterson, William McC. 1984. "Village Irrigation Systems Along the Senegal River: A Comparative Analysis." Ph.D. Dissertation. Ithaca, New York: Cornell University.
- Republic of Niger. 1985. Evaluation Comparative de la Formation et de ses Retombées au Sein des Projets Productivité de Maradi, Niamey et Zinder. Niamey, Niger: Ministère du Plan, Direction de l'Evaluation et de la Programmation des Projets, Cellule d'Appui et Synthèse.

- Rondinelli, Dennis A. 1981. "Government Decentralization in Comparative Perspective: Theory and Practice in Developing Countries." International Review of Administrative Sciences, Vol. XLVII: 137-139.
- Runge, C. Ford. 1986. "Common Property and Collective Action in Economic Development." In Proceedings of the Conference on Common Property Resource Management, 31-52. Washington, DC: National Academy Press.
- Seymour, Matt, Laura McPherson, and David Harmon. 1985. Development Management in Africa: The Case of the Bakel Small Irrigated Perimeters Project in Senegal. Evaluation Special Study No. 34. Washington, D.C.: U.S. Agency for International Development.
- Sidikou, Hamidou A. and Robert B. Charlick. 1985. Study of Local Organizations in Niamey Department, Niger. Washington, D.C: Development Alternatives, Inc.
- TAMS. 1985. Senegal River Basin Irrigation Review. Washington, D.C: Tippetts-Abbett-McCarthy-Stratton.
- Thomson, James T. 1980. "Preliminary Evaluation: OXFAM Micro-Catchment Project, Ouahigouya, Upper Volta." Draft paper submitted to OXFAM/Ouahigouya, May 8.
- USAID/Niger. 1980. Project Paper: Niamey Department Development Project, Phase II (683-0240). Niamey, Niger and Washington, D.C.: United States Agency for International Development.
- USAID/Senegal. 1987. Project Identification Paper, Southern Zone Water Management Project (685-0295). Dakar, Senegal: United States Agency for International Development.
- Waldstein, Alfred S., Djime Adoum, Wendy H. Ascher and Eric Johnson. 1988. Study of Irrigation Communities in Chad: Phase I Report. Burlington, Vermont: Associates in Rural Development, Inc.
- Weil, Peter M. 1981. Human Resources and Socio-Economic Constraints: The Lower Casamance Master Plan Project. Chicago, Illinois: Harza Engineering Corporation.